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Senate Environment and Public Works Committee
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One Page Summary

1. It is popular again to claim that extreme events, such as the current central U.S. drought, are evidence of human-caused climate change. Actually, the Earth is very large, the weather is very dynamic, and extreme events will continue to occur somewhere, every year, naturally. The recent “extremes” were exceeded in previous decades.

2. The average warming rate of 34 CMIP5 IPCC models is greater than observations, suggesting models are too sensitive to CO₂. Policy based on observations, where year-to-year variations cause the most harm, will likely be far more effective than policies based on speculative model output, no matter what the future climate does.

3. New discoveries explain part of the warming found in traditional surface temperature datasets. This partial warming is unrelated to the accumulation of heat due to the extra greenhouse gases, but related to human development around the thermometer stations. This means traditional surface datasets are limited as proxies for greenhouse warming.

4. Widely publicized consensus reports by “thousands” of scientists are misrepresentative of climate science, containing overstated confidence in their assertions of high climate sensitivity. They rarely represent the range of scientific opinion that attends our relatively murky field of climate research. Funding resources are recommended for “Red Teams” of credentialed, independent investigators, who already study low climate sensitivity and the role of natural variability. Policymakers need to be aware of the full range of scientific views, especially when it appears that one-sided-science is the basis for promoting significant increases to the cost of energy for the citizens.

5. Atmospheric CO₂ is food for plants which means it is food for people and animals. More CO₂ generally means more food for all. Today, affordable carbon-based energy is a key component for lifting people out of crippling poverty. Rising CO₂ emissions are, therefore, one indication of poverty-reduction which gives hope for those now living in a marginal existence without basic needs brought by electrification, transportation and industry. Additionally, modern, carbon-based energy reduces the need for deforestation and alleviates other environmental problems such as water and air pollution. Until affordable energy is developed from non-carbon sources, the world will continue to use carbon as the main energy source as it does today.

Written Statement of John R. Christy
The University of Alabama in Huntsville
Committee on Environment and Public Works
1 August 2012

I am John R. Christy, Distinguished Professor of Atmospheric Science, Alabama's State Climatologist and Director of the Earth System Science Center at The University of Alabama in Huntsville. I have served as a Lead Author and Contributing Author of IPCC assessments, have been awarded NASA's Medal for Exceptional Scientific Achievement and in 2002 elected a Fellow of the American Meteorological Society.

It is a privilege for me to offer my views of climate change based on my experience as a climate scientist. My research area might be best described as building datasets from scratch to advance our understanding of what the climate is doing and why. This often involves weeks and months of tedious examination of paper records and then digitizing the data for use in computational analysis. I have used traditional surface observations as well as measurements from balloons and satellites to document the climate story. Many of my datasets are used to test hypotheses of climate variability and change. In the following I will address five issues that are part of the discussion of climate change today, some of which will be assisted by the datasets I have built and published.

1. EXTREME EVENTS

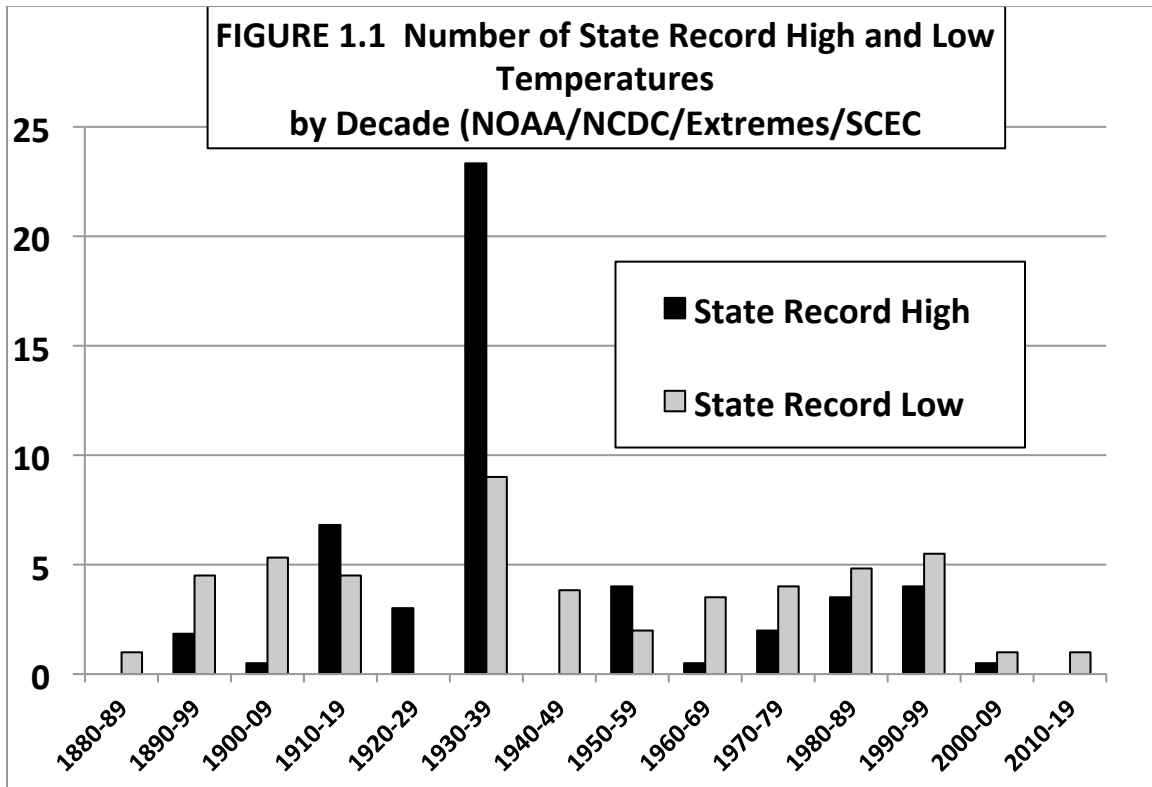
Recently it has become popular to try and attribute certain extreme events to human causation. The Earth however, is very large, the weather is very dynamic, especially at local scales, so that extreme events of one type or another will occur somewhere on the planet in every year. Since there are innumerable ways to define an extreme event (i.e. record high/low temperatures, number of days of a certain quantity, precipitation total over 1, 2, 10 ... days, snowfall amounts, etc.) this essentially assures us that there will be numerous "extreme events" in every year because every year has unique weather patterns. The following assesses some of the recent "extreme events" and demonstrates why they are poor proxies for making claims about human causation.

