

CLIMATE CHANGE RESOURCE TOOL (Compiled by Harry Kangis; v 2.0)
ENGAGING IN A FACT-BASED DEBATE WITH CLIMATE CHANGE CRITICS

INTRODUCTION

This Resource Tool identifies the most common arguments made by those who attempt to deny that global warming exists or alternatively, if it does, that is it caused by human activity, and offers broadly accepted facts and scientific data as a response. In each section below, the primary arguments made against climate change are identified, followed by the suggested responses that support the existence of man-made global climate changes. There is a corresponding Appendix with details and the source of the data and conclusions for each area. There are also areas identified that require further information to respond effectively to arguments made by climate change opponents, as a way to solicit input from others.

While I am not trained as a scientist, I have been studying environmental issues for the 40 years (as a student at The Center for Environmental Studies at Williams College), and more intently during my 11 years as a strategic and marketing advisor to The Nature Conservancy (TNC) and currently as the Chair of TNC's Ohio Program. The Nature Conservancy has long utilized rigorous scientific data when implementing its mission to "protect the diversity of life on earth." TNC is widely respected for its non-confrontation approach to partnering with business and government to achieve large-scale and tangible solutions to protection of the environment.

Recently, we have witnessed a renewed attack on a preponderance of scientific evidence supporting the impending risks to our planet from Global Climate Change. Some of this critique results from "skeptics" (1) who embrace traditional scientific discourse that develops hypotheses and continually refines them based on analysis and peer review of empirical data. Some skepticism also comes from the recognition that there is always some degree of "experimenter's bias" in scientific studies, mainly because humans are involved, making the complete elimination of bias impossible. And as is the norm in current partisan times, the loudest opposition comes from those with certain ideological, political or economic agendas -- one recent article referred to this cohort as the "denialists" -- who often argue that no action should be taken unless the concept of global warming or any of the data supporting it can be assured without any doubt.

The strategic plan for my Ohio TNC Program identifies a number of focus areas that would reduce factors contributing to climate disruptions (e.g. cleaner energy, less deforestation, etc) and enable species to survive by adapting to inevitable changes in the environment (e.g. connecting landscapes). I initially developed this Resource Tool to assist our TNC Ohio Trustees in responding proactively and factually to those who characterize either Global Warming or Climate Change as "nonexistent" or "unproven" or worse some sort of orchestrated "hoax." I believe that doing so will help us move more quickly to the legitimate debate that must continue on the most effective strategies needed to address Climate Change risks locally and globally.

This document was developed with ongoing input from friends and associates both inside and outside of The Nature Conservancy. But it is my personal compilation of the facts as I see them, and as such in no way is intended to reflect the official position of The Nature Conservancy or of the authors whose material is highlighted here. The citations are provided in part to facilitate the reader's ability to search for the full text of each piece via the Web to draw their own conclusions.

Comments pro or con, clarifications, or other materials that would enhance this Research Tool are welcome via e-mail to harry@kangis.com. I devoted considerable time to this effort, because I believe without doubt that the future for my five grandchildren is at great risk due to accelerating concentrations of carbon dioxide in the atmosphere. The fact that the potential solutions may be quite difficult, very expensive, or possibly even futile in some instances is irrelevant to me at this stage. Step one is to agree on the problem, so we can move cooperatively to the best solution.

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SUMMARY OF THE ARGUMENTS ON CLIMATE CHANGE

A. Global Temperatures Are Increasing

What Skeptics Say (2): The Earth isn't warming—at least not to any extent that could actually be called a "crisis." And some data even suggest that the Earth is getting colder. The planet may have grown warmer over the course of the 20th century. But that warming stopped more than 10 years ago, and since 1998 the trend shows less warming or even cooling. Indeed, the period from December 2007 through November 2008 was the coldest 12-month span of the decade. Even if the planet isn't cooling, there's no evidence that warming is accelerating or that temperatures are increasing at an alarming rate.

Suggested Responses:

- ✓ The basic science about climate change remains unchanged and unequivocal. The world is warming. In fact, this first decade of the 21st century is expected to supersede the previous decade as the warmest ever recorded. Furthermore, the scientific evidence points, with ever increasing certainty, to the burning of fossil fuels and loss of forests as the primary causes of this current warming trend. These conclusions are based on the sum total of scientific evidence drawn from all available sources and reported in peer-reviewed scientific literature (Jonathan Hoekstra, Director TNC Climate Program, 12/11/09)
- ✓ The evidence is now overwhelming that the world needs action to combat global warming, said Rajendra Pachauri, head of the Intergovernmental Panel on Climate Change (IPCC), a U.N. expert panel. (AP Story, 12/13/09)
- ✓ Numerous losses of glacier ice, receding ice caps at both poles, and increases in sea levels are just one result of warmer temperatures.
- ✓ There have been natural periods of warming and cooling in the past, and will be in the future. These are cyclical, and those natural cycles are incorporated into the leading climate change models. Those models show that what we are experiencing now is not normal. In fact if you consider only natural factors the Earth should be cooling right now. But instead it is warming. Why? The answer is the increase in heat-trapping gases caused by burning fossil fuels, and from deforestation. (Bill Stanley, Dir. Of Conservation, OH TNC, 12/7/09)
- ✓ Recent data suggests that concentrations of atmospheric CO₂ and corresponding increases in temperatures are accelerating, and exceeding past estimates from the IPCC scientists; opponents often attempt to skew the data by selecting one unusually warm year (i.e. 1998) as the base period and then claiming the earth has been cooling since then.
- ✓ Climate change is occurring faster than previously predicted (Accelerating Growth of CO₂ emissions: 1970-79 +1.3ppm, 1980-89 +1.6ppm, 1990-99 +1.5ppm, 2000-06 +1.9ppm per NOAA 2007 study). Emissions, concentrations, temperatures (regional & global), & sea level are all rising at rates at or above those of earlier IPCC "high" scenarios. Arctic sea ice was at its second lowest level in modern times. Significant harm to human well-being is already occurring. Avoiding "dangerous" human interference is no longer possible: we're experiencing "dangerous" now. (John Holden, Dir. Of US Office of Science and Technology Policy, 6/09)
- ✓ There is a huge amount of non-scientific, agenda-driven misinformation trying to undermine CC science. The evidence for man-caused climate change is overwhelming and requires action, but that this does not mean we should treat the science as "settled." Climate change should be studied for years to come to build our understanding, and that process must permit dissenting views that are science-based. We should condemn both "bad science" and any effort to prevent good science from being pursued or heard. And in the meantime, we should not allow the concept of "settled" science to be used as an excuse to delay action.

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B. Climate Change is Predominantly Caused by the Actions of Man

WHAT SKEPTICS SAY (2): There is no consensus that human-caused warming is creating a disastrous rise in global temperatures. The causes of 20th-century warming are in sharp dispute among scientists, as is the amount of warming expected in the future. Natural factors are enough to account for the moderate warming we've seen since 1900. Changes in solar output in the past have contributed to wide temperature swings across the globe. Other natural phenomena, such as the El Niño Southern Oscillation and its cooling counterpart, La Niña, can cause large but temporary climate shifts. These normal fluctuations are enough to cause the warming of the planet, while the effects of greenhouse-gas emissions remain relatively small.

