R.Happer
https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId={097F059B-4AC6-4542-A1C7-613BEB1165B0}&documentTitle=20158-113190-03
REBUTTALS TO: Martin, Hanemann, Polasky
SURREBUTTALS BY: Abraham, Dessler, Gurney
.
p.4 "These witnesses lack adequate formal training in the physical sciences, physics, chemistry, meteorology, oceanography, biology or other areas needed to assess the scientific performance of climate models. All the witnesses uncritically accept computer model predictions of climate change from the Intergovernmental Panel on Climate Change (IPCC). They discuss economic models built on these seriously flawed science models. Accordingly, their assessments of the social cost of carbon (SSC) are invalid for reasons already discussed in my testimony."
"The myth that more CO2 is harmful comes from:"
p.5 IPCC overestimates CS and underestimates improvement of more CO2 to agriculture.
p.6 "My opinion is that the sensitivity is somewhere between 0.5 C and 1.5 C, with a most likely value close to the feedback-free sensitivity, which is approximately 1 C. At the current rate of fossil fuel use, many centuries will be needed to cause a temperature increase of 2 C. This modest warming will be beneficial to humanity and other life on earth."
p.7 Cites D'Aleo and Watts, testimony challenged and stricken.
p.13 Cites Habibullo Abdussamatov in OMICS journal (infamous predatory open access) as a credible source, as well as Hermann Harde in another one.

In the Matter of the Further Investigation into

Environmental and Socioeconomic Costs

Under Minnesota Statute 216B.2422, Subdivision 3

OAH Docket No. 80-2500-31888

MPUC Docket No. E-999-CI-14-643

Exhibit _____

Rebuttal Testimony and Exhibits of

Professor William Happer

August 12, 2015

Q. Please state your name.

A. William Happer.

Q. Did you previously submit testimony in this proceeding?

A. Yes. I submitted pre-filed direct testimony on June 1, 2015.

Q. Have you reviewed other pre-filed testimony?

A. Yes. I reviewed written testimony by Michael Hanemann, Nicholas Martin, and Stephen Polasky.

Q. Have you prepared a rebuttal report that responds to this pre-filed testimony?

A. Yes, I have prepared a report, which is attached as Happer Rebuttal Exhibit 1.

Q. Have you responded to discovery requests in this proceeding?

A. Yes. I was asked to provide evidentiary support for certain statements. My responses, which are attached as Happer Rebuttal Exhibit 2, show there is ample evidentiary support for each of my statements.

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS FOR THE

MINNESOTA PUBLIC UTILITIES COMMISSION

STATE OF MINNESOTA

In the Matter of the Further Investigation in to Environmental and Socioeconomic Costs Under Minnesota Statute 216B.2422, Subdivision 3

OAH Docket No. 80-2500-31888

MPUC Docket No. E-999-CI-14-643

Exhibit 1

To

Rebuttal Testimony of William Happer

Professor of Physics, Emeritus

Princeton University

August 12, 2015

William Happer Rebuttal Report

This rebuttal report responds to Direct Testimony before the Office of Administrative Hearing of the Minnesota Public Utilities Commission, In the Matter of the Further Investigation into Environmental and Socioeconomic Costs Under Minnesota Statute § 216B.2422, Subdivision 3. I have reviewed written testimony by

- Michael Hanemann
- Nicholas Martin
- Stephen Polasky

These witnesses lack adequate formal training in the physical sciences, physics, chemistry, meteorology, oceanography, biology or other areas needed to assess the scientific performance of climate models. All the witnesses uncritically accept computer-model predictions of climate change from the Intergovernmental Panel on Climate Change (IPCC). They discuss economic models built on these seriously flawed science models. Accordingly, their assessments of the social cost of carbon (SSC) are invalid for reasons already discussed in my testimony.