Midwestern Drought

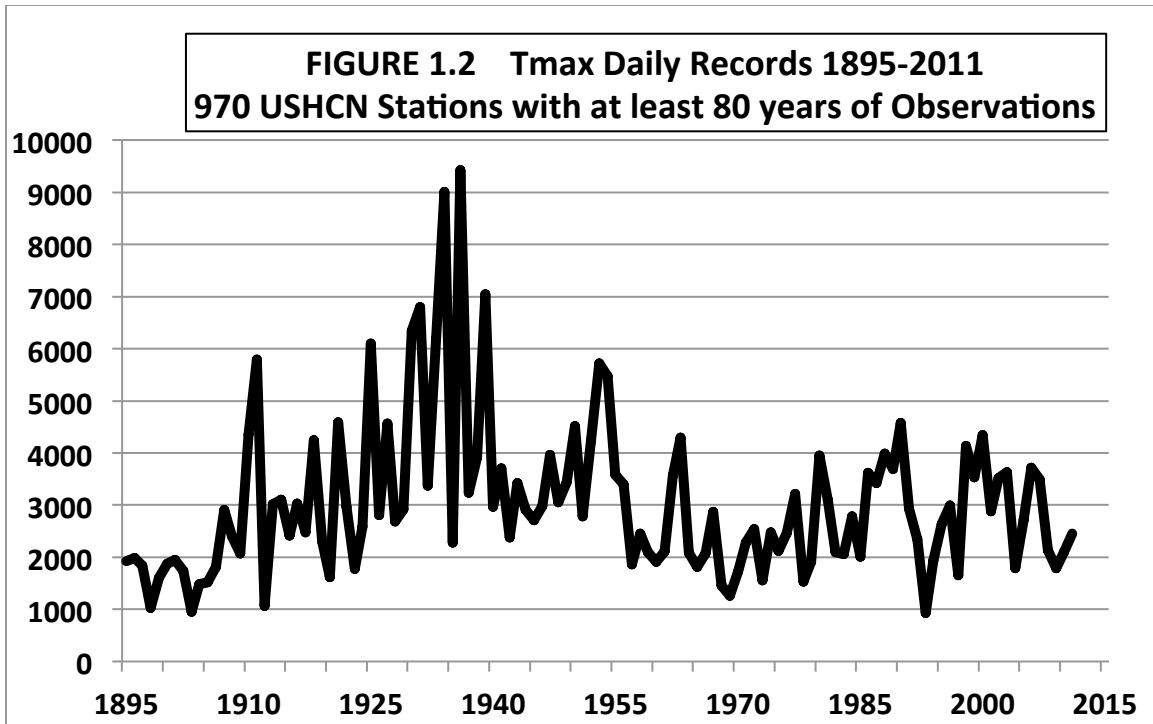
To put it simply, Andreadis and Lettenmaier (2006) found that for the Midwest, "Droughts have, for the most part, become shorter, less frequent, less severe, and cover a smaller portion of the country over the last century." In other words, droughts have always happened in the Midwest and they are not getting worse (more on Midwest heat waves below and on Midwest drought in Section 2).

Extreme High and Low Temperatures

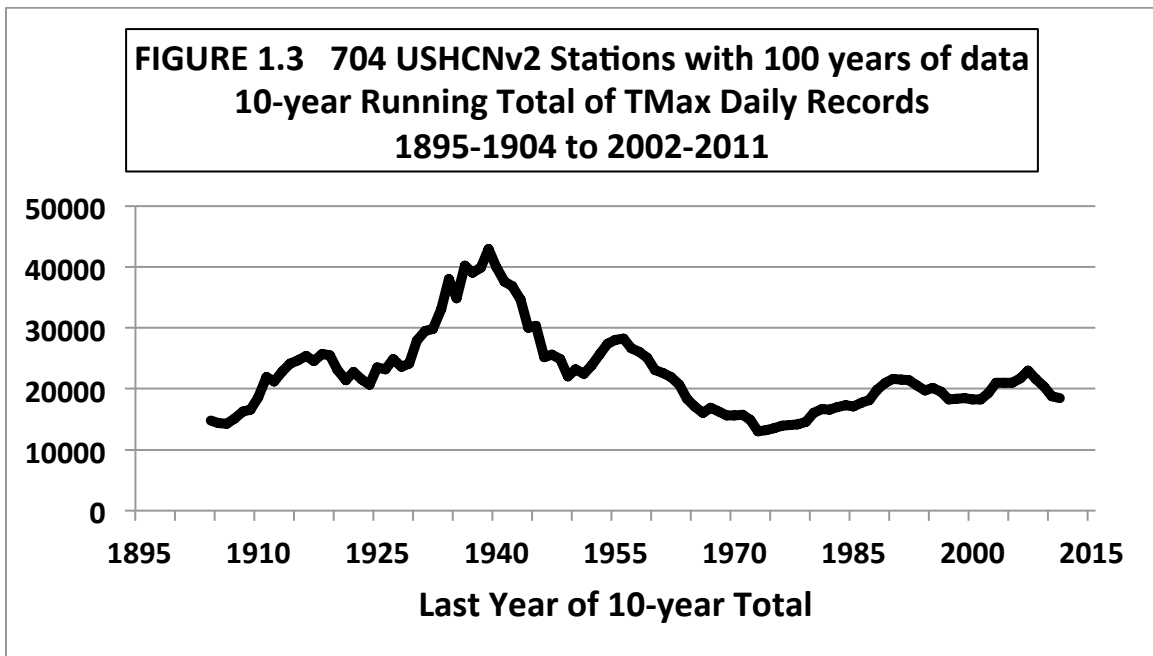
Another extreme metric is the all time record high temperature for each state. The occurrence of the records by decade (Figure 1.1 below) makes it obvious that the 1930s were the most extreme decade and that since 1960, there have been more all-time cold records set than hot records in each decade.



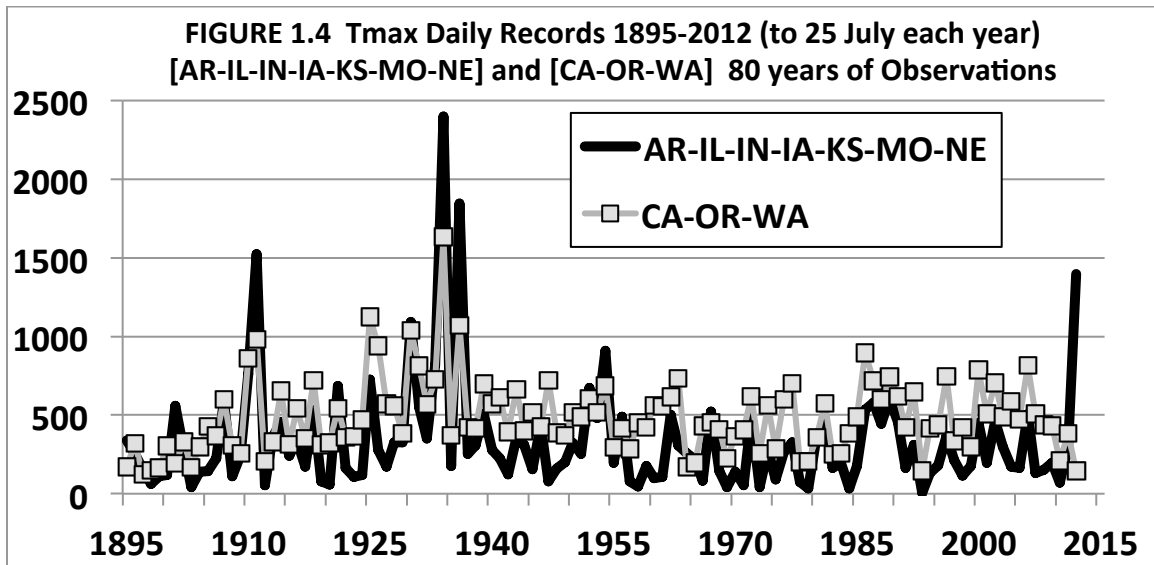
However, there are only 50 states, and this is a number that isn't large enough to give the best statistical results. Below are the year-by-year numbers of *daily* all-time record high temperatures from a set of 970 weather stations with at least 80 years of record (NOAA/NCDC/USHCNv2). There are 365 opportunities in each year (366 in leap years) for each of the 970 stations to set a record high (TMax). These have been added up by years and displayed in the Fig. 1.2 below. Note the several years above 6000 events prior to 1940 and none above 5000 since 1954. The clear evidence is that extreme high temperatures are not increasing in frequency, but actually appear to be decreasing. The recent claims about thousands of new record high temperatures were based on stations whose length-of-record could begin as recently as 1981, thus missing the many heat waves of the 20th century. Thus, any moderately hot day now will be publicized as setting records for these young stations because they were not operating in the 1930s. The figure below gives what a climatologist would want to know because it uses only stations with long records.