- ✓ Yet the case for human-driven warming, many scientists say, is far clearer now than a decade ago. Even some who remain skeptical about the extent or pace of warming say the premise underlying this week's talks is solid: that warming is to some extent driven by greenhouse gases spewing into the atmosphere from human activities like the burning of fossil fuels and deforestation. (AP Story, 12/13/09)
- ✓ Increases in atmospheric carbon dioxide are measurable back more than 650,000 years, via core samples from glaciers; high carbon dioxide levels are correlated directly with warmer temperatures. These increases grew, and at an accelerating rate, since the beginning of the industrial age and with the dramatic increases in population.
- ✓ Four-fifths of CO₂ emissions are from burning fossil fuels. Nearly all the rest is from deforestation and other changes in land use. (Nat'l Geographic 11/09)
- ✓ Higher concentrations of carbon dioxide are the "unambiguous result of human emissions." Concentrations of carbon dioxide and are gases are "well above the natural range of atmospheric concentrations compared to the last 650,000 years." (US EPA, 2009)
- ✓ Even if carbon usage per capita stabilized at today's levels, the earth's population is expected to grow from 6 billion to over 9 billion by 2050, leading to continued increases.
- ✓ Orbital cycles, solar flares, volcanic activity, and other natural factors appear to account for less than 10% of observed changes in global temperatures. Motor vehicles, power plants, buildings and industrial sources produce about 80% of the greenhouse gases from human activities while forest loss and forest degradation, and other land use changes contribute the balance. (TNC Climate Change Platform, 11/08)
- ✓ Most of the observed increase in globally averaged temperatures since the mid-20th century is *very likely** (**greater than 90% probability of occurrence*) due to the observed increase in anthropogenic greenhouse gas concentrations. (IPCC 4th Assessment Report and B. Santer, "Identifying Human Impacts on Climate Change", LLNL Program for Climate Model Diagnosis and Intercomparison). This study factors in the natural effects from solar and volcanic activity.

C. There Are Negative Impacts to Nature and Man From Climate Change

WHAT SKEPTICS SAY (2): There's no evidence that rising sea levels are linked to increased carbon-dioxide levels. Sea levels are certainly rising, and they have been since the last Ice Age 21,000 years ago. But the observed increases in the 20th century are relatively small, and recent studies indicate that sea levels may have risen more quickly in the first half of the century than in the second. There has been no sign of a recent acceleration in the rate of sea-level rise. The increases we have seen may reflect only periodic, decade-level fluctuations, not a continuing, long-term increase. This suggests the sea-level rises this century will be about the

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same as last century and could easily be accommodated.

- ✓ In addition to the mounting body of evidence in peer-reviewed scientific literature, TNC scientists are directly witnessing the consequences of climate change in many of the places we work. Coastal erosion is accelerating along the Eastern and Gulf coasts as sea level rises. Coral bleaching is more frequent and long lasting in part of the Coral Triangle. Receding sea ice and melting permafrost in the arctic is threatening bot wildlife and the livelihoods of people who live there. Warmer winters and drier summers are contributing to persistent bark beetle infestations and increased fire risks across huge swaths of the western US. (Jonathan Hoekstra, Director TNC Climate Program, 12/11/09)
- ✓ More severe and longer droughts and the negative effect on agriculture and drinking water.
- ✓ Melting of glacier and sea ice, resulting increase in sea levels already threatening low lying island nations (e.g. Maldives), and disappearing drinking water supplies reliant on glaciers (e.g. Bolivia).
- ✓ Species eradication from inability to adapt to changes happening faster than expected, bark beetles destroying millions of acres of N.A. forests as warmer winters cease to control their populations, spread of human diseases northward as host climate support viruses.
- ✓ More severe storms as warmer oceans help to fuel their power

D. Has There Been Climate Change Data Manipulation?

WHAT SKEPTICS SAY: After a recent e-mail scandal in East Anglia’s Climate Research Unit (CRU), opponents say this is evidence that scientists had been playing loose with the facts and that the entire case for man-made global warming could be fraudulent. (Time, 12/21/09)

Suggested Responses:

- ✓ E-mails stolen from climate scientists show they stonewalled skeptics and discussed hiding data from skeptics – but the messages don’t support claims that the science of global warming was faked, according to an exhaustive review by the Associated Press. (AP Story, 12/14/09)
- ✓ CRU data is just one strand among decades of studies that point toward the conclusion that global warming is real and dangerous and that man-made carbon emissions are the major cause. (Time, 12/21/09)
- ✓ To believe that global warming is a hoax you have to believe in a vast cabal consisting of thousands of scientists – a cabal so powerful that it has managed to create false records on everything from global temperatures to Arctic sea ice. (NYT, Paul Krugman, 6/29/09)
- ✓ The body of research in the literature is very large and the dependence on any one set of research results to the comprehensive understanding of the climate system is very, very small. Even if some of the charges of improper behavior in this particular case turn out to be true — which is not yet clearly the case — the impact on the science of climate change would be very limited. (American Meteorological Society, 11/25/09)
- ✓ In truth, of course, few if any of the CRU emails could legitimately be called scandalous. True, the files show scientists carrying on in a far less guarded fashion than they would in public, and some of them do appear suspicious—but in each individual case, we must also understand the context. Typically, the email-zipping scientists now under massive scrutiny are reacting in the communications to various controversies and scandals in the field—most of which are, in turn, the result of systematic attacks on climate research by conservative

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think tanks, politicians, and a small group of “skeptical” scientists. (Science Progress, Chris Mooney, 12/2/09)

- ✓ It is virtually impossible to disprove accusations of giant global conspiracies to those already convinced of them (can anyone prove that the Freemasons and the Roswell aliens aren't involved, too?). Let it therefore be noted that the magnitude of this hypothetical conspiracy would need to encompass many thousands of uncontroversial publications and respected scientists from around the world, stretching back through Arrhenius and Tyndall for almost 150 years. It is also one so powerful that it has co-opted the official positions of dozens of scientific organizations including the U.S. National Academy of Sciences, the Royal Society, the American Association for the Advancement of Science, the American Geophysical Union, the American Institute of Physics and the American Meteorological Society. (Scientific American, Seven Answers to Climate Contrarian Nonsense, 11/30/09)
- ✓ What we want to see are climate scientists earnestly engaged in the best traditions of the scientific process. Closely examining and calibrating their data to ensure quality and comparability. Reporting their methods, data and analyses in a transparent way that would allow others to verify and even replicate the work. Subjecting their findings to scrutiny by independent peer-reviewers. As a veteran of scientific publishing, I can attest that papers are more often than not rejected, and that sometimes reviewers' feedback is harshly critical. But that is part of healthy scientific discourse that improves papers and maintains high standards of scientific rigor. (Jonathan Hoekstra, Director TNC Climate Program, 12/11/09)

E. Is It Global Warming or Global Climate Change?

WHAT SKEPTICS SAY: Proponents are no longer calling the problem Global Warming, but now Global Climate Change, which proves that they are trying to hide something.