CO2 is not a pollutant

There can only be a social cost for carbon if more atmospheric CO2 is a negative externality, that is, if the emission of CO2 into the atmosphere does more harm than good. As I outlined in my testimony of June 1, 2015 “Benefits of CO2,” under current emissions projections more CO2 in the atmosphere will be a net benefit. The myth that more CO2 is harmful comes from:

- Major overestimates of the climate sensitivity in IPCC climate models. Observations over the past two decades indicated that the warming from doubling CO2 is closer to 1 C, or less than to the 3 C to 3.5 C assumed in most IPCC models. The warming from large increases in CO2 will therefore not exceed

The past 2 decades is rather carefully chosen.

2 C, a beneficial value for any reasonable emissions scenarios over the next few centuries.

- Most economic models fail to account for the major benefits to agriculture from more CO2. These agricultural benefits have been documented by thousands of experiments that have been published in the peer-reviewed literature. There are two main reasons for the benefits: 1) more CO2 increases the photosynthetic efficiency of C3 plants, including most agricultural crops and all forests, by countering O2 interference in the photosynthetic process, and 2) more CO2 substantially decreases the requirements of plants for water, so they are less susceptible to drought.

I therefore disagree with Professor Hanemann's statement (on p. 13 of this testimony) that "from an economic perspective, GHGs are pollutants as much as mercury, lead, fine particulates or carbon monoxide."

Climate models have grossly over-predicted warming.

This was the point made by Fig. 4 and Fig. 5 of my testimony, "Benefits of CO2." We are talking about very substantial over-predictions of warming compared to observations. As the great physicist Richard Feynman correctly pointed out about any scientific theory "If it disagrees with experiment, it's wrong." I do not deny that more CO2 WILL cause some amount of global warming. But as I stated in my opening testimony, the most important question is how much the increase will be. I accept the logarithmic dependence of temperature increase on CO2 given as Eq. (1) of my testimony2015 "Benefits of CO2." But the IPCC has pushed credible limits of every factor they can think of to inflate the climate sensitivity from a feedback-free value around 1 C to a positive-feedback value of 3 C to 3.5 C. And now they are stuck with a recalcitrant Nature that pays no attention to the flawed IPCC climate models. As I stated in my opening testimony, observations over the past two decades show that computer models have exaggerated the warming caused by additional

CO2 by several hundred percent. My opinion is that the sensitivity is somewhere between 0.5 C and 1.5 C, with a most likely value close to the feedback-free sensitivity, which is approximately 1 C. At the current rate of fossil fuel use, many centuries will be needed to cause a temperature increase of 2 C. This modest warming will be beneficial to humanity and other life on earth. Paleoclimate disagrees, and there is ocean acidification.

CO2's benefits to agriculture have been understated.

This was the point made by Fig. 7 and Fig. 8 of my testimony, "Benefits of CO2." Minnesota will double-dip on agricultural benefits. Not only will increased CO2 lead to more productive agricultural and forestry, and to more drought resistance. But as a northern state, Minnesota will benefit from the longer growing season that will go with modest warming.

Alarmist scenarios have no basis in science.