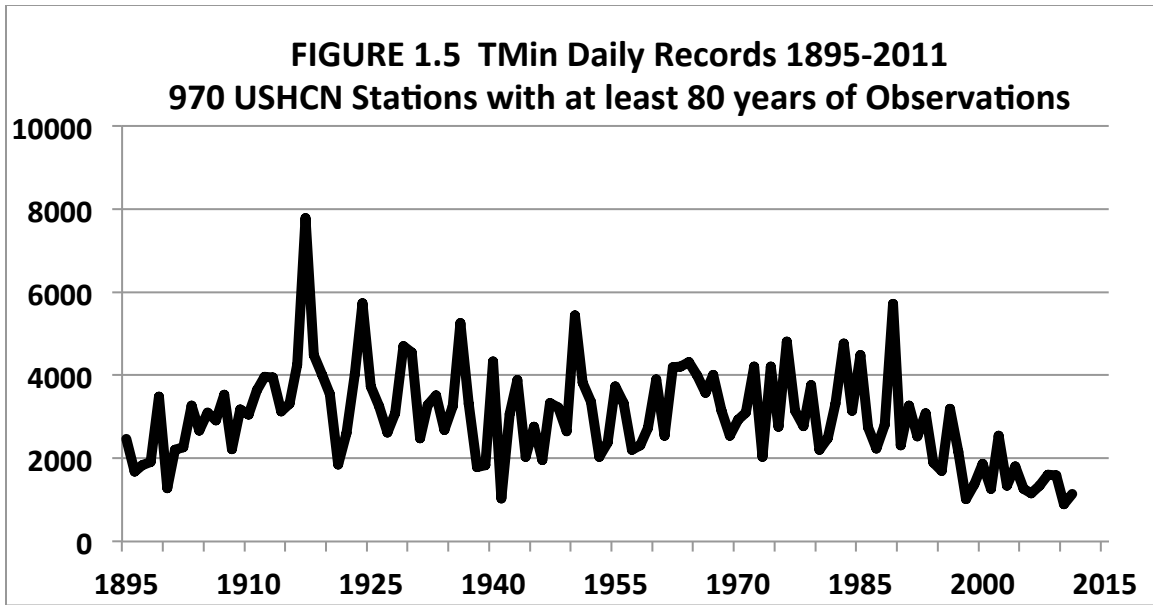
The somewhat ragged line above is more meaningful for climate purposes if we take the total record highs for ten-year periods, year-by-year, i.e. 1895-1904, 1896-1905, ... 2002-2011. In Figure 1.3 below the record daily highs for 704 stations which have at least 100 years of data are plotted. Note that the value for the most recent decade is less than half of what was observed in the 1930s.



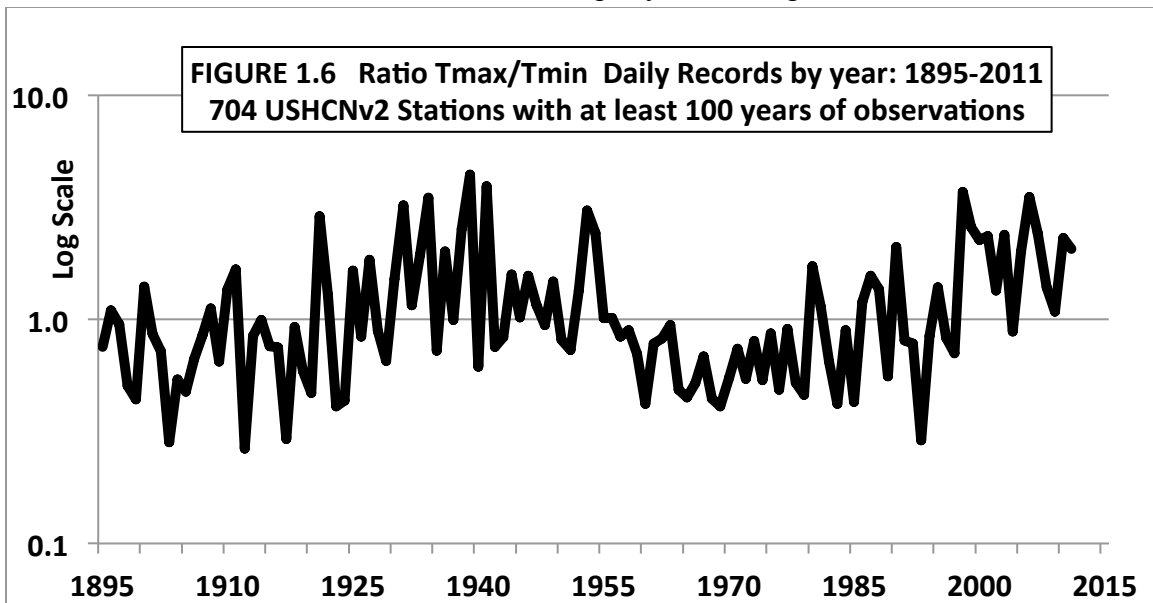
To include the heat wave of 2012 in this discussion, I have calculated the number of record high temperatures (Fig. 1.4) for stations in 7 central-US states where the heat is worst (AR-IL-IN-IA-MO-NE) and stations on the West Coast (CA-OR-WA). The groupings have about the same number of stations and all years show results beginning in January and ending on 25 July of each year. Notice that the Central-US and West Coast both felt the heat waves of 1911 and the 1930s when the highest number of events occurred for both regions. However, the current 2012 event shows high numbers in the Central-US, but a dearth of record highs along the West Coast, indicating the extent of the heat wave is smaller than previous events. (Note the values for 2012 have been increased by 15 percent to account for a few missing stations.)



A different picture emerges for the record cold temperatures for 970 US stations (TMin, Figure 1.5). Here we see a more even distribution up through the 1980's with a fairly noticeable drop-off in record low temperatures over the past 25 years. The cause for this drop-off is discussed in Section 3 of this testimony.



An interesting result is produced by taking the ratio year-by-year of the number of TMax daily records divided by the number of TMin daily records (Figure 1.6 below). The two large periods of more record highs than lows are in the 1930s and the last 15 years. The first high-ratio period in the 1930s was due to numerous TMax records while the more recent period was due to fewer TMin records. This decline in the record low temperatures (TMin) in the past 25 years is likely related to the general disturbance by human development around the thermometer stations (again, discussed in Section 3). Meehl et al., 2009 did a similar analysis, but started later, in 1950. This led to the claim of a rapidly rising ratio of record highs to record lows. Had the authors gone back only two more decades to look at a more complete climate record, and had taken into account the contamination of TMin values, the claim of rapidly increasing ratios would not hold.



Texas Drought of 2011

A recent claim that the 2011 drought in Texas was 20 times more likely due to extra greenhouse gases was based on statistics from a modeling exercise (http://www.noaanews.noaa.gov/stories2012/20120710_stateoftheclimaterreport.html.)

As it turns out, the model overstated the warming rate of Texas, so that its statistics wouldn't apply correctly to the real world. In fact, the authors of the original article actually made that point in their study saying the result gave very limited information regarding real world impacts, and that the amount of impact of greenhouse gases was unknown. See <http://cliffmass.blogspot.com/2012/07/texas-tall-tales-and-global-warming.html> and <http://blog.chron.com/climateabyss/2012/07/twenty-times-more-likely-not-the-science/> for more explanation. This was (another) unfortunate episode in misrepresenting the science of climatology.

