

S.Spencer

<https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId={BAEFE86B-DA5A-4CA3-97D9-F975B6DB0A91}&documentTitle=20159-113912-06>

REBUTTALS TO: Abraham, Dessler

Spencer insists computed satellite data most accurate, but also cites Anthony Watts in support, several times.

<http://www.skepticalscience.com/Satellite-record-vs-thermometers.htm>

<http://www.skepticalscience.com/Response-Data-or-Dogma-hearing.html>

<http://onlinelibrary.wiley.com/doi/10.1002/2014GL062366/full> volcanoes

<https://climatecrocks.com/2016/01/26/carl-mears-on-climate-data-vs-models/>

NASA GISS Director Gavin Schmidt explains the problems with the sort of model/observations comparisons seen here:

<http://www.realclimate.org/index.php/archives/2016/05/comparing-models-to-the-satellite-datasets/>

~~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

Sur-Rebuttal Testimony

Professor Roy Spencer

September 10, 2015

PROFESSOR ROY SPENCER

OAH 80-2500-31888

MPUC E-999/CI-14-643

TABLE OF CONTENTS

I. Inaccuracy of Climate Models 1
II. Reliability of Satellite Datasets..... 4
III. The Hiatus in Warming..... 11
IV. Equilibrium Climate Sensitivity 15

1 **Spencer Sur-Rebuttal**

2 **Q: Are you the same Roy Spencer who has testified previously in these proceedings?**

3 A: Yes I am.

4 **Q: On what topics will you testify?**

5 A: I will address:

- 6 • The inaccuracy of climate models
- 7 • The reliability of satellite datasets and the conclusions that can be drawn about
- 8 measuring surface temperatures
- 9 • The observed hiatus in warming
- 10 • Equilibrium climate sensitivity

11

12 **I. Inaccuracy of Climate Models**

13 **Q: You summarized your initial testimony as finding that “[t]hree independent**
14 **classes of temperature observations show that the climate models used by governments for**
15 **policy guidance have warmed 2 to 3 times faster than the real climate system over the last**
16 **35 to 55 years.” Do you stand by that conclusion?**

17 A: Yes, I do. Whatever measurement you use, whether surface thermometers, satellites,
18 or weather balloons, the result is the same: the rate of global warming is not nearly as high as
19 the models predicted, which calls into question the scientific reliability and predictive value of
20 the models themselves, and thus invalidating their use for SCC estimates.