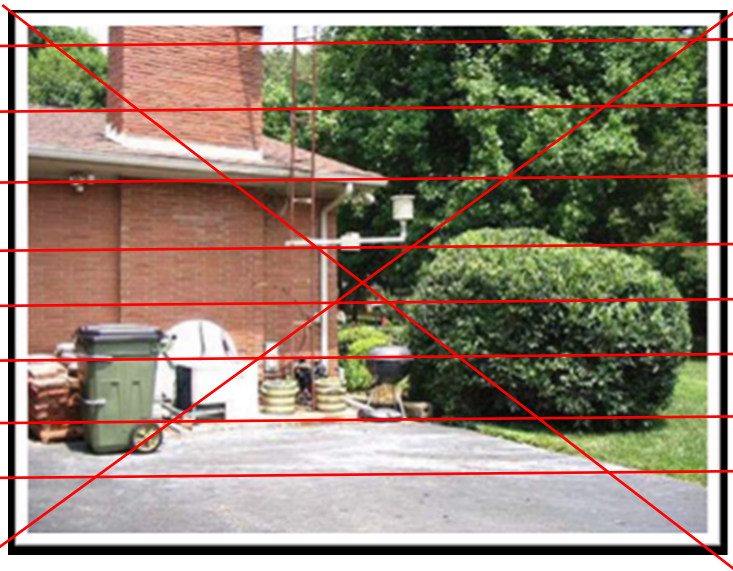
Professor Polasky's testimony talks extensively about "catastrophic events," "tipping points," and that "the social cost of carbon can be essentially infinitely high" (page 19). He ignores the fact that the earth has had much higher CO2 levels than now over most of the 550 million year history of multicellular living organisms, as shown in Fig. 6 of my testimony "Benefits of CO2," with no evidence that high CO2 levels ever induced catastrophic climate change.

Professor Polasky ignores the observational evidence that the doubling sensitivity has to be much less than the 3 C to 3.5 C taken as "most likely" by the IPCC, he talks about 6 C temperature rise. Even for the IPCC "most likely" doubling sensitivity of S = 3 C, this would take 600 years at the current growth rate of 2 ppm/year, as shown in Fig. 2 of my testimony, " Benefits of CO2." There probably is not enough economically recoverable fossil fuel to cause at temperature rise of 6 C for more realistic doubling sensitivities, close to the feedback-free value of S = 1 C.

Measurement errors.

As I pointed out in my initial testimony, ground-based warming measurements are known to have serious systematic errors associated with the loss of observing stations and urban heat island effects, both of which bias the results to more warming than actually exists. ~~For example, the photo below is a picture of a ground-based temperature sensor in Hopkinsville, Kentucky (the white coffee-can-shaped item extended out on the piping in the middle). Given the measurement sensor's location directly over the BBQ grill, one is left to wonder whether it skews hot on summer weekends and holidays like Memorial Day and July 4th.~~

This was challenged, and stricken in 201511-115402-01.



Actually, SPPI became a front for the Idso family's Center for the Study of Carbon Dioxide and Global Change - Rob Ferguson was CSCDGC's highest paid employee, and except for web support, SPPI seems to have been a one-man site, whose mailing address was a PO box in a UPS store in walking distance from his house.
It was fossil-funded, but no seems moribund - last post was December 2015.
http://scienceandpublicpolicy.org/
http://www.desmogblog.com/sites/beta.desmogblog.com/files/fake2.pdf
pp.77-82 includes a discussion of structure, IRS Form 990s, money flows. Ferguson had gotten Exxon and Koch money, via multiple routes.
Happer, a Member of the NAS, seemed to think this was credible source to present to judge.

https://en.wikipedia.org/wiki/Science_and_Public_Policy_Institute is a little out of date

~~(citation: Joseph D'Aleo & Anthony Watts, Sci. & Pub. Policy Inst., Surface Temperature Records: Policy Driven Deception? 29 (Jan. 27, 2010)).~~
http://scienceandpublicpolicy.org/science-papers/originals/policy-driven-deception

The Government Accountability Office and many other sources have also expressed concerns over the reliability of ground-based temperature data. [1]

[1] See, for example, Judith Curry, "Has NOAA 'busted' the pause in global warming?" June 4, 2015, available at http://judithcurry.com/2015/06/04/has-noaa-busted-the-pause-in-global-warming/.
de Freitas, C.R., Dedekind, M.O. and Brill, B.E. 2014. A reanalysis of long-term surface air temperature trends in New Zealand. Environmental Modeling and Assessment: 10.1007/s10666-014-9429-z.

Additional evidentiary support for my opinions

Finally, attached to this rebuttal report are copies of my responses to the discovery requests of certain parties in this proceeding, which provide citations and additional support regarding certain elements of my testimony.

