

BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS  
FOR THE MINNESOTA PUBLIC UTILITIES COMMISSION  
STATE OF MINNESOTA

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

**Roy W. Spencer, Ph.D.**

August 12, 2015

1 **Q. Please state your name.**

2 A. Roy W. Spencer.

3 **Q. Did you previously submit testimony in this proceeding?**

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

5 **Q. Have you reviewed other pre-filed testimony?**

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

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

10 A. Yes, I have prepared a report, which is attached as Spencer Rebuttal Exhibit  
11 1.

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

13 A. Yes. I was asked to provide evidentiary support for certain statements. My  
14 responses, which are attached as Spencer Rebuttal Exhibit 2, provide  
15 significant evidentiary support for these statements.

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Exhibit 1

to

**Rebuttal Testimony of Roy W. Spencer, Ph.D.**

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**Roy W. Spencer, Ph. D.**

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I am filing this rebuttal report in response to the testimony of Professor W. Michael Hanemann, on behalf of the Division of Energy Resources of the Minnesota Department of Commerce, in consultation with the Minnesota Pollution Control Agency, Professor Stephen Polasky, on behalf of Clean Energy Organizations, and Nicholas Martin, on behalf of Xcel Energy. All three of these witnesses rely on estimates of the social cost of carbon developed by the U.S. government's Interagency Working Group ("IWG"). Mr. Martin uses the IWG's data and draws his own conclusions.

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In my opening testimony, I discussed the shortcomings in climate models that form the foundation of the IWG's estimates of the social cost of carbon. I explained that recent research suggests that the climate models are too sensitive to CO2 emissions, and that increasing greenhouse gases do not cause as much warming and associated climate change as is commonly believed. These results suggest that any SCC estimates based upon such models will be biased high.

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I am also attaching to this supplemental report my responses to the discovery requests I have received in this proceeding. My discovery responses provide significant evidentiary support for the following statements in my report and testimony:

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*"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."*

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*"[S]urface thermometers are capable of directly measuring temperatures near the surface of the Earth, but tend to have long-term spurious warming effects over land from urbanization effects."*

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*"An increasing number of peer-reviewed studies are suggesting much lower climate sensitivity than the IPCC and its models assume, possibly as low as 1 deg. C or less for a doubling of atmospheric CO2."*

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Exhibit 2

to

**Rebuttal Testimony of  
Roy W. Spencer, Ph.D.  
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  
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**PUC Docket No. E999/CI-14-643**

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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:**

- 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<sub>2</sub> were properly accounted for, they would far outweigh the losses and the social cost of more CO<sub>2</sub> 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>.

- 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/>.
- Alexander M.R. Bakker, “The Robustness of the Climate Modelling Paradigm,” Ph.D. thesis (Jan. 8, 2015), available at <http://dare.ubvu.vu.nl/handle/1871/52184>.
- Paul Ballonoff, “A Fresh Look at Climate Change,” 34 *Cato Journal* 113 (Feb. 24, 2014), available at <http://object.cato.org/sites/cato.org/files/serials/files/cato-journal/2014/2/v34n1-6.pdf>.
- Judith Curry, Presentation to the American Physical Society, “Causes and Implications of the Growing Divergence between Model Simulations and Observations” (Mar. 4, 2014), available at <https://curryja.files.wordpress.com/2014/03/aps-curry.pdf>.
- Judith Curry, “The Global Warming Statistical Meltdown,” *Wall Street Journal* (Oct. 9, 2014).
- H. Douville, *et al.*, “The Recent Global Warming Hiatus: What is the Role of Pacific Variability?,” 42 *Geophys. Resch. Letters* 880 (Feb. 16, 2015).
- 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, “Can Increasing Carbon Dioxide Cause Climate Change?,” 94 *Proceedings of the Nat’l Acad. of Sciences of the United States* 8335 (Aug. 5, 1997), available at <http://www.pnas.org/content/94/16/8335.full>.
- Richard Lindzen & Yong-Sang Choi, “On the Determination of Climate Feedbacks from ERBE Data,” 36 *Geophys. Resch. Letters* L16705 (2009), available at <http://www.drroyspencer.com/Lindzen-and-Choi-GRL-2009.pdf>.
- 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>.
- 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. McKittrick, “HAC-Robust Measurement of the Duration of a Trendless Subsample in Global Climate Time Series,” 4 *Open J. Statistics* 527 (2014).
- T.C. Peterson & M. O. Baringer, “2009: State of the Climate in 2008,” 90 *Bull. Am. Meteor. Soc.* S1 (2009).
- b. p. 5, line 18: “Yes, surface thermometers are capable of directly measuring temperatures near the surface of the Earth, but tend to have long-term spurious warming effects over land from urbanization effects.”*

**RESPONSE:**



The core claim has been documented by the Government Accountability Office: United States Government Accountability Office, NOAA Can Improve Management of the U. S. Historical Climatology Network, GAO-11-800 (2011).