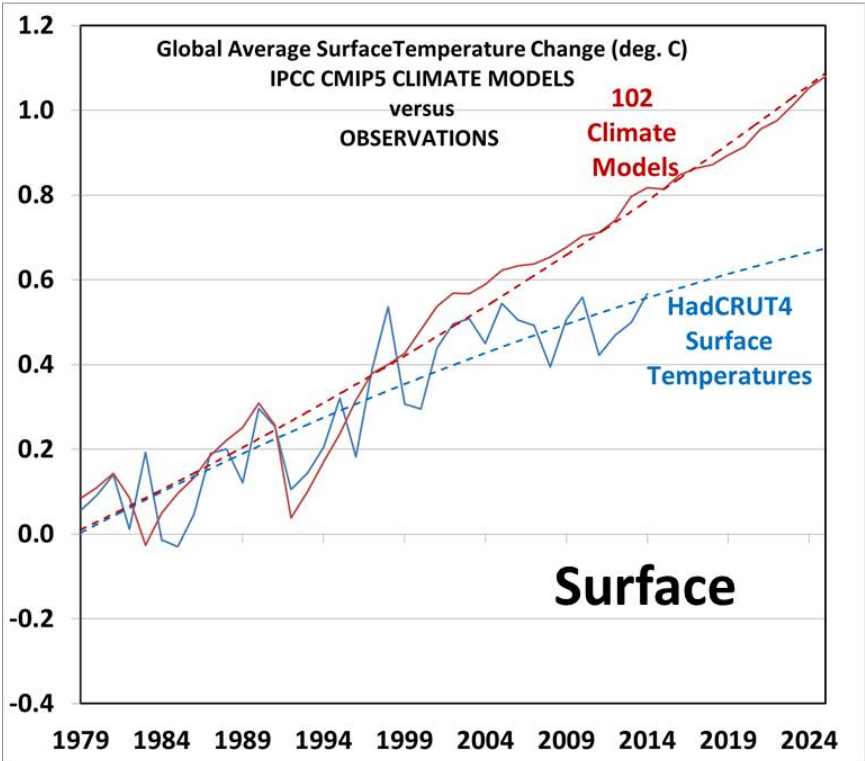
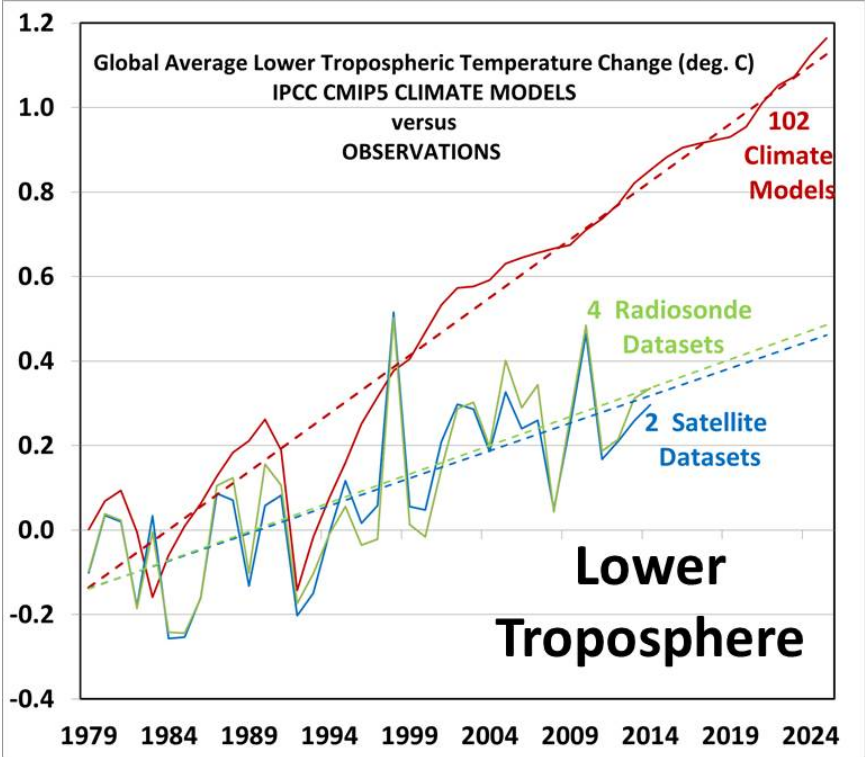
1 This is summarized in the following figure, showing how models have consistently over-
2 estimated warming during the period of greatest greenhouse gas emissions and greenhouse gas
3 concentrations in the atmosphere. There is no “cherry picking” because we can make the point
4 with all three datasets, or with only the surface temperature data that Dr. Dessler believes.

5 We need only look at the HadCRUT4 surface thermometer data most cited by the IPCC,
6 (second panel in the following figure) to see the divergence between the global average surface
7 temperatures and the average IPCC model predictions. Whether we call the recent lack of
8 significant warming a “slow-down” or a “hiatus” or a “pause” is arguing over terminology, when
9 what we should be examining is the quantitative basis for SCC calculations.

10 Specifically, the average surface warming trend across 102 models is 1.5 times as rapid
11 during 1979-2014, but then in the second half of the period (1997-2014) the models’ warming
12 becomes 3.4 times as rapid as in the observations. Thus, during the most recent decades when
13 warming is supposed to be the strongest, the observations show warming actually weakening,
14 and possibly disappearing altogether (as in the RSS satellite dataset during 1997-2014).