In particular, I was asked to provide evidentiary support for the following statements:

- "A small increase [in temperature] will be a net benefit to the Earth."
- "Observations are consistent with little, and perhaps even negative feedback, corresponding to doubling sensitivities of S = 1 K or less."
- "Even the lower limit, 1.5 K, is hard to reconcile with the almost complete lack of warming since the year 1998."
- "And ground-based warming are known to have serious systematic errors associated with the loss of observing stations and urban heat island effects, both of which bias the results to more warming than actually exists."
- "If the benefits of more atmospheric CO2 were properly accounted for, they would far outweigh the losses and the social cost of more CO2 would be negative."
- "Most studies suggest that warmings of up to 2 K will be good for the planet."

As the attached discovery responses show, there is ample evidentiary support for each of my statements.

Government Accountability Office, NOAA Can Improve Management of the U. S. Historical Climatology Network, GAO-11-800 (2011).
Wang, C., Zhang, L., Lee, S.-K., Wu, L. and Mechoso, C.R. 2014. A global perspective on CMIP5 climate model biases. Nature Climate Change 4: 201-205.
Yang, X., Hou, Y. and Chen, B. 2011. Observed surface warming induced by urbanization in east China. Journal of Geophysical Research 116: 10.1029/2010JD015452.

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS FOR THE
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In the Matter of the Further Investigation in to Environmental and Socioeconomic Costs Under Minnesota Statute 216B.2422, Subdivision 3

OAH Docket No. 80-2500-31888
MPUC Docket No. E-999-CI-14-643
Exhibit 2
to

Rebuttal Testimony of
William Happer
Professor of Physics, Emeritus
Princeton University
August 12, 2015

CLEAN ENERGY ORGANIZATIONS
INFORMATION REQUESTS

Date of Request: July 6, 2015

Requested By: Leigh Currie
Minnesota Center for Environmental Advocacy
26 East Exchange Street, Suite 206
St. Paul, MN 55101-1667
lcurrie@mncenter.org
651-287-4873 (direct)

Attorney for Izaak Walton League of America – Midwest Office, Fresh Energy, Sierra Club, and Minnesota Center for Environmental Advocacy (collectively "Clean Energy Organizations")

Requested From: Peabody Energy

Response Due: July 16, 2015

In the Matter of the Further Investigation into Environmental and Socioeconomic Costs Under MN Statute 216B.2422, Subdivision 3

PUC Docket No. E999/CI-14-643

INFORMATION REQUESTS NOS. 2-10 OF CLEAN ENERGY ORGANIZATIONS TO PEABODY ENERGY

To Roger Bezdek:

2. On pages 2, 9, and 16 of his Direct Testimony, Dr. Bezdek references "thousands" of studies demonstrating that carbon dioxide is beneficial to plant growth. Provide citations for the studies that purport to demonstrate that increased carbon dioxide emissions and increased global temperature will result in increased crop production.

RESPONSE:

Please see response contained in the attached Exhibit A.

3. On page 8 of his Direct Testimony, Dr. Bezdek states: "Researchers have thus concluded that IAMs are of little or no value for evaluating alternative climate change policies and estimating the SCC." List the names of the researchers who have reached these conclusions and provide citations to the publications in which those researchers have made those statements.

RESPONSE:

To William Happer:

9. Provide the basis (including, as appropriate, citations to the peer-reviewed literature in which these statements have been published) for the following statements:

    a. *p. 5, line 12: "A small increase will be a net benefit to the Earth." In addition to providing a basis for this statement, please define "small" as used in this statement.*

RESPONSE:

Professor Happer's report states: "If increasing CO2 causes large warming, harm can indeed be done, and it makes sense to talk about a social cost of carbon. Most studies suggest that warmings of up to 2 K will be good for the planet. So if more CO_2 does not cause warming of more than 2 K, the additional CO2 will be beneficial and the social cost of carbon will be negative." (Happer Report at 3.) That is the context in which he is using the word "small."