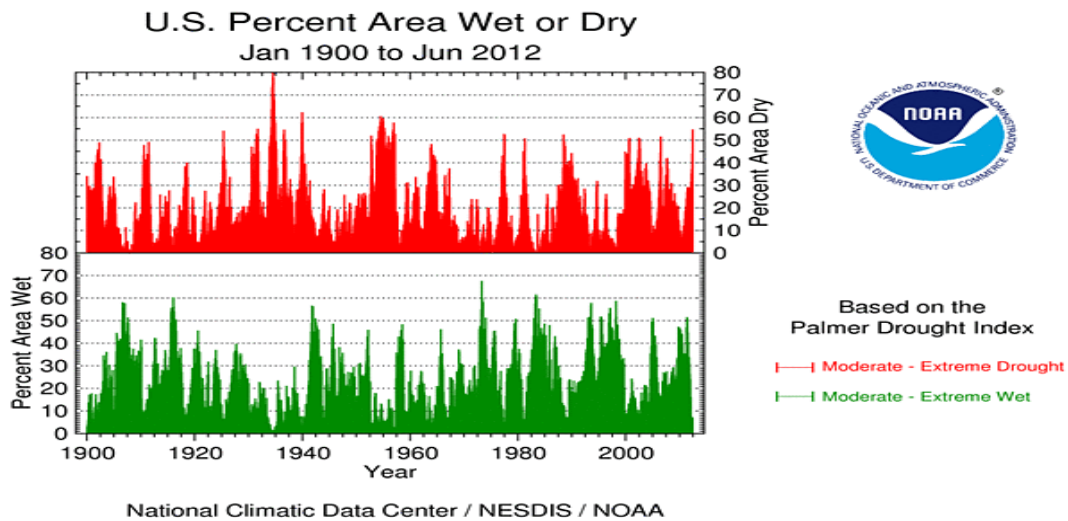
Colorado Fires

Colorado has been in the news this year due to a number of serious wildfires. These fires are usually caused by humans and problematic to study from a climate standpoint because of fire suppression activities that have been around since the turn of the 20th century. Whereas there were many low-intensity fires before these efforts began, now there tend to be fewer but more intense fires due to the buildup of fuel. Western fires in the past have covered much more ground than the tragic fires we see today (e.g. 1910 over 3 million acres). In any case, droughts are related to weather patterns that become stationary, so it is useful to ask the question: have weather patterns shown a tendency to become more stationary, thus creating the opportunity for long dry/hot or wet/cool spells? (Note that the current heat in the Plains is one half of the pattern, the cooler-than-normal West Coast/Alaska is the other.)

A project which seeks to generate consistent and systematic weather maps back to 1871 (20th Century Reanalysis Project, http://www.esrl.noaa.gov/psd/data/20thC_Rean/) has taken a look at the three major indices which are often related to extreme events. As Dr. Gill Compo of the University of Colorado, leader of the study, noted to the *Wall Street Journal* (10 Feb 2011) "... we were surprised that none of the three major indices of climate variability that we used show a trend of increased circulation going back to 1871." (The three indices were the Pacific Walker Circulation, the North Atlantic Oscillation and the Pacific-North America Oscillation, Compo et al. 2011.) In other words, there appears to be no supporting evidence over this period that human factors have influenced the major circulation patterns which drive the larger-scale extreme events. Again we point to natural, unforced variability (i.e. Mother Nature) as the dominant feature of events that have transpired in the past 130 years.

U.S. Drought

Though the conterminous U.S. covers only 1.8 percent of the globe, there are good records for many weather variables. Below is the month-by-month percentage of the area that is classified as moderate to extreme for dryness and wetness from NOAA. As can be seen below there is a tremendous amount of variability (near zero to near 80 percent), but no long-term trend.



Recent snowfall in the United States

Snowfall reached record levels in 2009-10 and 2010-11 in some eastern US locations and also in a few western locations in 2010-11. NOAA's Climate Scene Investigators committee issued the following statement regarding this, indicating, again, that natural, unforced variability (again, Mother Nature) explains the events.

Specifically, they wanted to know if human-induced global warming could have caused the snowstorms due to the fact that a warmer atmosphere holds more water vapor. The CSI Team's analysis indicates that's not likely. They found no evidence — no human "fingerprints" — to implicate our involvement in the snowstorms. If global warming was the culprit, the team would have expected to find a gradual increase in heavy snowstorms in the mid-Atlantic region as temperatures rose during the past century. But historical analysis revealed no such increase in snowfall.

In some of my own studies I have looked closely at the snowfall records of the Sierra Nevada mountains of California from the earliest records from the Southern Pacific Railroad beginning in 1878. Long-term trends in snowfall (and thus water resources) in

this part of California are essentially zero, indicating no change in this valuable resource to the state (Christy and Hnilo, 2010, Christy 2012.)

From the broad perspective, where we consider all the extremes above, we should see a warning – that the climate system has always had within itself the capability of causing devastating events and these will certainly continue with or without human influence on the climate. Thus, societies should plan for infrastructure projects to withstand the worst that we already know has occurred, and to recognize, in such a dynamical system, that even worse events *should* be expected. In other words, the set of the *measured* extreme events of the small climate history we have, since about 1880, does *not* represent the full range of extreme events that the climate system (i.e. Mother Nature) can actually generate. The most recent 130 years is simply our current era’s small sample of the long history of climate.

There will certainly be events in this coming century that exceed the magnitude of extremes measured in the past 130 years in many locations. To put it another way, a large percentage of the worst extremes over the period 1880 to 2100 will occur after 2011 simply by statistical probability without any appeal to human forcing at all. Records are made to be broken. Going further, one would assume that about 10 percent of the record extremes that occur over a thousand-year period ending in 2100 should occur in the 21st century. Are we prepared to deal with events even worse than we’ve seen so far? Spending which is directed to creating resiliency to these sure-to-come extremes, particularly drought/flood extremes, seems rather prudent to me – since there are no human means to make them go away regardless of what some regulators might believe.

Looking at the longer record of climate patterns

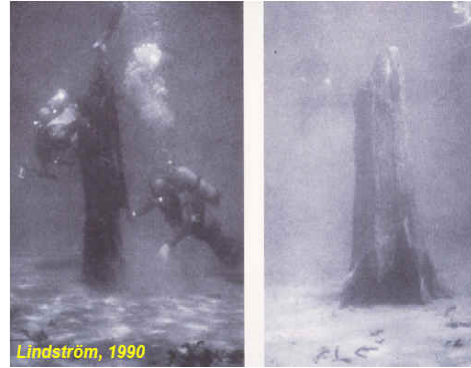
Climatologists realize that the period of time over which we have had instruments to measure the climate (~130 years) is very brief compared to the history of the current 10,000-year interglacial period. Taking a look at the larger picture shows the capability of Mother Nature to produce extreme situations.

Megadroughts of the past 1000+ years

There are several types of records from the flora and fauna of the past 1000 years that provide evidence that droughts of extreme duration (decades) occurred in our nation, primarily in the Great Plains westward to the Pacific Coast.

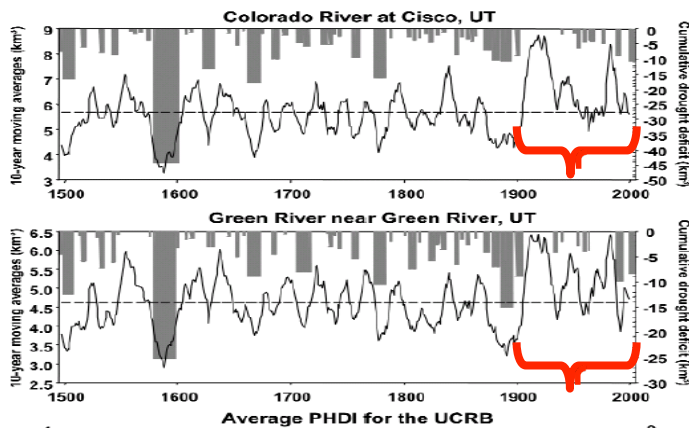
California

At right are photos from Lindstrom (1990) in which trees grew on dry ground around 900 years ago in what is now a Sierra Nevada alpine lake. This indicates that a drastic but natural change to a much drier climate must have lasted for at least a century for trees to have grown to these sizes on dry ground.