Suggested Responses:

- ✓ The decision to “rebrand” this potential crisis as Climate Change is actually an attempt to prevent confusion. How many times have you heard someone say on a cold day “so much for global warming.” Climate Change is a more accurate description of a broad range of global problems that will result from atmospheric warming, such as droughts, torrential rains, more severe hurricanes or tornados, or melting glaciers and corresponding increases in sea levels.
- ✓ The Director of the White House Office of Science and Technology, John Holden, suggests that Global Climate Disruption is an even more appropriate name, given the major disruptions likely to a wide range of natural systems due to increasing temperatures.

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APPENDICES (3)

A. APPENDIX - Data on Changes in Global Temperature

- GW-1 The key finding of IPCC AR4, "The warming in the climate system is unequivocal [...] ", is based on measurements made by many independent institutions worldwide that demonstrate significant changes on land, in the atmosphere, the ocean and in the ice-covered areas of the Earth. Through further, independent scientific work involving statistical methods and a range of different climate models, these changes have been detected as significant deviations from natural climate variability and have been attributed to the increase of greenhouse gases. (IPCC Working Group I, 12/4/09)
- GW-2 This decade is on track to become the warmest since records began in 1850, and 2009 could rank among the top-five warmest years, the U.N. weather agency reported at a 192 nation climate conference . . . In central Africa and southern Asia, this will probably be the warmest year . . . It said parts of China experienced their warmest year on record, and that Australia so far has had its third-warmest year. (AP Story, 12/9/09)
- GW-3 Despite recent fluctuations in global temperature year to year, which fueled claims of global cooling, a sustained global warming trend shows no signs of ending, according to a new analysis by the World Meteorological Organization made public on 12/8,09. The decade of the 2000s is very likely the warmest decade in the modern record. (Thomas Friedman, 12/13/09).
- GW-4 An example of the dynamic nature of climate variability was evident in 1998 when the average temperature lurched upward significantly (more than .72°C [1.3°F]). It turned out that the Pacific El Niño current was especially strong that year. Afterward, temperatures actually dropped a bit for the next couple of years. So, while measurements show that the average temperature of the planet has risen over the past century and likely will keep rising over the next 100 years, we should not expect every year to be warmer than the year before at every spot on the Earth. In some places, and even for the Earth as a whole, there may be years when it is actually a little cooler than the previous year. Nevertheless, the data indicates that over the long term, we're heading toward a hotter world—a reality that is further supported by our knowledge of the relationship between carbon dioxide, or CO₂, and other greenhouse gases and temperature, as well as our knowledge of the climate system. (Climate Central Website, 11/7/09)
- GW-5 July was the hottest the world's oceans have been in almost 130 years of recordkeeping. The average water temperature worldwide was 62.6 degrees, according to the National Climatic Data Center, the branch of the U.S. government that keeps world weather records . . . Breaking heat records in water is more ominous as a sign of global warming than on land, because water takes longer to heat up and does not cool off as easily . . . The warmer water affects weather on land . . . What's happening on the oceans will add extra juice to the hurricanes. (AP Story, 8/21/09).
- GW-6 There has been mounting scientific evidence of climate change – from melting ice caps to the world's ocean's hitting the highest monthly recorded temperatures this summer . . . Though there are exceptions, the vast majority of scientists agree that global warming is occurring and that the primary cause is a buildup of greenhouse gases in the atmosphere from the burning of fossil fuels. (AP Story, 10/23/09)
- GW-7 "The Arctic is warmer than it has been in 2,000 years, even though it should be cooling because of changes in the Earth's orbit that cause the region to get less direct sunlight. The Arctic had been cooling for nearly two millennia before reversing course in the last century and starting to warm as human activities added greenhouse gases to the atmosphere . . . The new report is based on a decade by decade reconstruction of temperatures over the past 2,000 years developed using information from ancient lake sediments, ice cores, tree

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rings and other samples.” (AP Story, study of Arctic temperatures published in the journal *Science*, 9/4/2009)

- GW-8 Cooler temperatures in North America last year do not mean global warming is easing, government and academic scientists said Friday . . . the last decade has been the hottest in thousands of years, according to climate records . . . North America wasn't as warm as expected because of cooler water in the North Pacific, but the rest of the world continued to warm. La Nina caused cold air from the Arctic to move south into North America, temporarily overwhelming the warming influence from climate change in the region . . . Our research shows there can be cold periods, but that does not mean the end of global warming . . . While temperature readings in North America dropped back to about the level of 1996 last year, it would have been even colder without the underlying effects of human-induced climate warming, said co-author Martin Hoerling of the earth Systems research Laboratory of the government's National Oceanic and Atmospheric Administration. (Judith Perlwitz, University of Colorado, report in the journal *Geophysical Research Letters*).
- GW-9 1998 was the world's warmest year in the U.K. Met Office Hadley Centre's records; recent years have been cooler, therefore, the previous century's global warming trend is over, right? Anyone with even a glancing familiarity with statistics should be able to spot the weaknesses of that argument. Given the extended duration of the warming trend, the expected (and observed) variations in the rate of increase and the range of uncertainties in the temperature measurements and forecasts, a decade's worth of mild interruption is too small a deviation to prove a break in the pattern, climatologists say. Recently, Associated Press reporter Seth Borenstein asked four independent statisticians to look for trends in the temperature data sets without telling them what the numbers represented. "The experts found no true temperature declines over time," he wrote. If a lull in global warming continues for another decade, would that vindicate the contrarians' case? Not necessarily, because climate is complex. For instance, Mojib Latif of the Leibniz Institute of Marine Sciences in Germany and his colleagues published a paper in 2008 that suggested ocean circulation patterns might cause a period of cooling in parts of the northern hemisphere, even though the long-term pattern of warming remained in effect. Fundamentally, contrarians who have resisted the abundant evidence that supports warming should not be too quick to leap on evidence that only hints at the opposite. (*Scientific American*, Seven Answers to Climate Contrarian Nonsense, 11/30/09)
- GW-10 Does a cold winter mean that global warming is over? No. Weather conditions at specific locations, including temperature, are dynamic and vary with regional and hemispheric weather patterns. The average global air temperature, which is the sum of regional temperatures, has been gradually rising over the past 100 years. According to NASA, the ten warmest years on record have occurred since 1997. *The Fourth Assessment of the Intergovernmental Panel on Climate Change*, or IPCC, reported in 2007 that 11 out of 12 of the years from 1995 to 2006—the exception being 1996—are 11 of the 12 warmest years since 1850. Despite the current global warming trend, it is important to remember that not all parts of the Earth warm equally or at the same rate. The Arctic, for example, is warming faster than other areas, while the equatorial region is warming much more slowly. In fact, the Arctic is warming so fast that some climate modelers project an ice-free Arctic Ocean in summertime—possibly as early as 2040, but very likely by end of the century—if emissions of greenhouse gases continue to grow at current rates. For periods of a few years, regional weather patterns can dominate local temperatures, masking a general upward trend in global temperatures. For example, suppose that the world's average temperature rises a fraction of a degree in a given year. The prevailing winds where you live might shift into a pattern that could actually make the winter in your area several degrees colder than normal. Even the worldwide trend is not a smoothly rising line, but rather a signal that fluctuates. Over a short timescale of a couple years, one can expect temperatures actually to fall below the average value, even though over a longer timescale