The benefits of warming are explained in the Happer Report at 8-11. Further support includes the report and testimony of Robert Mendelsohn in this proceeding, as well as the following:

David Anthoff & Richard S.J. Tol, "The Impact of Climate Change on the Balanced Growth Equivalent: An Application of FUND," 43 Envt'l & Res. Econ. 351 (2009).
C.M. Bennett, *et al.*, "Shifts in the Seasonal Distribution of Deaths in Australia, 1968-2007," 58 Int'l J. Biometeorology 835 (2014) (finding that ratio of mortality in summer months versus winter months has risen since 1968, driven by fewer deaths in winters.
R. A. Berner and C. Kothavala, Geocarb:III, a revised model of atmospheric CO2 over the Phanerozoic time, American Journal of Science, 301, 182 (2001).
J. Cheng, *et al.*, "Impact of Diurnal Temperature Range on Human Health: A Systematic Review," 58 Int'l J. Biometeorology 2011 (Feb. 18, 2014).
N. Christidis, *et al.*, "Causes for the Recent Changes in Cold- and Heat-Related Mortality in England and Wales," 102 Climatic Change 539 (2010).
Roy F. Darwin & Richard S.J. Tol, "Estimates of the Economic Effects of Sea Level Rise," 19 Envt'l & Res. Econ. 113 (2001).
J. K. Dippery, D. T. Tissue, R. B. Thomas and B. R. Strain, Effects of low and elevated CO2 levels on C3 and C4 annuals, Oecologia, 101, 13 (1995).
Randall J. Donohue, *et al.*, "Impact of CO2 Fertilization on Maximum Foliage Cover Across the Globe's Warm, Arid Environments," 40 Geophys. Rsch. Letters 1 (June 2013).
J. Ronald Eastman, *et al.*, "Global Trends in Seasonality of Normalized Difference Vegetation Index (NDVI), 1982-2011," 5 Remote Sensing 4799-4818 (2013).
J.B. Fisher, *et al.*, "African Tropical Rainforest Net Carbon Dioxide Fluxes in the Twentieth Century," 368 Philosophical Transactions of the Royal Society B 1625 (2013).
Gerber, S., J. Fortunat, and I .C. Prentice. 2004. "Sensitivity of a dynamic global vegetation model to climate and atmospheric CO2" *Global Change Biology* 10: 1223–1239.
Guo, Y., Gasparrini, A., Armstrong, B., Li, S., Tawatsupa, B., Tobias, A., & Williams, G. (2014). Global Variation in the Effects of Ambient Temperature on Mortality: A Systematic Evaluation. *Epidemiology*, 25(6), 781-789.

S. B. Idso and B. A. Kimball, Effects of the enrichment of CO2 on regrowth of sour orange trees (Citrus aurantium; Rutacea) after copicing, Am. J. Bot. 81,843 (1994).

Idso, C. et al, 2000, Ultra-enhanced spring branch growth in CO2-enriched trees: can it alter the phase of the atmosphere's seasonal CO2 cycle?, 43 Environmental and Experimental Botany 91 (April 2000).

Kimball, B. A. 1983. "Carbon Dioxide and Agricultural Yields: An Assemblage and assessment of 430 prior observations" *Agronomy Journal* 75: 779-788.

M. B. Kirkham, Elevated Carbon Dioxide, Impacts on Soil and Plant Water Relations, CRC Press. Boca Raton (2011).

P. Michael Link & Richard S.J. Tol, "Estimation of the Economic Impact of Temperature Changes Induced by a Shutdown of the Thermohaline Circulation: An Application of FUND," 104 Climatic Change 287 (2011).

Robert Mendelsohn, "The Impact of Climate Change on Agriculture in Asia," 13 J. Integrative Agric. S2095 (2013).

Mendelsohn et al., *The Impact of Global Warming on Agriculture: A Ricardian Analysis,* 84 AM. ECON. REV. 753, 769 (1994).