Rocky Mountains

A 500-year history of moisture in the upper Colorado River basin (below) indicates the past century was quite moist while major



multi-decadal droughts occurred in all four prior centuries (Piechota et al. 2004.) Indeed, the conclusion of Piechota et al. states that after examining the paleo-record, the present-day droughts “could be worse.” These and other evidences point to the real probability that water supply in the West will see declines

simply as a matter of the natural variability of climate.

Great Plains

In the Great Plains, the period from 3000 to 1500 years ago saw a drier and warmer climate during which a significant parabolic sand dune ecosystem developed, especially in western Nebraska and NE Colorado (Muhs 1985). In other words, the Great Plains resembled a desert. Many of these areas experienced dune “reactivation” during Medieval times (900-1300 AD). Then, the climate moistened and cooled beginning around 1300 AD to support the short-grass prairie seen today, though “reactivation” is possible at any time (Schmeisser, 2009). Indeed, Muhs and Holliday (1995) found that dune reactivation can occur within decadal time scales from extended drought by examining the Great Plains environment of only the past 150 years.

With the massive use of ground water for irrigation, the High Plains Aquifer has declined an average of 12.8 ft, with some areas in the Texas panhandle down over 150 ft. The key point here is that the Plains is subject to natural (and sobering) long-term droughts that would very likely tax the current water management system (ground-water

withdrawals) while not replenishing the aquifer, producing a situation of reduced agricultural productivity, especially in its southern reaches.

A sample study of why extreme events are poor metrics for global changes

In the examples above, we don't see increases in extreme events (which is also true for tornadoes, hurricanes, floods, etc. - see my House testimony of 31 March 2011) but we must certainly be ready for more to come as part of nature's variability. I want to illustrate how one might use extreme events to conclude (improperly I believe) that the weather in the USA is becoming less extreme and/or colder.

Going back to Fig. 1.1 (the number of all-time state records) we see the following. About 75 percent of the states recorded their hottest temperature prior to 1955, and, over 50 percent of the states experienced their record cold temperatures after 1940. Overall, only a third of the records (hot or cold) have been set in the second half of the whole period. One could conclude, if they were so inclined, that the climate of the US is becoming less extreme because the occurrence of state extremes of hot and cold has diminished dramatically since 1955. Since 100 of anything appears to be a fairly large sample (2 values for each of 50 states), this on the surface seems a reasonable conclusion.

Then, one might look at the more recent record of extremes and learn that no state has achieved a record high temperature in the last 15 years (though one state has tied theirs.) However, five states have observed their all-time record low temperature in these past 15 years plus one tie. This includes last year's record low of 31°F below zero in Oklahoma, breaking their previous record by a rather remarkable 4°F. If one were so inclined, one could conclude that the weather that people worry about (extreme cold) is getting worse in the US. (Note: this lowering of absolute cold temperature records is nowhere forecast in climate model projections, nor is a significant drop in the occurrence of extreme high temperature records.)

I am not using these statistics to prove the weather in the US is becoming less extreme and/or colder. My point is that extreme events are poor metrics to use for detecting climate change. Indeed, because of their rarity (by definition) using extreme events to bolster a claim about any type of climate change (warming or cooling) runs the risk of setting up the classic "non-falsifiable hypothesis." For example, we were told by the IPCC that "milder winter temperatures will decrease heavy snowstorms" (TAR WG2, 15.2.4.1.2.4). After the winters of 2009-10 and 2010-11, we are told the opposite by advocates of the IPCC position, "Climate Change Makes Major Snowstorms More Likely" (http://www.ucsusa.org/news/press_release/climate-change-makes-snowstorms-more-likely-0506.html).

The non-falsifiable hypotheses can be stated this way, “whatever happens is consistent with my hypothesis.” In other words, there is no event that would “falsify” the hypothesis. As such, these assertions cannot be considered science or in anyway informative since the hypothesis’ fundamental prediction is “anything may happen.” In the example above if winters become milder or they become snowier, the non-falsifiable hypothesis stands. This is not science.

As noted above, there are innumerable types of events that can be defined as extreme events – so for the enterprising individual (unencumbered by the scientific method), weather statistics can supply an unlimited, target-rich environment in which to discover a “useful” extreme event. It’s like looking at all of the baseball games in history to calculate an extreme event. Since every game is unique in some way, that uniqueness can be asserted to be an extreme (i.e. number of consecutive alternating strikes and balls, number of fouls from left-handed batters thrown by left-handed pitchers, number of players in third inning with last name starting with “R”, etc.)

Thus, when the enterprising individual observes an unusual weather event, it may be tempting to define it as a once-for-all extreme metric to “prove” a point about climate change – even if the event was measured at a station with only 30 years of record. This works both ways with extremes. If one were prescient enough to have predicted in 1996 that over the next 15 years, five states would break all-time record cold temperatures while none would break record high temperatures as evidence for cooling, would that prove CO2 emissions have no impact on climate? No. Extreme events happen, and their causes are intricately tied to the semi-unstable dynamical situations that can occur out of an environment of natural, unforced variability.

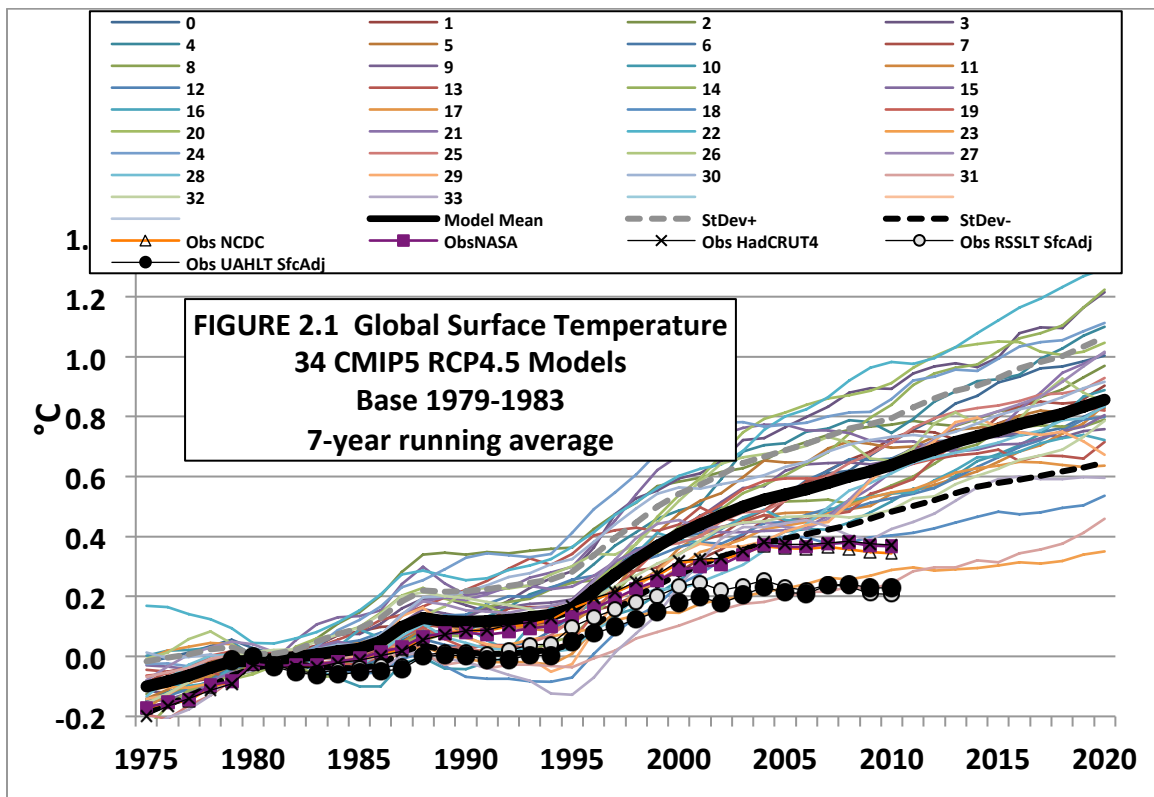
Science checks hypotheses (assertions) by testing specific, falsifiable predictions implied by those hypotheses. The predictions are to be made in a manner that, as much as possible, is blind to the data against which they are evaluated. It is the testable predictions from hypotheses, derived from climate model output, that run into trouble as shown in Section 2. Before going on to that test, the main point here is that extreme events do not lend themselves as being rigorous metrics for *convicting* human CO2 emissions of being guilty of causing them.