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the average is still rising. There is, as one would expect, natural variability within the overall trend. (Climate Central Website, 11/7/09)

- GW-11 The five hottest years on record have all occurred since 1997 and the 10 hottest since 1990, including the warmest year on record – 2005. During the 20th century, the Earth's average temperature rose one degree Fahrenheit to its highest level in the past four centuries – believed to be the fastest rise in a thousand years. Scientists project that if emissions of heat-trapping carbon emissions aren't reduced, average surface temperatures could increase by 3 to 10 degrees by the end of the century. Don't let *average* temperatures fool you: A one-degree increase may be found in one place, a 12-degree increase in another place, and yet other areas may become much colder. (TNC Website 12/09)

WHAT SKEPTICS SAY: Anthropogenic CO₂ can't be changing climate, because CO₂ is only a trace gas in the atmosphere and the amount produced by humans is dwarfed by the amount from volcanoes and other natural sources. Water vapor is by far the most important greenhouse gas, so changes in CO₂ are irrelevant.

- GW-12 Although CO₂ makes up only 0.04 percent of the atmosphere, that small number says nothing about its significance in climate dynamics. Even at that low concentration, CO₂ absorbs infrared radiation and acts as a greenhouse gas, as physicist John Tyndall demonstrated in 1859. The chemist Svante Arrhenius went further in 1896 by estimating the impact of CO₂ on the climate; after painstaking hand calculations he concluded that doubling its concentration might cause almost 6 degrees Celsius of warming—an answer not much out of line with recent, far more rigorous computations. (Scientific American, Seven Answers to Climate Contrarian Nonsense, 11/30/09)

WHAT SKEPTICS SAY: The alleged "hockey stick" graph of temperatures over the past 1,600 years has been disproved. It doesn't even acknowledge the existence of a "medieval warm period" around 1000 A.D. that was hotter than today is. Therefore, global warming is a myth.

WHAT SKEPTICS SAY (2): There's nothing especially unusual about today's temperatures. The Earth's climate is constantly changing, and climate shifts have been far more dramatic in the past. Temperatures rose during the Medieval Warm Period, which extended from about 800 to 1300 A.D., and the period was as warm or warmer than the 20th century. That's long before industrialization caused an increase in CO₂ levels, undermining the link between rising atmospheric carbon dioxide and rising temperatures. It's likely that the warming trend we're experiencing today is merely the expected return to warmer temperatures after the Little Ice Age, a period of extremely cold winters from the 16th to the early 19th century.

- GW-13 It is hard to know which is greater: contrarians' overstatement of the flaws in the historical temperature reconstruction from 1998 by Michael E. Mann and his colleagues, or the ultimate insignificance of their argument to the case for climate change. First, there is not simply one hockey-stick reconstruction of historical temperatures using one set of proxy data. Similar evidence for sharply increasing temperatures over the past couple of centuries has turned up independently while looking at ice cores, tree rings and other proxies for direct measurements, from many locations. Notwithstanding their differences, they corroborate that Earth has been getting sharply warmer. A 2006 National Research Council review of the evidence concluded "with a high level of confidence that global mean surface temperature was higher during the last few decades of the 20th century than during any comparable period during the preceding four centuries"—which is the section of the graph most relevant to current climate trends.

The report placed less faith in the reconstructions back to 900 A.D., although it still viewed them as "plausible." Medieval warm periods in Europe and Asia with temperatures

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comparable to those seen in the 20th century were therefore similarly plausible but might have been local phenomena: the report noted "the magnitude and geographic extent of the warmth are uncertain." And a new research paper by Mann and his colleagues seems to confirm that the Medieval Warm Period and the "Little Ice Age" between 1400 and 1700 were both caused by shifts in solar radiance and other natural factors that do not seem to be happening today. After the NRC review was released, another analysis by four statisticians, called the Wegman report, which was not formally peer reviewed, was more critical of the hockey stick paper. But correction of the errors it pointed out did not substantially change the shape of the hockey stick graph. In 2008 Mann and his colleagues issued an updated version of the temperature reconstruction that echoed their earlier findings. But hypothetically, even if the hockey stick was busted... What of it? The case for anthropogenic global warming originally came from studies of climate mechanics, not from reconstructions of past temperatures seeking a cause. Warnings about current warming trends came out years before Mann's hockey stick graph. Even if the world were incontrovertibly warmer 1,000 years ago, it would not change the fact that the recent rapid rise in CO₂ explains the current episode of warming more credibly than any natural factor does—and that no natural factor seems poised to offset further warming in the years ahead. (Scientific American, Seven Answers to Climate Contrarian Nonsense, 11/30/09)

B. APPENDIX - Data on Changes in Atmospheric Carbon Dioxide Levels; Caused By Man

- CD-1 If humanity wishes to preserve a planet similar to that on which civilization developed and to which life on earth is adapted, then the concentration of carbon dioxide in the atmosphere would have to be reduced from 395 parts per million to at most 350 ppm. (NYT Op-Ed, 12/15/09, Stewart Brand quoting scientist James Hansen)
- CD-2 Scientists generally regard 450ppm of CO₂ as a "tipping point" that could lead to irreversible damage to the planet . . . CO₂ has not been this high for at least 800,000 years, say the oldest air bubbles found in Antarctic ice cores . . . by 2008, the level of CO₂ was 385ppm and rising by 2 or 3 ppm per year . . . 450ppm will be passed by mid-century, a level many scientists consider dangerously high . . . the preindustrial level was 271ppm . . . even if we stop emissions completely, it will take centuries for plants and the ocean to soak up most of the human-made CO₂ . . . to stop it at 450ppm, the world will have to cut emissions by around 80% by 2050. (Nat'l Geographic 11/09)
- CD-3 As long as we pour CO₂ into the atmosphere faster than nature drains it out, the planet warms . . . even at the current emissions rate, CO₂ is released into the atmosphere nearly twice as fast as it is removed . . . plants and soil absorb about a third each year, and ocean surface water about a quarter . . . CO₂ absorbs some of the heat radiation coming off the Earth's sun-baked surface and radiates it back downward" (Nat'l Geographic 11/09)
- CD-4 Climate scientists, such as Rajenda Pachauri, head of a U.N.-organized group (IPCC) of thousands of climate experts, say the world is headed for dramatic changes unless nations slash emissions of carbon dioxide . . . the Earth already has warmed 1½ degrees" (USA Today Story, 9/23/09)
- CD-5 Researchers at MIT, who were previously predicting a temperature rise of little more than 4 degrees by the end of this century, are now predicting a rise of more than 9 degrees. Global gas emissions are rising faster than expected; some mitigating factors, like absorption of carbon dioxide by the oceans, are turning out to be weaker than hoped; and there's growing evidence that climate change is self-reinforcing – that for example, rising temperatures will cause some arctic tundra to defrost, releasing even more carbon dioxide into the atmosphere. (NYT, Paul Krugman, 6/29/09)
- CD-6 The basic physics of greenhouse gases have been understood since the late 19th century, at least. Certain gases absorb, and then re-emit heat. This has been proven irrefutably