Mendelsohn, R. and J. Neumann (eds.) 1999. *The Impact of Climate Change on the United States Economy* Cambridge University Press, Cambridge, UK.

Mendelsohn, R and A. Dinar. 2009. *Climate Change and Agriculture: An Economic Analysis of Global Impacts, Adaptation, and Distributional Effects.* Edward Elgar Publishing, England.

Mendelsohn, R. 2001. *Global Warming and the American Economy: A Regional Analysis*. Edward Elgar Publishing, England.

Daiju Narita, *et al.*, "Economic Costs of Extratropical Storms under Climate Change: An application of FUND," 53 J. Envt'l Planning and Mgmt. 371 (April 2010).

Roger A. Sedjo & Brent Sohngen, "What are the Impacts of Global Warming on U.S. Forests, Regions, and the U.S. Timber Industry?," 12 Penn. St. Envt'l L. Rev. 95 (Winter 2004).

S. Niggol Seo, *et al.*, "A Ricardian Analysis of the Distribution of Climate Change Impacts on Agriculture across Agro-Ecological Zones in Africa," 43 Envt'l. & Res. Econ. 313 (2009).

Ying Sun, *et al.*, "Impact of Mesophyll Diffusion on Estimated Global Land Co2 Fertilization," 111 Proceedings Nat'l Acad. Scis. 15774 (Nov. 4, 2014).

Richard S.J. Tol, "On the Uncertainty About the Total Economic Impact of Climate Change," 53 Envt'l & Res. Econ. 97 (2012).

R.S.J. Tol, "Targets for global climate policy: An overview," 37 Journal of Economic Dynamics & Control 911, 912 (2013).

Richard S.J. Tol, Corrigendum to "Targets for global climate policy: An overview," Journal of Economic Dynamics & Control 42 (2014) 121.

Richard S.J. Tol & Hadi Dowlatabadi, "Vector-Borne Diseases, Development & Climate Change," 2 Integrated Assessment 173 (2001).

Richard S.J. Tol & Sebastian Wagner, "Climate Change and Violent Conflict in Europe over the Last Millennium," 99 Climatic Change 65 (2010).

Jinxia Wang, *et al.*, "The Impact of Climate Change on China's Agriculture," 40 Agric. Econ. 323 (2009).

J. Wilcox, & D. Makowski, "A Meta-Analysis of the Predicted Effects of Climate Change on Wheat Yields Using Simulation Studies," 156 Field Crops Research 180 (2014).

D.D. Zhang, *et al.*, "Climate Change and Large-Scale Human Population Collapses in the Pre-Industrial Era," 20 Global Ecology and Biogeography 520 (2011).

b. *p. 8, line 1: "Observations are consistent with little, and perhaps even negative feedback, corresponding to doubling sensitivities of S = 1 K or less."*

RESPONSE

Abdussamatove is a Russian astophysicist who has been predicting cooling for a long time.
OMICS is an especially infamous predatory open access (vanity) publisher, https://scholarlyoa.com/

Habibullo Abdussamatov, "Current Long-Term Negative Energy Balance of the Earth Leads to the New Little Ice Age," 2 Journal of Geology and Geophysics 113 (2013), available at http://omicsgroup.org/journals/grand-minimum-of-the-total-solar-irradiance-leads-to-the-little-ice-age-2329-6755.1000113.php.

J. R. Christy, http://energycommerce.house.gov/sites/republicans.energycommerce.house.gov/files/He112-IF03-WState-ChristyJ-20120920.pdf.

Judith Curry, "The Global Warming Statistical Meltdown," *Wall Street Journal* (Oct. 9, 2014).

J. C. Fyfe, N. P. Gillett, F. W. Zwiers, Overestimated Global Warming over the Past 20 Years, 3 Nature Climate Change 767 (2013).