2. RECENT CLIMATE MODEL SIMULATIONS

One of the key questions policymakers ask is what will happen with the Earth’s weather in the decades to come. More importantly, they want to know how things might change specifically for their constituents. One pathway to follow is to examine the output of

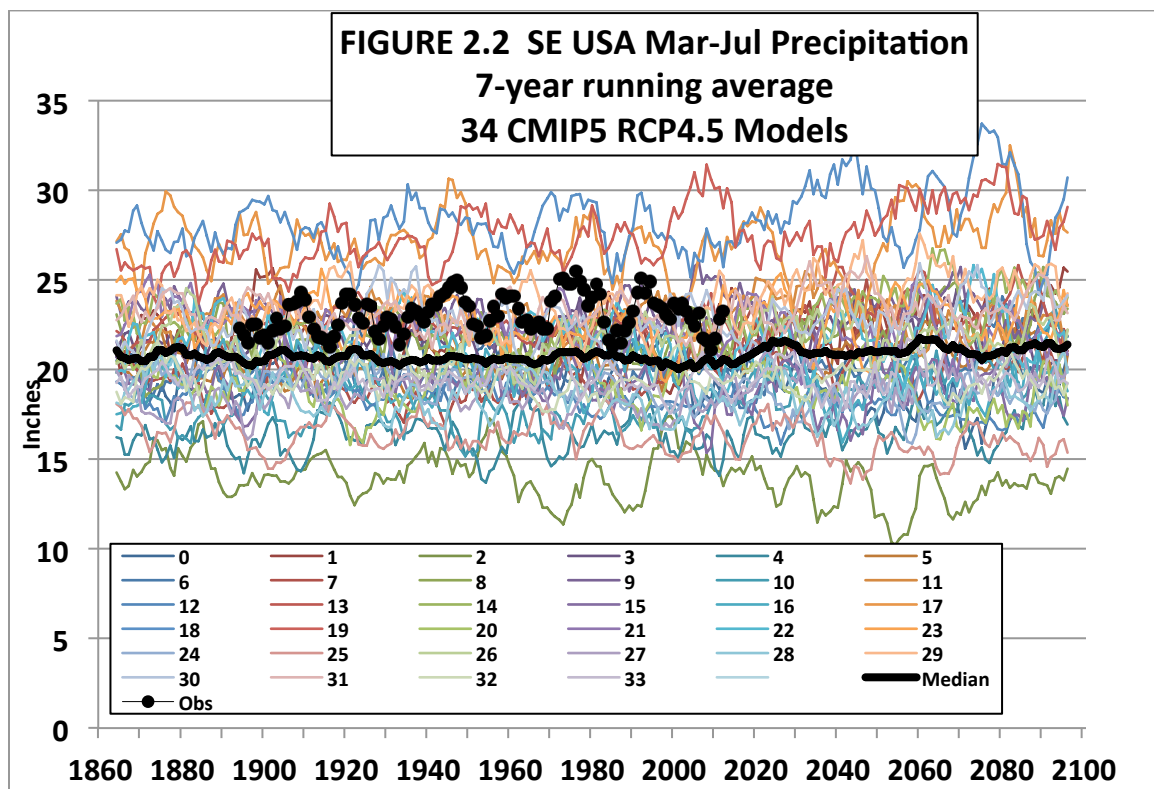
climate models that seek to predict likely outcomes. If one has a lot of confidence in the model projections that terrible weather is on the horizon, then it is tempting to devise policy that the same models say would indicate would somehow mitigate that problem.

In Figure 2.1 below, I display the results from 34 of the latest climate model simulations of global temperature that will be used in the upcoming IPCC AR5 assessment on climate change (KNMI Climate Explorer). All of the data are given a reference of 1979-1983, i.e. the same starting line. Along with these individual model runs I show their average (thick black line) and the results from observations (symbols). The two satellite-based results (circles, UAH and RSS) have been proportionally adjusted so they represent surface variations for an apples-to-apples comparison. The evidence indicates the models on average are over-warming the planet by quite a bit, implying there should be little confidence that the models can answer the question asked by policymakers. Basing policy on the circles (i.e. real data) seems more prudent than basing policy on the thick line of model output. Policies based on the circles would include adaptation to extreme events that will happen because they've happened before (noted above and below) and since the underlying trend is relatively small.



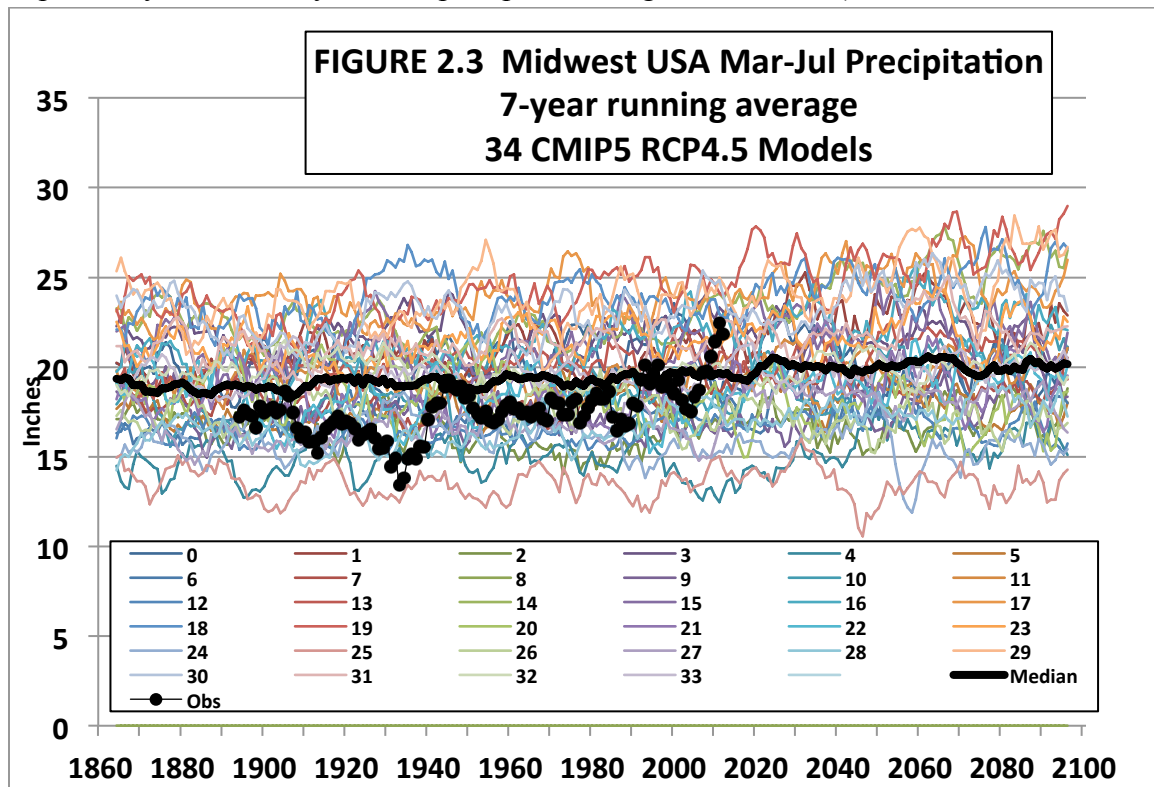
A more specific question for those of us in the Southeast is what might happen to our growing season rainfall – a key variable for our economy. Figure 2.2 below shows what

these 34 models depict for March to July rainfall (7-year running averages) with the circles being the observations. It's apparent first of all that the models are generally too dry. Secondly, there really is no information for policy here. The trend in the average of the models is so close to zero as to be uninformative (+0.8 inches/century for 1980 - 2100) with results varying from 3.7 inches/century wetter to 1.6 inches/century drier. Neither one of these rates is important because the year-to-year variations in rainfall from observations show a range from 14.9 to 30.7 inches. It is apparent that for a critical quantity such as precipitation, one cannot have confidence in model projections, nor in their attempts to demonstrate what might happen with control strategies for carbon dioxide. Again, an examination of the historical record of rainfall (circles) gives considerable information on what might be expected in terms of the variability, and thus a pathway to plan to accommodate the droughts and floods that are sure to come since they've happened in the past.