15 If the models cannot even explain the past, how can they be relied upon to predict the
16 future?

All 3 Global Temperature Dataset Types Disagree with Climate Models during the Period of Greatest Greenhouse Gas Concentrations



1 **Q: Does any other research validate your conclusion?**

2 A: Yes. For example, researchers from Justus Liebig Universität-Giessen recently
3 examined the longest available temperature observations in Antarctica and found not only an
4 extended hiatus, but also that the pattern of temperature shift (“large and enduring natural
5 excursions from the mean”) reduces supposed anthropogenic warming effects below the level of
6 statistical significance.¹

7 **Q: Dr. Abraham argues that several mutually reinforcing measures show ongoing**
8 **warming, including ocean heat content and changes to surface temperatures across ocean**
9 **and land. Do you agree that these measures show that warming has continued?**

10 A: This issue is not so much whether *some* warming has occurred – I believe it has – *it is*
11 *that the warming has been at a slower rate than can currently be explained by the IPCC models,*
12 *and those models provide the ultimate quantitative basis for social cost of carbon calculations.*
13 The warming has, depending upon the observational dataset used, slowed to near-zero in the last
14 18+ years (see the first panel in the above figure), despite record-high amounts of anthropogenic
15 greenhouse gas concentration.

16 **II. Reliability of Satellite Datasets**

17 **Q: Dr. Dessler “do[es] not view the satellite record as a robust data set.” Can you**
18 **please explain the relevant expertise you possess in order to render an opinion on the**
19 **quality of the data?**

¹ Josef Ludescher, *et al.*, *Long-Term Persistence Enhances Uncertainty About Anthropogenic Warming Of Antarctica*, *Climate Dynamics* 1-9 (April 16, 2015), available at <http://link.springer.com/article/10.1007/s00382-015-2582-5>.

https://www.researchgate.net/profile/Christian_Franzke/publication/275260445_Long-term_persistence_enhances_uncertainty_about_anthropogenic_warming_of_Antarctica/links/55df1c0508ae45e825d50b13.pdf **Spencer misrepresented their paper:**
"warming trend is still not significant in East Antarctica and the Antarctic Peninsula. In West Antarctica, however, the significance of the trend is above 97.4 %, and its magnitude is between 0.08°C and 0.96°C per decade."

1 A: My work on satellite temperature recording earned an “Exceptional Scientific
2 Achievement Medal” from NASA and a “Special Award” from the American Meteorological
3 Society “for developing a global, precise record of earth's temperature from operational polar-
4 orbiting satellites, fundamentally advancing our ability to monitor climate.” I stand by my
5 ongoing peer-reviewed work on this subject and note that both NASA and AMS have recognized
6 its quality. Far from a “well-documented history of errors and inaccuracies” (Abraham
7 Testimony at 22:11), my work has been endorsed for its scientific merit. The satellite datasets
8 have been widely used in the climate research community for over twenty years.

9 **Q: Do you believe the satellite measurements are robust?**

10 A: Yes, I believe they are the most robust measure of temperature trends we have
11 available from any dataset. As I explained in my initial testimony, satellites provide nearly
12 complete global coverage (except for small regions at the poles). They are able to measure deep-
13 layer atmospheric temperatures, without the spurious warming effects over land from
14 urbanization effects that plague land-based thermometers. Further, only the U.S. and Europe are
15 well sampled by thermometers, while most other countries have fair to poor coverage. In
16 addition, oceans are not well sampled with surface thermometers, especially the southern
17 hemisphere oceans.

18 **Q: Does your conclusion depend solely on using data from satellites?**

19 A: No. As the above graphs show, ultimately it does not matter whether one looks at land
20 surface temperatures, sea surface temperatures, deep-ocean temperatures, radiosondes (weather
21 balloons), or satellite measurements: climate models predict warming well in excess of what any
22 of those datasets show.

1 **Q: Drs. Abraham and Dessler point to several peer-reviewed articles showing**
2 **problems with the satellite dataset, such as Mears and Wentz (2005) and Po-Chedley et al.**
3 **(2012). Do you agree that those articles discredit the satellite temperature record?**

4 A: No. Every method of measuring temperature requires adjustments and correction. Dr.
5 Dessler’s criticisms regarding periodic adjustments and corrections required in the satellite data
6 can equally be made regarding the surface thermometer data – yet the surface thermometer data
7 are the data he trusts the most, which is an inconsistency on his part. In fact, surface data (1)
8 have been adjusted on many occasions over the years, and (2) the adjustments almost always
9 lead to increasing warming trends (which is a bit suspicious, because one would expect the
10 adjustments to have effects in either direction, rather than to be biased in favor of increased
11 warming).