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through research and simply cannot be debated. It stands to reason then that increasing the concentrations of those gases will, and has, increased global temperatures. There may be an honest debate about how much. (Bill Stanley, Dir. of Conservation, OH TNC. 12/7/09)

- CD-7 The world should stabilize atmospheric concentrations to limit global warming to 2 degrees F. above current levels . . . The most dangerous impacts of climate change are expected above this level . . . The IPCC estimates that past emissions will lead to unavoidable warming of about 1.3 degrees F. by the end of the century, even if atmospheric concentrations of greenhouse gases remain at 2000 levels . . . To have a 50% chance of staying below this tipping point level, we must stabilize CO₂ at 450ppm. This requires developed countries to reduce emissions by 35-50% below current levels (~387ppm) by 2020, and by 80-95% below current levels by 2050. (TNC Climate Change Platform, 11/08)
- CD-8 Contrarians frequently object that water vapor, not CO₂, is the most abundant and powerful greenhouse gas; they insist that climate scientists routinely leave it out of their models. The latter is simply untrue: from Arrhenius on, climatologists have incorporated water vapor into their models. In fact, water vapor is why rising CO₂ has such a big effect on climate. CO₂ absorbs some wavelengths of infrared that water does not so it independently adds heat to the atmosphere. As the temperature rises, more water vapor enters the atmosphere and multiplies CO₂'s greenhouse effect; the IPCC notes that water vapor may "approximately double the increase in the greenhouse effect due to the added CO₂ alone." (Scientific American, Seven Answers to Climate Contrarian Nonsense, 11/30/09)
- CD-9 Contrary to the contrarians, human activity is by far the largest contributor to the observed increase in atmospheric CO₂. According to the U.S. Geological Survey, anthropogenic CO₂ amounts to about 30 billion tons annually—more than 130 times as much as volcanoes produce. True, 95 percent of the releases of CO₂ to the atmosphere are natural, but natural processes such as plant growth and absorption into the oceans pull the gas back out of the atmosphere and almost precisely offset them, leaving the human additions as a net surplus. Moreover, several sets of experimental measurements, including analyses of the shifting ratio of carbon isotopes in the air, further confirm that fossil-fuel burning and deforestation are the primary reasons that CO₂ levels have risen 35 percent since 1832, from 284 parts per million (ppm) to 388 ppm—a remarkable jump to the highest levels seen in millions of years. (Scientific American, Seven Answers to Climate Contrarian Nonsense, 11/30/09)
- CD-10 Livestock methane results from the need to feed a growing population (expected to reach 9.3 billion by 2050), this will only make the climate change problem worse. (Fortune)
- CD-11 "The U.N.'s Intergovernmental Panel on Climate Change published a report two years ago saying the odds are better than 90% that global warming is caused by humans." (USA Today Story, 9/23/09)
- CD-12 The U.S. National Academy of Sciences has declared that climate change is occurring and that humans are very likely causing it. So have the scientific societies of China, France, Germany, India, Japan, Russia, Brazil, the United Kingdom, and many other countries. The Intergovernmental Panel on Climate Change, or IPCC, a body made up of hundreds of experts from scores of countries, issued their most recent report, the Fourth Assessment Report, in 2007, saying that "warming of the climate system is unequivocal." The IPCC periodically assembles peer-reviewed research on climate science into an overall picture. Representatives from member countries, including the U.S., negotiate the wording of the final report line by line. The most recent report says, "Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic GHG [human greenhouse gas] concentrations." More recently, in June 2009, the U.S. Global Change Research Program, which is a joint scientific venture of 13 federal agencies and the White House, released the results of a multiyear study. This

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study, like many others, found that “the global warming observed over the past 50 years is due primarily to human-induced emissions of heat-trapping gases. These emissions come mainly from the burning of fossil fuels (coal, oil, and gas), with important contributions from the clearing of forests, agricultural practices, and other activities.” Therefore, the overwhelming scientific consensus is that climate change is real, that it is being caused by human actions, and that there will be potentially significant impacts for people around the globe. (Climate Central Website, 11/7/09)

- CD-13 We know that burning coal, oil, and gas releases heat-trapping carbon dioxide, or CO₂. And we know, thanks to careful measurements that started in the late 1950s, that CO₂ levels in the atmosphere have been steadily climbing as we burn more. Not only that—chemists can tell the difference between the CO₂ released naturally by plants and animals and the CO₂ from burning fossil fuels. About a quarter of the CO₂ now in the atmosphere is the result of human activity. The one obvious natural suspect—the Sun—can pretty much be ruled out. It is an obvious suspect because astronomers know that the Sun can vary in brightness. When it does, the amount of heat it sends to the Earth varies too. It would not take much brightening to cause the increases in temperature we have seen. But satellites have been monitoring the Sun since the 1970s—when the fastest warming has been taking place—and the brightening just is not there. There is plenty of other evidence—the pattern of warming, for example, which is greatest in the Arctic, and the pace, which is faster (as best we can tell) than prehistoric warming episodes. The upper atmosphere has actually cooled, because so much heat has been trapped below. The bottom line is that nobody has come up with a natural explanation for the current warming episode that fits the observations. At the same time, the un-natural explanation—that our industrial civilization is a big part of the cause—fits the evidence. That’s how we know it is not natural. If the Earth has survived earlier warming episodes, what is so bad about this one even if it is not natural? The problem is that our civilization—where cities are located, where we grow food, where we get fresh water—is all based on the climate we have experienced for the last 10,000 years. So are many of the world’s ecosystems. If the climate changes, many of those things will suddenly find themselves in the wrong place. (Climate Central Website, 11/7/09)
- CD-14 Carbon dioxide (CO₂) is the most important greenhouse gas produced by human activity. Atmospheric CO₂ concentrations have increased from pre-industrial (1850’s) levels of 280 ppm to 379 ppm in 2005. The atmospheric concentration of CO₂ of today significantly exceeds the natural range of 180-300 ppm in the historical record of the last 650,000 years. Carbon dating confirms fossil fuel combustion is the primary source of increased CO₂ concentrations from the pre-industrial period. Global average temperature increases track upward with increasing atmospheric CO₂ concentrations. Warming of the climate system is evidenced by average global air and ocean temperatures increases, snow & ice pack melting, glacial retreat and rising global mean sea level. (Don McConnell, CEO Battelle Energy Technology, July 2009)
- CD-15 About 20% of greenhouse gases emitted into the atmosphere each year come from the destruction of forests – more than from all the planes, trains and automobiles in the entire world. And forests are disappearing at an alarming rate. One acre of forest is destroyed every second – a total of 37 million acres every year, or an area larger than Ohio. (REDD Conference sponsored by Ohio TNC and American Electric Power, April 2009)