John Christy, *CEQ Draft Guidance for GHG Emissions and the Effects of Climate Change*, http://naturalresources.house.gov/uploadedfiles/christytestimonyemr.pdf

H. Harde, Advanced Two Layer Climate Model for the Assessment of Global Warming by CO2, 1 Open Journal of Atmospheric and Climate Change (Nov. 2014), DOI: 10.15764/ACC.2014.03001.

Nicholas Lewis, "The implications for climate sensitivity of Bjorn Stevens' new aerosol forcing paper," Mar. 15, 2015, http://climateaudit.org/2015/03/19/the-implications-for-climate-sensitivity-of-bjorn-stevens-new-aerosol-forcing-paper/.

N. Lewis & J.A. Curry, "The Implications for Climate Sensitivity of AR5 Forcing and Heat Uptake Estimates," *Climate Dynamics* (Sep. 25, 2014), available at http://link.springer.com/article/10.1007%2Fs00382-014-2342-y#page-1.

Richard Lindzen, *et al.*, "Does the Earth Have An Adaptive Infrared Iris?," 82 Bull. Am. Meteorological Soc'y 417 (Mar. 2001), available at http://www-eaps.mit.edu/faculty/lindzen/adinfriris.pdf.

Richard Lindzen & Yong-Sang Choi, "On the Determination of Climate Feedbacks from ERBE Data," 36 Geophys. Rsch. Letters L16705 (2009), available at http://www.drroyspencer.com/Lindzen-and-Choi-GRL-2009.pdf.

R.S. Lindzen and Choi, Y.-S., "On the Observational Determination of Climate Sensitivity and Its Implications." *Asia-Pacific Journal of Atmospheric Science* 47: 377-390, 2011.

Thorsten Mauritsen & Bjorn Stevens, "Missing Iris Effect as a Possible Cause of Muted Hydrological Change and High Climate Sensitivity in Models," __ Nature Geosci. __ (Apr. 20, 2015) (advance online publication), available at http://www.nature.com/ngeo/journal/vaop/ncurrent/full/ngeo2414.html.

Ross R. McKitrick, "HAC-Robust Measurement of the Duration of a Trendless Subsample in Global Climate Time Series," 4 Open J. Statistics 527 (2014).

Hermann Harde is a retired Materials Science/Physicist from Helmut Schmidt U (German military academy), involved in 2013 visit by Murry Salby. Earlier work was refuted as very poor: http://rabett.blogspot.com/2011/03/toy-model.html then: http://rabett.blogspot.com/2014/10/harde-is-very-wet.html
http://rabett.blogspot.com/2014/10/all-wet.html Scientific Online is in the list at https://scholarlyoa.com/publishers/
http://www.scipublish.com/journals/ACC/ is yet another predatory open access journal.

Patrick J. Michaels & Paul C. Knappenberger, "The Collection of Evidence for a Low Climate Sensitivity Continues to Grow," *Cato Institute* (Sep. 25, 2014), available at http://www.cato.org/blog/collection-evidence-low-climate-sensitivity-continues-grow.

Christopher Monckton, *et al.*, "Why Climate Models Run Hot: Results from an Irreducibly Simple Climate Model," 60 Sci. Bull. 122 (2015), available at http://wmbriggs.com/public/Monckton.et.al.pdf.

Roy Spencer, report and testimony in this proceeding.

R. Spencer, http://www.drroyspencer.com/latest-global-temperatures/

Bjorn Stevens, "Rethinking the Lower Bound on Aerosol Radiative Forcing," __ J. Climate __ (2015) (early online release), available at http://journals.ametsoc.org/doi/abs/10.1175/JCLI-D-14-00656.1.