12 In the case of our satellite adjustments, two adjustments (orbit decay adjustment [lower
13 troposphere product only] and diurnal drift adjustment) have had the effect of moving
14 temperature trends in one direction, while another adjustment which Dr. Dessler neglected to
15 mention (the instrument body temperature effect) has had the effect of moving data in the other
16 direction. Thus, the adjustments to the satellite data have the hallmarks of scientific validity –
17 generally moving the data in either direction. This is what one would expect from impartial
18 adjustments.

19 It is ironic that Dr. Dessler would highlight Mears and Wentz, who produce their own
20 satellite temperature dataset (“RSS”) which is used more by global warming “skeptics” than our
21 UAH dataset because it shows no warming for over 18 years, while ours shows very slight
22 warming (and much less than models predict). Therefore, their disagreements with us regarding

1 just how specific corrections should be made to the satellite data have little impact on the final
2 temperature trends, and thus on the question at hand: how much warming has occurred in recent
3 decades and does it support social cost of carbon calculations?

4 The Po-Chedley and Fu (2012) paper dealt with disagreement over how much instrument
5 body temperature correction should be applied to a single satellite early in the record, and we do
6 not accept their calculation of either (1) the correction or (2) how much it would impact the final
7 temperature product, since they did not follow through with calculations of how all of the others
8 satellite adjustments would be affected. They merely made an uninformed guesstimate.

9 **Q: Would models predict that satellite data should show faster warming than**
10 **surface measurements?**

11 A: Yes, all climate models predict more warming for the deep troposphere which the
12 satellite measures than for the surface temperature. This enhanced warming has not occurred.

13 **Q: Do the satellite data warm faster than surface measurements?**

14 A: No. If anything, the deep-troposphere has warmed more slowly than surface
15 temperatures have, in contrast to the expectations of climate modelers. New research we have
16 been conducting under a Department of Energy grant suggests the lack of deep-troposphere
17 warming (which then suppresses the surface warming) is due to the deep troposphere not
18 moistening (i.e., gaining humidity) as has been assumed in climate models. This provides yet
19 one more reason that the models have “run hot” and have over-predicted warming.

20 To explain briefly: the troposphere is the part of the atmosphere closest to the Earth’s
21 surface, and is where all weather occurs. It contains 99% of the water vapor and aerosols, and
22 80% of the mass of the entire atmosphere. On average it is about 17km (11 mi) deep. When the

1 high troposphere is moist, it reduces the Earth's ability to cool to outer space through infrared
2 radiation. It also affects the formation of ice crystals in cirrus clouds, which also reduce cooling
3 by emitting infrared radiation (heat) back to the surface. If the troposphere is drier, it will allow
4 more heat to escape through both the humidity and cirrus cloud effect.

5 **Q: Dr. Dessler also criticizes using data from radiosondes. Do you agree that this**
6 **data is also unreliable?**

7 A: No. Out of three basic types of measurements (surface thermometers, radiosondes,
8 and satellites) it would seem unlikely that the latter two are wrong yet so closely match each
9 other (see the first panel the above illustration), while in Dr. Dessler's view both should be
10 excluded in favor of the surface thermometer measurements ... which still disagree with IPCC
11 model projections over the last few decades.

12 So, while Dr. Dessler claims we are "cherry picking", it is he who only accepts one of the
13 three measurement types, yet we use all three measurement types to claim warming has not
14 progressed as fast as models predict. Thus, we maintain it is Dr. Dessler who is cherry picking.

15 In addition, it is worth pointing out that while Dr. Dessler criticizes the use of radiosonde
16 data, Po-Chedley and Fu (2012), whom he cites, disagree: "Independent measurements of
17 atmospheric temperature such as those from radiosondes will continue to be an important tool in
18 evaluating temperature products over limited time periods."²

² Stephen Po-Chedley and Qiang Fu, *A Bias in the Midtropospheric Channel Warm Target Factor on the NOAA-9 Microwave Sounding Unit 29* J. Atmospheric and Oceanic Tech. 646, 651 (May 2012).