C. APPENDIX – Data on Negative Impacts to Nature and Man From Climate Change

- IM-1 In 2007-2009, the summer melt reduced the Arctic Ocean ice cap to its smallest extent ever recorded . . . researchers found that Antarctica is warming more than previously believed. Almost all glaciers worldwide are retreating. Meanwhile, such destructive species as jellyfish and bark-eating beetles are moving northward out of normal ranges, and seas expanding

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from warmth and glacier melt are encroaching on low-lying island states. (AP Story, 12/9/09)

- IM-2 Unequivocal scientific evidence indicates that climate change is now occurring at an unprecedented rate. In the 20th Century, global temperatures increased by 1.3 degrees F., global sea level rose 7 in., and Northern Hemisphere snow cover declined 7%. Melting of glaciers at high elevations and latitudes has accelerated. Climate change is causing more droughts and other extreme weather events around the world, and warmer ocean surface waters are fueling an increase in the intensity of Atlantic hurricanes. The build up of atmospheric CO₂ is also increasing acidity in the oceans – threatening the health of marine systems. (TNC Climate Change Platform, 11/08)
- IM-3 Since 1997 (Kyoto), 1) the world's oceans have risen by about an inch and a half, 2) droughts and wildfires have turned more severe worldwide, from the U.S. West to Australia to the Sahel desert of North Africa, 3) temperatures are 0.4 of a degree warmer than the dozen years leading up to 1997, 4) in Greenland and Antarctica, ice sheets have lost trillions of tons of ice, 5) the level of CO₂ in the atmosphere has increased 6.5%, 6) world carbon emissions from burning of fossil fuels have increased 31%, 6) entire stands of North American pine forests are now in trouble due to changing climate. (AP Story 11/23/09)
- IM-4 "A marine scientist reports that Alaskan waters are turning acidic from absorbing greenhouse gasses faster than tropical waters, potentially endangering the state's \$4.6B fishing industry . . . Global warming effects in Alaska also include shrinking glaciers, coastal erosion and the march north of destructive forest beetles formerly held in check by cold winters." (AP Story, 9/4/09)
- IM-5 Climate change could cost between 5 and 20 percent of the annual global GDP, according to a British government report. In comparison, it would take 1 percent of GDP to lessen the most damaging effects of climate change. These global costs will be felt by local communities: a) In southern New England lobster catches have plummeted because of heat stresses and growing parasite threats due to rising sea temperatures; b) Ski resorts in the lower altitudes of the Swiss Alps have difficulty obtaining bank loans because of declining snow; c) In Lake Erie, climate change may significantly lower lake levels, altering shoreline habitats and costing millions for the relocation of ports and shore infrastructure; d) Globally, more intense hurricanes and downpours could cause billions of dollars in damage to property and infrastructure; e) Declining crop yields due to prolonged drought and high temperatures, especially in Africa, could put hundreds of thousands of people at risk for starvation; f) High sea temperatures also threaten the survival of coral reefs, which generate an estimated \$375 billion per year in goods and services. (TNC Website, 12/09)
- IM-6 Rising temperatures are changing weather and vegetation patterns across the globe, forcing animal species to migrate to new, cooler areas in order to survive. The rapid nature of climate change is likely to exceed the ability of many species to migrate or adjust. Experts predict that one-fourth of Earth's species will be headed for extinction by 2050 if the warming trend continues at its current rate. Many species are already feeling the heat: a) In 1999, the death of the last Golden Toad in Central America marked the first documented species extinction driven by climate change; b) Due to melting ice in the Arctic, polar bears may be gone from the planet in as little as 100 years; c) In the tropics, increased sea temperatures are causing more coral reefs to "bleach," as the heat kills colorful algae that are necessary to coral health and survival. (TNC Website, 12/09)
- IM-7 Scientific research indicates that climate change will cause hurricanes and tropical storms to become more intense — lasting longer, unleashing stronger winds, and causing more damage to coastal ecosystems and communities. Scientists point to higher ocean temperatures as the main culprit, since hurricanes and tropical storms get their energy from warm water. As sea surface temperatures rise, developing storms will contain more energy.

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At the same time, other factors such as rising sea levels, disappearing wetlands, and increased coastal development threaten to intensify the damage caused by hurricanes and tropical storms. (TNC Website, 12/09)

- IM-8 Higher temperatures increase the amount of moisture that evaporates from land and water, leading to drought in many areas. Lands affected by drought are more vulnerable to flooding once rain falls. As temperatures rise globally, droughts will become more frequent and more severe, with potentially devastating consequences for agriculture, water supply and human health. This phenomenon has already been observed in some parts of Asia and Africa, where droughts have become longer and more intense. Hot temperatures and dry conditions also increase the likelihood of forest fires. In the conifer forests of the western United States, earlier snowmelts, longer summers and an increase in spring and summer temperatures have increased fire frequency by 400 percent and have increased the amount of land burned by 650 percent since 1970. (TNC Website, 12/09)
- IM-9 As temperatures rise, so do the risks of heat-related illness and even death for the most vulnerable human populations. In 2003, for example, extreme heat waves caused more than 20,000 deaths in Europe and more than 1,500 deaths in India. Scientists have linked the deadly heat waves to climate change and warn of more to come. In addition to heat-related illness, climate change may increase the spread of infectious diseases, mainly because warmer temperatures allow disease carrying insects, animals and microbes to survive in areas where they were once thwarted by cold weather. Diseases and pests that were once limited to the tropics — such as mosquitoes that carry malaria — may find hospitable conditions in new areas that were once too cold to support them. The WHO estimates that climate change may have caused more than 150,000 deaths in the year 2000 alone, with an increase in deaths likely in the future. (TNC Website, 12/09)
- IM-10 If we prepare for climate change by building a cleaner power economy, but climate change turns out to be a hoax, what would be the result? During a transition period, we would have higher energy prices. But gradually we would be driving battery-powered electric cars and powering more and more of our homes and factories with wind, solar, nuclear and second-generation biofuels. We would be much less dependent on oil dictators who have drawn a bulls-eye on our backs; our trade deficit would improve; the dollar would strengthen; and the air we breathe would be cleaner . . . But if we don't prepare and climate change turns out to be real, life on this planet could become a living hell. . . . When I see a problem that has even a 1 percent probability of occurring and is "irreversible" and potentially "catastrophic," I buy insurance. That is what taking climate change seriously is all about. (Thomas Freidman, 12/13/09)
- IM-11 "A temperature rise of more than 3½ degrees could melt the ice covering Greenland – raising sea levels 20 feet . . . If Antarctica's ice melts too, cities such as Hong Kong and Miami would be threatened . . . At above 3½ degrees, great swaths of the Amazon rainforest will die." (USA Today Story, 9/23/09)
- IM-12 As the Earth heats up, sea levels rise because warmer water takes up more room than colder water, a process known as thermal expansion. Melting glaciers compound the problem by dumping even more fresh water into the oceans. Rising seas threaten to inundate low-lying areas and islands, threaten dense coastal populations, erode shorelines, damage property and destroy ecosystems such as mangroves and wetlands that protect coasts against storms. Sea levels have risen between four and eight inches in the past 100 years. Current projections suggest that sea levels could continue to rise between 4 inches and 36 inches over the next 100 years. A 36-inch increase in sea levels would swamp every city on the East Coast of the United States, from Miami to Boston. Worldwide, approximately 100 million people live within three feet of sea level. Sea level rise associated with climate change could displace tens of millions of people in low-lying areas – especially in developing countries. Inhabitants of some small island countries that rest barely above