The inaccuracy of surface measurements is becoming more widely known and documented in scientific literature; the first reference below is the original Oke (1973) study documenting that towns with as little as 1,000 population have significant spurious warming effects on measured temperatures. There are as yet no accepted methods for explicitly removing this ubiquitous effect from thermometer measurements.

T.R. Oke, 1973. City Size and the Urban Heat Island. *Atmospheric Environment*, Vol. 7, Issue 8, 769-779.

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.

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.

c. p. 8, line 18: “An increasing number of peer-reviewed studies are suggesting much lower climate sensitivity than the IPCC and its models assume, possibly as low as 1 deg. C or less for a doubling of atmospheric CO<sub>2</sub>.”

### **RESPONSE:**

The following references also include 14 peer reviewed studies supporting climate sensitivity lower than the IPCC central estimate of about 3 deg. C:

Aldrin, M., et al., 2012. Bayesian estimation of climate sensitivity based on a simple climate model fitted to observations of hemispheric temperature and global ocean heat content. *Environmetrics*, doi: 10.1002/env.2140.

Annan, J.D., and J.C Hargreaves, 2011. On the generation and interpretation of probabilistic estimates of climate sensitivity. *Climatic Change*, 104, 324436.

J.C. Hargreaves et al., “Can the Last Glacial Maximum Constrain Climate Sensitivity?” *Geophysical Research Letters* 39: L24702, Doi: 10.1029/ 2012GL053872, 2012

Lewis, N. 2013. An objective Bayesian, improved approach for applying optimal fingerprint techniques to estimate climate sensitivity. *Journal of Climate*, doi:10.1175/JCLID1200473.1.

Lewis, N. and M. Crok, 2014, *A Sensitive Matter: How The IPCC Buried Evidence Showing Good News About Global Warming*, Global Warming Policy Foundation Report No. 13, 65 pp. <http://www.thegwpcf.org/content/uploads/2014/02/A-Sensitive-Matter-Foreword-inc.pdf>

Lewis, N. and J.A. Curry, C., 2014. The implications for climate sensitivity of AR5 forcing and heat uptake estimates. 45 *Climate Dynamics*, 1009 (2015), doi:10.1007/s003820142342y. The most recent science on the issue shows that the errors most likely lie in accounting

- Lewis, N., “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/>.
- Lindzen, R.S., and YS. Choi, 2011. On the observational determination of climate sensitivity and its implications. *Asia-Pacific Journal of Atmospheric Science*, 47, 377-390.
- Lindzen, R.S., M.-D. Chou, and A.Y. Hou (2001) Does the Earth have an adaptive infrared iris? *Bull. Amer. Met. Soc.* 82, 417-432.
- Loehle, C., 2014. A minimal model for estimating climate sensitivity. *Ecological Modelling*, 276, 80-84.
- Masters, T., 2013. Observational estimates of climate sensitivity from changes in the rate of ocean heat uptake and comparison to CMIP5 models. *Climate Dynamics*, doi:101007/s00382-013-1770-4
- Mauritsen, T. and B. Stevens, 2015, Missing iris effect as a possible cause of muted hydrological change and high climate sensitivity in models, *Nature Geoscience*, DOI: 10:1038/NGEO2414.
- 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>.
- Otto, A., *et al.*, “Energy Budget Constraints on Climate Response,” *Nature Geoscience* (pub. online, May 19, 2013), available at <http://www.iac.ethz.ch/people/knuttir/papers/otto13nat.pdf>.
- Ring, M.J., *et al.*, 2012. Causes of the global warming observed since the 19th century. *Atmospheric and Climate Sciences*, 2, 401415, doi: 10.4236/acs.2012.24035.
- A. Schmittner *et al.*, “Climate Sensitivity Estimated From Temperature Reconstructions of the Last Glacial Maximum.” *Science* 334: 1385-1388, 2011
- Skeie, R.B., *et al.*, A lower and more constrained estimate of climate sensitivity using updated observations and detailed radiative forcing time series, 5 *Earth Sys. Dynamics* 139 (2014).
- Spencer, R. W., and W. D. Braswell, 2013. The role of ENSO in global ocean temperature changes during 1955-2011 simulated with a 1D climate model. *Asia-Pacific Journal of Atmospheric Science*, doi:10.1007/s13143-014-0011-z.
- J.H. Van Hateren, “A Fractal Climate Response Function Can Simulate Global Average Temperature Trends of the Modern Era and the Past Millennium.” *Climate Dynamics*, Doi: 10.1007/S00382-012-1375-3 (2013) (applying fractal techniques over both very short and very long spans of time to find an ECS of 2.0 °C ± 0.3 °C).