1 The source Dr. Dessler cites to criticize the use of radiosondes, Sherwood and Nishant
2 (2015) is suspect. While they use a known statistical method (“Kriging”) they omit observations
3 they don’t like in order to create a better fit, and use statistical gyrations in a labored attempt to
4 make the data confess to the existence of the tropical ‘hot spot’ others have failed to find.
5 Sherwood himself confirmed that they located and threw out troublesome data: “We deduced
6 from the data what natural weather and climate variations look like, then found anomalies in the
7 data that looked more like sudden one-off shifts from these natural variations and removed
8 them.”³ This methodology seems rather arbitrary and prone to finding only the data that supports
9 one’s hypothesis, while omitting data that does not.

10 **Q: Do you agree with Dr. Dessler that surface temperature records are**
11 **“unscathed”?**

12 A: No. Surface measurements over land still suffer from an urban heat island effect,
13 despite limited attempts to correct for it. Dr. Abraham contends that urban heat islands only have
14 a “negligible effect.” Researchers from NASA’s Goddard Space Flight Center and Arizona State
15 University disagree, however.⁴ Dr. Dessler’s characterization may be right if “unscathed” means,
16 as Hausfather 2015 shows, that researchers are figuring out ways to use data homogenization to

³ Australian Research Council, “Climate Scientists Confirm Elusive Tropospheric Hot Spot,” *ARC Center of Excellent for Climate System Science* (May 14, 2015), available at <https://www.climate-science.org.au/content/873-climate-scientists-confirm-elusive-tropospheric-hot-spot>.

⁴ Marc L. Imhoff, *et al.*, *Remote Sensing of the Urban Heat Island Effect Across Biomes in the Continental USA*, 114 *Remote Sensing of Envir.* 504 (Mar., 15, 2010), available online at <http://www.sciencedirect.com/science/article/pii/S0034425709003174>; F. Salamanca, *et al.*, *Summertime Response of Temperature and Cooling Energy Demand to Urban Expansion in a Semiarid Environment*, 54 *J. Applied Meteorology and Climatology* 1756 (Aug. 2015), available at <http://journals.ametsoc.org/doi/abs/10.1175/JAMC-D-14-0313.1>.

1 achieve “the real elimination of an urban warming bias present in the raw data.”⁵ Hausfather
2 admits that urban warming bias is real, and has published his method for correcting it—which is
3 not exactly an “unscathed” record for the raw dataset.

4 It should be remembered that the urban heat island effect is expected to appear as gradual
5 warming, as loss of vegetation and manmade heat sources increase over time in the vicinity of
6 temperature measurement sites. As such, it is likely indistinguishable from global warming,
7 which is also expected to be slow and gradual. There is no known way to correct for such an
8 effect, as most data homogenization techniques look for time discontinuities in the data, related
9 to abrupt spurious temperature effects, not long gradual ones.

10 That the surface thermometer data likely indicate some level of warming, I agree. That
11 they have been corrected for spurious warming influences, I do not agree.

12 **Q: Dr. Abraham cites Fall, et al. (2011) for the proposition that “poorly sited**
13 **sensors lead to an ‘underestimate of maximum temperature trends.’” Is that a viable**
14 **understanding of Fall, et al. (2011)?**

15 A: No. I have spoken to one of the authors of that study (A. Watts) who told me, “most of
16 the effect is in Tmin. (It) biases the Tmin upwards in almost every case, more so than affecting
17 Tmax. The most important conclusion of Fall *et al.* is that we found no century scale trend in the
18 diurnal range.” (Email available upon request). What this means in plain English is ... while it is
19 possible for one of the urbanization effects to contribute to a depression of maximum

⁵ Zeke Hausfather, *et al.*, *Quantifying the Effect of Urbanization on U.S. Historical Climatology Network Temperature Records*, 118 J. Geophys. Resch. Atmospheres 481, 492 (Jan. 30, 2013).