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the existing sea level are already abandoning their islands, some of the world's first climate change refugees. (TNC Website, 12/09)

D. APPENDIX Data on the Recent Controversy About UK Scientists Manipulating Data

- UK-1 While critics now question CRU's climate records, its results match those of other agencies (National Oceanic and Atmospheric Administration and NASA Goddard Institute); all show a dramatic warming trend. Temperature graph from 1880 to present for all three groups track with a high degree of consistency (Time, 12/21/09)
- UK-2 The 1,073 e-mails show that scientists harbor private doubts, however slight and fleeting, even as they told the world they were certain about climate change. However, the exchanges don't undercut the vast body of evidence showing the world is warming because of man-made greenhouse gas emissions. (AP Story, 12/14/09)
- UK-3 The body of evidence is the result of the careful and painstaking work of hundreds of scientists worldwide. The internal consistency from multiple lines of evidence strongly supports the work of the scientific community, including those individuals singled out in these email exchanges, many of whom have dedicated their time and effort to develop these findings in teams of Lead Authors within the production of the series of IPCC Assessment Reports during the past 20 years. The IPCC assessment process is designed to ensure consideration of all relevant scientific information from established journals with robust peer review processes, or from other sources that have undergone robust and independent peer review. The entire report writing process of the IPCC is subjected to extensive and repeated review by experts as well as by governments. Consequently, there is full opportunity for experts in the field to draw attention to any piece of published literature and its basic findings that would ensure inclusion of a wide range of views. In compliance with the procedures of IPCC, the conclusions of AR4 have undergone scrutiny in the form of several stages of reviews by peers and governments, have been revised and refined to take into account these review comments, and have finally been approved word by word by the governments of the world¹. Every layer in the process (including large author teams, extensive and multi-step reviews, independent monitoring of review compliance, and plenary approval by governments) plays a major role in keeping IPCC assessments comprehensive, unbiased, open to the identification of new relevant literature, and policy relevant but not policy prescriptive. Therefore, no individual scientist in the IPCC assessment process is in a position to change the conclusions, or to exclude relevant peer-reviewed papers and scientific work from an IPCC Assessment Report.
- UK-4 It is unfortunate that an illegal act of accessing private email communications between scientists who have been involved as authors in IPCC assessments in the past has led to several questions and concerns. It is important for me to clarify that the IPCC as a body follows impartial, open and objective assessment of every aspect of climate change carried out with complete transparency. IPCC relies mainly on peer-reviewed literature in carrying out its assessment and follows a process that renders it unlikely that any peer reviewed piece of literature, however contrary to the views of any individual author, would be left out. The entire report writing process of the IPCC is subjected to extensive and repeated review by experts as well as governments. Consequently, there is at every stage full opportunity for experts in the field to draw attention to any piece of literature and its basic findings that would ensure inclusion of a wide range of views. There is, therefore, no possibility of exclusion of any contrarian views, if they have been published in established journals or other publications which are peer reviewed. (P.K. Pachauri, head of the IPCC)
- UK-5 Lawrence Livermore National Lab scientist Ben Santer said that he and others are inundated by frivolous requests from skeptics designed to "tie-up government funded scientists." (AP Story, 12/14/09)

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- UK-6 The truth, however, is that while the CRU emails don't always look very good—and not all of them can necessarily be defended—in the end this saga amounts to little more than a distraction from the real and burning issues in climate science and climate policy. Moreover, its suspicious timing—coming just weeks before the U.N. Copenhagen climate conference—suggests a strategic attempt to undermine those international deliberations by once again casting doubt on the scientific basis for concern about climate change—a tried, true, and seemingly unending political strategy. Unfortunately for climate skeptics, the CRU hacking incident fails to support the burden that they have placed upon it. Whatever behavior was revealed in these emails, even its most salacious interpretation can scarcely undermine the global edifice of knowledge about the causes of ongoing climate change—which may be bolstered by, but certainly does not rely solely upon, CRU's research and analyses. Mainline scientists fully recognize this; thus, following the CRU hacking, the American Meteorological Society reaffirmed its longstanding statement on the human causation of climate change, remarking that "Even if some of the charges of improper behavior in this particular case turn out to be true—which is not yet clearly the case—the impact on the science of climate change would be very limited." (Science Progress, Chris Mooney, 12/2/09)
- UK-7 The beauty of science is that it depends on independent verification and replication as part of the process of confirming research results. This process, which is tied intrinsically to the procedures leading to publication of research results in the peer-reviewed literature, allows the scientific community to confirm some results while rejecting others. It also, in a sense, lessens the impact of any one set of research results, especially as the body of research on any topic grows. (American Meteorological Society, 11/25/09)
- UK-8 Climate scientists continue their research to increase knowledge on many aspects of climate change, including predictions about how quickly temperatures are likely to rise, what impact melting glaciers will have on sea level, and whether hurricanes will increase in quantity or intensity. Such information is essential if we are to wisely and effectively mitigate the potential impacts of climate change. The climate system is extraordinarily complex. Understanding it is a grand scientific challenge. (Climate Central Website, 11/7/09)
- UK-9 The stolen emails come from a single research center, and concern only a fraction of available data sets – not enough to overturn the entire body of climate science. Opponents of climate action are portraying the content of these emails as "evidence" that the science of climate change is wrong. However, mostly what they reveal is that scientists are still people, and that some of them can be derisive – even vindictive – toward their critics. While some scientists' comments were unbecoming, charges of nefarious manipulation or censorship of the science do not appear substantiated. For example, in one of the e-mails, a scientist says he uses a "trick" in analyzing climate information, but taken in context of conversation between scientists, "tricks" are just clever ways of doing otherwise complicated analysis, and does not mean that the science being used is bad or misleading. Nonetheless, we support decisions by East Anglia and Penn State to investigate this matter more thoroughly to ensure that open scientific inquiry is not impeded by political agendas of any sort. (Jonathan Hoekstra, Director TNC Climate Program, 12/11/09)

WHAT SKEPTICS SAY: Climatologists have a vested interest in raising the alarm because it brings them money and prestige.