Peter Stott, *et al.*, The Upper End of Climate Model Temperature Projections is Inconsistent with Past Warming, 8 Envir. Res. Letters (pub. online, Feb. 19, 2013), available at http://iopscience.iop.org/1748-9326/8/1/014024/pdf/1748-9326_8_1_014024.pdf.

c. *p. 8, line 11: "Even the lower limit, 1.5 K, is hard to reconcile with the almost complete lack of warming since the year 1998."*

RESPONSE:

Please see the response to Questions 9b and 9d.

d. *p. 8, line 21: "And ground-based warming are known to have serious systematic errors associated with the loss of observing stations and urban heat island effects, both of which bias the results to more warming than actually exists."*

RESPONSE:

Judith Curry, "Has NOAA 'busted' the pause in global warming?" June 4, 2015, available at http://judithcurry.com/2015/06/04/has-noaa-busted-the-pause-in-global-warming/.

de Freitas, C.R., Dedekind, M.O. and Brill, B.E. 2014. A reanalysis of long-term surface air temperature trends in New Zealand. Environmental Modeling and Assessment: 10.1007/s10666-014-9429-z.

Government Accountability Office, *NOAA Can Improve Management of the U. S. Historical Climatology Network*, GAO-11-800 (2011).

Joseph D'Aleo and Anthony Watts, Surface Temperature Records: Policy Driven Deception? http://scienceandpublicpolicy.org/originals/policy_driven_deception.html?Itemid=0

Sejrup, H.P., Lehman, S.J., Haflidason, H., Noone, D., Muscheler, R., Berstad, I.M. and Andrews, J.T. 2010. Response of Norwegian Sea temperature to solar forcing since 1000 A.D. *Journal of Geophysical Research* **115**: 10.1029/2010JC006264.

Richard Lindzen, Patrick J. Michaels, and Paul C. Knappenberger, Is There No "Hiatus" in Global Warming After All?, Cato Institute Blog, June 4, 2015, available at http://www.cato.org/blog/there-no-hiatus-global-warming-after-all.

Roy Spencer, report and testimony in this proceeding.

Wang, C., Zhang, L., Lee, S.-K., Wu, L. and Mechoso, C.R. 2014. A global perspective on CMIP5 climate model biases. *Nature Climate Change* **4**: 201-205.

Yang, X., Hou, Y. and Chen, B. 2011. Observed surface warming induced by urbanization in east China. *Journal of Geophysical Research* **116**: 10.1029/2010JD015452.

e. p. 12, line 6: "If the benefits of more atmospheric CO_2 were properly accounted for, they would far outweigh the losses and the social cost of more CO_2 would be negative."

RESPONSE:

Please see the response to Question 9a.

f. Exhibit 2, page 3: "Most studies suggest that warmings of up to 2 K will be good for the planet."

RESPONSE:

Please see the response to Question 9a.

To Roy Spencer:

10. Provide the basis (including, as appropriate, citations to the peer-reviewed literature in which these statements have been published) for the following statements:

a. p. 4, line 17: "The models, on average, produce surface warming rates at least twice those observed since the satellite record began in 1979. Models, on average, produce deep-atmosphere (tropospheric) warming rates about 2-3 times those observed over the same period."

RESPONSE:

The core article for the particular claim is: J. C. Fyfe, N. P. Gillett, F. W. Zwiers, Overestimated Global Warming over the Past 20 Years, 3, Nature Climate Change, 767 (2013) (showing that models fail to reproduce either the actual global temperatures or slowdown in the increase over the past 20 years).

Other literature substantiates the argument that climate models tend to warm spuriously compared to real, observed temperatures:

Patrick J. Michaels & Paul C. Knappenberger, "The Collection of Evidence for a Low Climate Sensitivity Continues to Grow," *Cato Institute* (Sep. 25, 2014), available at http://www.cato.org/blog/collection-evidence-low-climate-sensitivity-continues-grow.

Bjorn Stevens, "Rethinking the Lower Bound on Aerosol Radiative Forcing," __ J. Climate __ (2015) (early online release), available at http://journals.ametsoc.org/doi/abs/10.1175/JCLI-D-14-00656.1.