1 temperatures in the afternoon, the overall effect on [Tmax+Tmin], which is what is monitored for
2 climate change, is still an urban *heat* island ... hence its name.

3 **III. The Hiatus in Warming**

4 **Q: How many different explanations are you aware of for the hiatus in measurable**
5 **warming?**

6 A: At least 52⁶ by one count. In my view, almost all of these can be grouped into just a
7 few categories: 1) natural atmospheric climate variability has caused recent cooling; 2) the
8 climate system is less sensitive to GHG forcing than the IPCC claims (my view, supported by
9 our publications); and 3) increased vertical mixing in the ocean has cooled the surface and stored
10 some of the extra energy in the deep ocean. It is possible for some of all 3 processes to be
11 operating.

12 **Q: How many have been widely accepted as a valid explanation for the hiatus?**

13 A: No single explanation has been validated, although people agree or disagree with
14 different theories in varying degrees.

15 **Q: Is the hiatus grounds for reasonable scientific debate?**

16 A: Yes—and Dr. Dessler has said so. Commenting on the hiatus (specifically, one of the
17 most recent theories about the heat hiding in the ocean), he admitted that “the real question” is
18 “how much of the hiatus is pure internal variability and how much is a forced response (from

⁶ Anthony Watts has maintained a running list. Anthony Watts, “List of Excuses for ‘the Pause’ in Global Warming is Now up to 52,” *Watts Up With That* (Sep. 11, 2014), available at <http://wattsupwiththat.com/2014/09/11/list-of-excuses-for-the-pause-in-global-warming-is-now-up-to-52/>.

1 loading the atmosphere with carbon.”⁷ Notably, he did not even attempt to assert that the hiatus
2 *did not exist*. Indeed, he noted that “the hiatus is [an] example of how science works” and that it
3 is grounds for “legitimate uncertainty.”⁸ If Dr. Abraham believes there has been no hiatus in
4 oceanic warming, maybe he should address his comments to Dr. Dessler, too?

5 **Q: Do other scientists suggest there is reason to question why measurable global**
6 **warming appears to have stopped?**

7 A: Yes. Kevin Trenberth, as recently as 2009, cast doubt on basic scientific
8 understandings because he could not account for why there was no statistically significant
9 warming. “The fact is that we can’t account for the lack of warming at the moment and it is a
10 travesty that we can’t. ... [T]he data are surely wrong. Our observing system is inadequate.”⁹

11 **Q: Dr. Dessler criticizes you for relying on short-term trends that do not define a**
12 **long-term trend. Do you see a robust long-term warming trend?**

13 A: Given all of the available evidence, there has likely been a long-term warming trend,
14 but this appears to be, at least partly, a natural trend that started before humans began to affect
15 CO₂ levels in the atmosphere in any significant way.

16 Further, its *magnitude* is what is important for the purposes of justifying a specific social
17 cost of carbon.

⁷ Andrew Revkin, “A Closer Look at Turbulent Oceans and Greenhouse Heating,” *New York Times* (Aug. 26, 2014), available at http://dotearth.blogs.nytimes.com/2014/08/26/a-closer-look-at-turbulent-oceans-and-greenhouse-heating/?_php=true&_type=blogs&partner=rssnyt&emc=rss&_r=1.

⁸ *Id.*

⁹ Kevin Trenberth, CRU email 1255523796.txt (Oct. 14, 2009). This email was one of many released as part of the “ClimateGate” scandal, involving investigations by several universities and a committee of the British Parliament for violations of freedom of information laws. See *See Climate row unit ‘broke data law,’* Jan. 28, 2010 available at http://news.bbc.co.uk/2/hi/uk_news/8484385.stm.

1 Finally, we emphasize only the last 30-40 years partly because that is when the
2 greenhouse effect has supposedly been a maximum ... and yet, its effect on the climate system
3 seems to be minimal. Also, it is the period when we have the best globally-distributed datasets.
4 Any agreement between models and observations before the 1950s (like Dr. Dessler shows) are
5 not terribly useful for determining whether climate models are accurate or not since we have
6 little quantitative knowledge of climate forcings before then, and the resulting agreement is more
7 an exercise in curve fitting (meaning that the models are arbitrarily adjusted to fit past results,
8 and don't necessarily tell us anything about the future).