- UK-10 If climate scientists are angling for more money by hyping fears of climate change, they are not doing so very effectively. According to a 2006 Government Accountability Office study, between 1993 and 2004, U.S. federal spending on climate change rose from \$3.3 billion to \$5.1 billion—a 55 percent increase. (Total federal nondefense spending on research in 2004 exceeded \$50 billion.) However, the research share of that money fell

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from 56 percent to 39 percent: most of it went to energy conservation projects and other technology programs. Climatologists' funding therefore stayed almost flat while others, including those in industry, benefited handsomely. (Scientific American, Seven Answers to Climate Contrarian Nonsense, 11/30/09)

E. APPENDIX – Data on Rebranding of Global Warming as Global Climate Change

- CC-1 Climate experts now believe that “global warming” is not a precise enough definition of this problem, because it misleads people to believe that the problem is a) uniform across the planet, b) mainly about temperature, c) gradual, and d) quite possibly benign. What’s actually happening is a) non-uniform, b) not just about temperature, c) rapid compared to capacities for adjustment, and d) harmful for most places and times. Climate = Weather Patterns that are in reality averages, extremes, timing and spatial distribution of hot & cold, cloudy & clear, humid & dry, drizzles & downpours, snowfall/snowpack & snowmelt, breezes/blizzards/tornados & typhoons. Climate Change is about disruptions of these patterns. (John Holden, Dir. Of US Office of Science and Technology Policy, 6/09)
- CC-2 Depending on who is talking, there can be an enormous difference between global warming and climate change—or no difference at all. A lot of people, including many journalists who write about the topic, use the two terms interchangeably. When reporters first began doing stories back in the late 1980s about how humans seemed to be doing things that result in heating up the planet, the term they usually used was global warming. That’s because the basic effect of greenhouse gases like carbon dioxide is to do exactly that. They trap more and more of the Sun’s energy and drive the average temperature of the planet upward. But that is only one dimension of the issue. Average temperature is global. Climate is local, and involves not just average temperature, but also other factors that vary, such as humidity, cloudiness, rain (or snow), how this precipitation is spread throughout the year (does it mostly come in one short burst, or over a rainy season, or evenly all year long, or something in between?). If you live by the sea, ocean currents also make a difference. London, England, is farther north than Montreal, Canada, for example but it has much milder winters, because the Gulf Stream carries warm water across the Atlantic to keep it relatively balmy.

Scientists have learned that raising the Earth’s temperature is very likely to change many of these factors. So while global warming is what’s causing it, what most people are going to notice is not necessarily warming but rather a change in climate. There is one more factor. Some people want to emphasize the potentially serious consequences of the problem. Others want to convince everyone to think that it is not such a big deal, or that humans are not really causing the problem in the first place. So they choose one term or the other because they think it sounds more or less scary. But since nobody can agree about which term actually is scarier, both groups use both terms at different times. That sounds pretty confusing. The bottom line is that while global warming is not wrong, climate change more accurately describes what is happening. That is a major reason that many people have settled on the latter term. But most of the time, whether people use global warming or climate change, they’re almost certainly talking about the same thing. (Climate Central, 20 Questions and Answers About Climate Change, 11/7/09)

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OTHER QUESTIONS RAISED BY CLIMATE CHANGE CRITICS

WHAT SKEPTICS SAY: Records of surface temperatures are unreliable and exaggerate the amount of warming. The reason some scientists think the planet is warming drastically is that they're relying on temperature readings from ground weather stations that in many cases have been artificially boosted by an "urban heat island" effect. Most temperature-gathering weather stations are located in cities or towns. Yet cities generally trap more heat—in asphalt, concrete and other structures—and the effect can be significantly greater than any warming effects of greenhouse gases.

WHAT SKEPTICS SAY: Satellite temperature readings are more reliable than those taken from surface weather stations, and satellites show little warming over the past 30 years. Satellite readings of temperatures of the lower atmosphere compiled by the University of Alabama-Huntsville show a smaller warming trend over the past 30 years than the surface record. This minor temperature increase is well within natural variations. It may even point to a break, around 2002-03, in the 20 century warming trend.

WHAT SKEPTICS SAY: An increasing amount of climate research suggests a possibility of global cooling. Geologist Dr. Don. J. Easterbrook, emeritus professor at Western Washington University says "Recent solar changes suggest that it could fairly severe, perhaps more like the 1880 to 1915 cool cycle than the more moderate 1945-1977 cool cycle. A more drastic cooling, similar to that during the Dalton and Maunder minimums, could plunge the earth into another Little Ice Age, but only time will tell if that is likely"

WHAT SKEPTICS SAY: Polar ice isn't disappearing. Warmer temperatures are partly responsible for recent declines in sea ice in the Arctic, but shifting winds are the main factor. What's more, declines in the northern ice cap have been counterbalanced by increases in the Antarctic ice pack, so there's little net loss of polar ice. These opposite trends argue against the existence of man-made global warming.

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FOOTNOTES

- (1) A NYT Op-Ed written by Stewart Brand (12/15/09) categorized the views on Global Warming into four major groups: "Denialists" who are loud, sure and political. Their view is that climatologists and their fellow travelers are engaged in a vast conspiracy to panic the public into following an agenda that is political and pernicious (think Sen. James Inofe). "Skeptics" is a group most interested in the limitations of climate science so far: they like to examine in detail the contradictions and shortcomings in climate data and models, and they are wary about any "consensus" in science (think James Hansen). To skeptics' discomfort, their arguments are frequently quoted by the denialists. "Warners" are the climatologists who see the trends in climate heading toward planetary disaster, and they blame human production of greenhouse gases as the primary culprit (think Al Gore). "Calamatists" believe that industrial civilization has committed crimes against nature, and retribution is coming (think Jeremy Rifkin).

The calamitists and denialists are primarily political figures, with firm ideological loyalties, whereas the warners and skeptics are primarily scientists, guided by ever-changing evidence. That distinction between ideology and science not only helps clarify the strengths and weaknesses of the four stances, it can also be used to predict how they might respond to future climate developments.

- (2) Most of the information on skeptics came from an excellent article in the 12/7/09 Wall Street Journal, "The Case Against Global Warming and How Believers Respond" by Michael Totty
- (3) Each citation is uniquely numbered to make cross-referencing and discussion easier. The letter codes correspond to the issues addressed: GW (Global Warming), CD (Carbon Dioxide), IM (Impacts on the planet), UK (the UK hacked e-mails controversy), and CC (Climate Change vs Global Warming as the concept)