A similar exercise was done for the Midwest region (100W-85W, 37.5N-45N) since it is in the news in Figure 2.3 below. The character of the observed precipitation shows a clear rise in total amount through the years. However, the same comments regarding the model results for the Southeast apply for the Midwest too as the models indicate an average trend (1980-2100) of a tiny +0.9 inches/century but which really comes down to a shift around 2020 with steady values thereon. The natural range for this region from history varies wildly from 8.7 to 26.7 inches from one growing season to the next. Once

again, policies which deal with the large year-to-year variations which cause the most problems for the economy would address a real threat that will continue to occur regardless of the human effects on climate change. The model output provides no information for substantive policy (see also Stephens et al. 2010 whose title is self explanatory, “The dreary state of precipitation in global models.”)



3. NEW INFORMATION ON SURFACE TEMPERATURE PROCESSES

In general, the issue of global warming is dominated by considering the near-surface air temperature (T_{sfc}) as if it were a standard by which one might measure the climate impact of the extra warming due to increases in greenhouse gases. Fundamentally, the proper variable to measure is heat content, or the amount of heat energy (measured in joules) in the climate system, mainly in the oceans and atmosphere. Thus the basic measurement for detecting greenhouse warming is how many more joules of energy are accumulating in the climate system over that which would have occurred naturally. This is a truly “wicked” problem (see House Testimony, Dr. Judith Curry, 17 Nov 2010) because we do not know how much accumulation can occur naturally.

Unfortunately, discussions about global warming focus on T_{sfc} even though it is affected by many more processes than the accumulation of heat in the climate system. Much has been documented on the problems, and is largely focused on changes in the local

environment, i.e. buildings, asphalt, etc. This means that using T_{sfc} , as measured today, as a proxy for heat content (the real greenhouse variable) can lead to an overstatement of greenhouse warming if the two are assumed to be too closely related.

A new paper by my UAHuntsville colleague Dr. Richard McNider (McNider et al. 2012) looked at reasons for the fact daytime high temperatures (T_{Max}) are really not warming much while nighttime low temperatures (T_{Min}) show significant warming. This has been known for some time and found in several locations around the world (e.g. California - Christy et al. 2006, East Africa – Christy et al. 2009, Uganda – just released data). Without going into much detail, the bottom line of the study is that as humans disturb the surface (cities, farming, deforestation, etc.) this disrupts the normal formation of the shallow, surface layer of cooler air during the night when T_{Min} is measured. In a complicated process, due to these local changes, there is greater mixing of the naturally warmer air above down to the shallow nighttime cool layer. This makes T_{Min} warmer, giving the appearance of warmer nights over time. The subtle consequence of this phenomenon is that T_{Min} temperatures will show warming, but this warming is from a turbulent process which redistributes heat near the surface not to the accumulation of heat related to greenhouse warming of the deep atmosphere. The importance of this is that many of the positive feedbacks that amplify the CO_2 effect in climate models depend on warming of the deep atmosphere not the shallow nighttime layer.

During the day, the sun generally heats up the surface, and so air is mixed through a deep layer. Thus, the daily high temperature (T_{Max}) is a better proxy of the heat content of the deep atmosphere since that air is being mixed more thoroughly down to where the thermometer station is. The relative lack of warming in T_{Max} is an indication that the rate of warming due to the greenhouse effect is smaller than models project (Section 2).

The problem with the popular surface temperature datasets is they use the average of the daytime high and nighttime low as their measurement (i.e. $(T_{Max}+T_{Min})/2$). But if T_{Min} is not representative of the greenhouse effect, then the use of T_{Min} with T_{Max} will be a misleading indicator of the greenhouse effect. T_{Max} should be viewed as a more reliable proxy for the heat content of the atmosphere and thus a better indicator of the enhanced greenhouse effect. This exposes a double problem with models. First of all, they overwarm their surface compared with the popular surface datasets (the non-circle symbols in Fig. 2.1). Secondly, the popular surface datasets are likely warming too much to begin with. This is why I include the global satellite datasets of temperature which are not affected by these surface problems and more directly represent the heat content of the atmosphere (see Christy et al. 2010, Klotzbach et al. 2010).

Fall et al. 2011 found evidence for spurious surface temperature warming in certain US stations which were selected by NOAA for their assumed high quality. Fall et al. categorized stations by an official system based on Leroy 1999 that attempted to determine the impact of encroaching civilization on the thermometer stations. The result was not completely clear-cut as Fall et al. showed that disturbance of the surface around a station was not a big problem, but it was a problem. A new manuscript by Muller et al. 2012, using the old categorizations of Fall et al., found roughly the same thing. Now, however, Leroy 2010 has revised the categorization technique to include more details of changes near the stations. This new categorization was applied to the US stations of Fall et al., and the results, led by Anthony Watts, are much clearer now. Muller et al. 2012 did not use the new categorizations. Watts et al. demonstrate that when humans alter the immediate landscape around the thermometer stations, there is a clear warming signal due simply to those alterations, especially at night. An even more worrisome result is that the adjustment procedure for one of the popular surface temperature datasets actually increases the temperature of the rural (i.e. best) stations to match and even exceed the more urbanized (i.e. poor) stations. This is a case where it appears the adjustment process took the spurious warming of the poorer stations and spread it throughout the entire set of stations and even magnified it. This is ongoing research and bears watching as other factors as still under investigation, such as changes in the time-of-day readings were taken, but at this point it helps explain why the surface measurements appear to be warming more than the deep atmosphere (where the greenhouse effect should appear.)

4. CONSENSUS SCIENCE

The term “consensus science” will often be appealed to regarding arguments about climate change to bolster an assertion. This is a form of “argument from authority.” Consensus, however, is a political notion, not a scientific notion. As I testified to the Inter-Academy Council in June 2010, wrote in *Nature* that same year (Christy 2010), and documented in my written House Testimony last year (House Space, Science and Technology, 31 Mar 2011) the IPCC and other similar Assessments do not represent for me a consensus of much more than the consensus of those selected to agree with a particular consensus. The content of these climate reports is actually under the control of a relatively small number of individuals - I often refer to them as the “climate establishment” – who through the years, in my opinion, came to act as *gatekeepers* of scientific opinion and information, rather than *brokers*. The voices of those of us who object to various statements and emphases in these assessments are by-in-large dismissed rather than acknowledged. This establishment includes the same individuals who become the “experts” called on to promote IPCC claims in trickle-down fashion to government reports such as the endangerment finding by the Environmental Protection Agency. As outlined in my House Testimony, these “experts” become the authors and evaluators of

their own research relative to research which challenges their work. But with the luxury of having the “last word” as “expert” authors of the reports, alternative views vanish.

I’ve often stated that climate science is a “murky” science. We do not have laboratory methods of testing our hypotheses as many other sciences do. As a result what passes for science includes, opinion, arguments from authority, dramatic press releases, and fuzzy notions of consensus generated by a preselected group. This is not science.