9 **Q: Do studies of ocean temperatures at depth (down to 700 m, below 700 m) show**
10 **significant warming?**

11 A: Not conclusively. We should remember that, depending upon depth, the observed rate
12 of warming in the ocean has been much less than in the atmosphere, with warming of 0.01 to at
13 most 0.1 C/decade being near the limit of observability. Both Drs. Abraham and Dessler
14 "cherry-pick" a single analysis from a much more varied set of findings. Even the IPCC
15 recognizes that some studies of the upper 700 m of ocean find a hiatus, while others do not.¹⁰
16 Publications since those cited by Abraham and Dessler have found mixed results: there has been
17 a flattening or cooling of the upper 100 and 300 meters, but some studies show the upper 700
18 meters as a whole has warmed, suggesting a more localized warming than expected.¹¹ Dessler's

¹⁰ IPCC Working Group I, *Climate Change 2013: The Physical Science Basis* 262-63 (Fi. 3.2) (2013) [hereafter, "AR5 WG1"].

¹¹ W. Llovel, *et al.*, *Deep-Ocean Contribution to Sea Level and Energy Budget Not Detectable Over the Past Decade*, 4 *Nature Climate Change* 1031 (Oct. 5, 2014); Veronica Nieves, *et al.*, *Recent Hiatus Caused by Decadal Shift in Indo-Pacific Heating*, 349 *Science* 532 (Jul. 31, 2015); Paul J. Durack, *et al.*, *Quantifying Underestimates of Long-Term Upper-Ocean Warming*, 4 *Nature Climate Change* 999 (Oct. 5, 2014); Carl Wunsch

1 citation to Balamseda, *et al.* (2013) reveals that he is using a model fed with some observational
2 data, not observations alone, to generate his results.¹² Some studies of *observed* deep ocean
3 temperatures show cooling, not warming.¹³ Because of the new ARGO systems brought online in
4 2005, it is impossible to tell which of the measurements of the upper ocean (0 to 700m) is
5 correct. There are very few temperature data from the deep ocean before 2005, and the data since
6 then show little if any warming. If Dr. Dessler is correct that we should look to the oceans to find
7 the effects of climate change (Dessler Testimony at 8:1-7), then—if we look at the full record—
8 we will find very mixed results and no clear support for his thesis.

9 **Q: Do you agree with Dr. Dessler’s insistence that oceans make up such a large**
10 **proportion of the heat reservoirs that we can safely ignore measurements in the**
11 **atmosphere and on the surface?**

12 A: No. That would be like saying that the windows and wall insulation in a giant building
13 are not important to the heating and cooling of the whole building interior.

14 Processes in the atmosphere largely control how much the oceans will warm, *e.g.* through
15 their control of cloud cover (affecting solar heating) and water vapor content (affecting infrared
16 cooling). So, while it is true that the atmosphere represents a tiny portion of the total heat
17 content of the system, monitoring its behavior – along with the ocean – is critical to
18 understanding just how much warming (if any) can be expected in the future where people live.

and Patrick Heimbach, *Bidecadal Thermal Changes in the Abyssal Ocean*, 44 J. Phys. Oceanography 2013 (Aug. 2014).

¹² Magdalena A. Balamseda, *et al.*, *Distinctive Climate Signals in Reanalysis of Global Ocean Heat Content*, 40 Geophys. Resch. Letters 1 (2013).

¹³ Llovel, *supra* n.11; Wunsch and Heimbach, *supra* n.11.

1 The rate of observed temperature increase of the atmosphere is now so much below that expected
2 by climate models (models which cannot ignore the atmosphere in their calculation of ocean
3 temperature change) that we must consider the very real possibility that something is
4 fundamentally wrong with the models.

5 **Q: Dr. Abraham points to recent scholarship by Karl, et al. (2015) showing a clear**
6 **warming effect. Do you agree it is relevant?**

7 A: No. Prof. Lindzen has already submitted a supplemental report giving the reasons why
8 the Karl paper¹⁴ is based on cherry-picked data that are then further massaged to fit a
9 preconceived conclusion.

10 **IV. Equilibrium Climate Sensitivity**

11 **Q: Dr. Abraham argues that he has published a “correcting study” for one of your**
12 **recent papers regarding equilibrium climate sensitivity (“ECS”). He says that you “made a**
13 **series of mistakes which invalidated the conclusion.” How do you respond to that**
14 **contention?**

15 A: Dr. Abraham is responding to a recent paper I co-authored, which took into account
16 deep-ocean warming measurements and the observed natural climate forcing caused by El Niño
17 and La Niña to arrive at an ECS of 1.3 C for a doubling of CO₂. I strongly contest Dr.

¹⁴ Thomas R. Karl, et al., Possible Artifacts Of Data Biases In The Recent Global Surface Warming Hiatus, 348 Science 1469 (June 26, 2015), DOI: 10.1126/science.aaa5632, available at <http://www.sciencemag.org/content/early/2015/06/05/science.aaa5632.abstract>.

1 Abraham's criticisms of that paper and have responded to them.¹⁵ Our examination of only the
2 ocean (excluding the 30% of the land area) is not a detriment to our study, as he suggests. The
3 oceans have warmed at a given rate, and that can be studied using ocean-average quantities. This
4 has been done in many previous modeling studies, and the approach we used was well
5 established.

6 Moreover, Dr. Abraham's criticism of our ocean vertical heat diffusion scheme (which
7 was admittedly an approximation) is irrelevant ... all that is required is that any surface heating
8 from greenhouse gases be mixed downward into the ocean depths at the observed rate. It doesn't
9 matter whether that is accomplished with state-of-the-art computer algorithms, or with a
10 mechanism that is much simpler. It doesn't affect the bottom-line result or the accuracy of our
11 study. Our model was perfectly sufficient to address the factors that determine the rate of rise of
12 temperature, and in fact I explained in my response why our approach might actually be
13 preferable to what Dr. Abraham was proposing. It seems perverse to nitpick our model (which
14 *can* explain temperature observations) when more complex models such as those used by the
15 IPCC or proposed by Dr. Abraham *cannot* explain them, and raise new difficulties of their own
16 (because, for example, they do not seem to be consistent with basic principles of physics, such as
17 the First Law of Thermodynamics, also called "conservation of energy").¹⁶

18 In sum, his criticism of the study is off-base, and that study supports a climate sensitivity
19 value of less than 50% of what the IWG used to calculate the federal social cost of carbon.

¹⁵ Roy Spencer, "Our Initial Comments on the Abraham et al. Critique of the Spencer & Braswell 1D model," *DrRoySpencer.com* (Oct. 23, 2014), available at <http://www.drroyspencer.com/2014/10/our-initial-comments-on-the-abraham-et-al-critique-of-the-spencer-braswell-1d-model/>.

¹⁶ *Id.*

1 **Q: Dr. Dessler criticizes your opinion on ECS for not recognizing *upward***
2 **uncertainty, the possibility that the value could be higher than the median. How do you**
3 **respond?**

4 A: Dr. Dessler presents a skewed vision of the range of opinion on ECS in the first place,
5 and neglects to discuss the most recent scholarship, including a revival of interest in Dr.
6 Lindzen’s iris effect. It is important to notice the trends in ECS values over time, and it is fairly
7 clear: the proposed values are decreasing, and so the tendency is to recognize that positive
8 feedbacks are most likely over- rather than under-estimated.

9 Therefore, the best available measure is the measure that is most tethered to actual
10 observational data, not theories about what might happen. Right now, there is no actual data to
11 justify increasing the value. Quite the opposite. The data that currently exists, whether one
12 considers the surface temperature, satellite or weather balloon datasets, all demonstrate that the
13 actual warming is far below the model predictions. Under such circumstances, to increase the
14 value based upon uncertainty alone—and in disregard of this data—is the opposite of scientific
15 reasoning. Stated another way, to increase the value based upon uncertainty alone goes too far
16 and would impose externality values based upon pure speculation.