I noticed the House passed an amendment last year to de-fund the U.N.’s Intergovernmental Panel on Climate Change (IPCC.) We know from Climategate emails and many other sources of information that the IPCC has had problems with those who take different positions on climate change than what the IPCC promotes. There is another way to deal with this however. Since the IPCC activity *is* funded by US taxpayers, then I propose that five to ten percent of the funds be allocated to a group of well-credentialed scientists to produce an assessment that expresses legitimate, alternative hypotheses that have been (in their view) marginalized, misrepresented or ignored in previous IPCC reports (and thus EPA and National Climate Assessments). Such activities are often called “Red Team” reports and are widely used in government and industry. Decisions regarding funding for “Red Teams” should not be placed in the hands of the current “establishment” but in panels populated by credentialed scientists who have experience in examining these issues. Some efforts along this line have arisen from the private sector (i.e. *The Non-governmental International Panel on Climate Change* at <http://nipccreport.org/> and Michaels (2012) *ADDENDUM:Global Climate Change Impacts in the United States*). I believe policymakers, with the public’s purse, should actively support the assembling all of the information that is vital to addressing this murky and wicked science, since the public will ultimately pay the cost of any legislation alleged to deal with climate.

Topics to be addressed in this “Red Team” assessment, for example, would include (a) evidence for a low climate sensitivity to increasing greenhouse gases, (b) the role and importance of natural, unforced variability, (c) a rigorous and independent evaluation of climate model output, (d) a thorough discussion of uncertainty, (e) a focus on metrics that most directly relate to the rate of accumulation of heat in the climate system (which, for example, the problematic surface temperature record does not represent well), (f) analysis of the many consequences, including benefits, that result from CO₂ increases, and (g) the importance that affordable and accessible energy has to human health and welfare. What this proposal seeks to accomplish is to provide to the congress and other policymakers a parallel, scientifically-based assessment regarding the state of climate science which addresses issues which here-to-for have been un- or under-represented by previous tax-

payer funded, government-directed climate reports. In other words, our policymakers need to see the entire range of scientific findings regarding climate change.

5. IMPACT OF EMISSION CONTROL MEASURES

The evidence above suggests that climate models overestimate the response of temperature to greenhouse gas increases. Also shown was a lack of evidence to blame humans for an increase in extreme events. One cannot convict CO₂ of causing any of these events, because they've happened in the past before CO₂ levels rose. Even so, using these climate model simulations we can calculate that the theoretical impact of legislative actions being considered on the global temperature is essentially imperceptible (Christy JR, House Ways and Means Testimony, 25 Feb 2009). In such calculations we simply run the model with and without the proposed changes in greenhouse gases to see the difference in the models' climates. The result is that actions will not produce a measurable climate effect that can be attributable or predictable with any level of confidence, especially at the regional level.

When I testified before the Energy and Commerce Oversight and Investigations subcommittee in 2006 I provided information on an imaginary world in which 1,000 1.4 gW nuclear power plants would be built and operated by 2020. This, of course, will not happen. Even so, this Herculean effort would result in at most a 10 percent reduction in global CO₂ emissions, and thus exert a tiny impact on whatever the climate is going to do. The results today are still the same. Indeed, with the most recent estimates of low climate sensitivity, the impact of these emission-control measures will be even tinier since the climate system doesn't seem to be very sensitive to CO₂ emissions. The recent switch to natural gas represents a partial move to decarbonize our energy production since methane has four hydrogen atoms for every one carbon atom. Thus, there are now even less U.S. CO₂ emissions to legislate away.

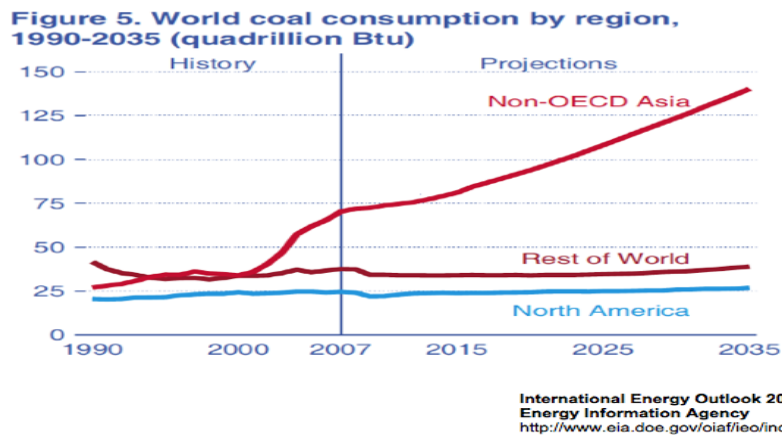
The Energy Information Administration lists 190 countries by CO₂ emissions and Gross Domestic Product. This can be used to answer the question, how much in terms of goods and services does a country generate per ton of CO₂ emissions? In terms of efficiency, the U.S. is ranked 81st near Australia (91st) and Canada (78th) two other geographically-large and well-advanced countries with considerable natural resources. China is 186th but France is 9th due to the fact over 80 percent of its electricity comes from nuclear power rather than carbon. A different way to look at this is to realize the U.S. produces 29 percent of the world's goods and emits only 18 percent of the world's CO₂ emissions (EIA 2009 values.) In other words, the U.S. ranks rather well considering the energy intensive industries of farming, manufacturing, mining, metals processing, etc. that are performed here, the goods of which are sold to the world. So, we produce quite a bit

relative to our emissions – the kind of products and services that the world wants to buy. With the recent shift to more natural gas, the U.S. efficiency continues to rise. I suppose if one wanted to reduce U.S. emissions, one could legislate what the world should and should not buy. This, of course, is not a serious idea.

When thinking about policy regarding CO₂, one cannot ignore the immense benefits produced directly by CO₂ or indirectly from its relationship to low-cost energy. It is a simple fact that CO₂ is plant food and the world around us evolved when levels of CO₂ were five to ten times what they are today. Our green world is a consequence of atmospheric CO₂. And, food for plants means food for people. The extra CO₂ we are putting into the atmosphere not only invigorates the biosphere, but also enhances the yields of our food crops. This is a tremendous benefit to nature and us in my view.

A rising CO₂ concentration is also an indicator of human progress in health, welfare and security provided by affordable carbon-based energy. As someone who has lived in a developing country, I can assure the committee that without energy, life is brutal and short. At present, hundreds of millions of people are dependent on low-grade biomass (tree branches, dung, etc.) for energy. These sources place a huge burden, literally, on people to find, cut and carry the material where needed. Landscapes are deforested and waterways contaminated by these activities. And tragically, the U.N. estimates about 2 million children die each year due to diseases fostered by the toxic fumes produced when burning wood and dung in the homes. Higher density sources of fuel such as coal and natural gas utilized in centrally-produced power stations actually improve the environmental footprint of the poorest nations while at the same time lifting people from the scourge of poverty.

Coal use, which generates a major portion of CO₂ emissions, will continue to rise as indicated by the Energy Information Administration's chart below. Developing countries in Asia already burn more than twice the coal that North America does, and that discrepancy will continue to expand. The fact our legislative actions will be inconsequential in the grand scheme of things can be seen by noting that these actions attempt to bend the blue curve for North American down a little, and that's all. So, downward adjustments to North American coal use will have virtually no effect on global CO₂ emissions (or the climate), no matter how sensitive one thinks the climate system might be to the extra CO₂ we are putting back into the atmosphere.



Thus, if the country deems it necessary to de-carbonize civilization’s main energy sources, then *compelling* reasons beyond human-induced climate change need to be offered that must address, for example, ways to help poor countries develop affordable energy. Climate change alone is a weak leg on which to stand to justify a centrally-planned, massive change in energy production, infrastructure and cost.

Thank you for this opportunity to offer my views on climate change.

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