Global Warming and Climate Change in a Nutshell

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June 23, 1988 was a big day for this story. On that day, James Hansen, director of NASA's Goddard Institute for Space Studies, testified in Washington before a packed congressional hearing, saying that earth's temperatures were being increased by human-caused greenhouse gases and that the planet had entered a period of long-term warming. Hansen's statement that day had particular force since the outside temperature was a record 98° F and the air-conditioning in the committee room had failed. The response of the Reagan administration was to cut the funds of the Goddard Institute.

The Global Warming Record: The UN's Intergovernmental Panel on Climate Change (IPCC) has found that the earth's land/ocean temperature has increased since 1880 by 0.85° Celsius (1.45° F) and that 13 of the hottest years have occurred over the past 14 years. Both the National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA) have found that 2014 was the planet's hottest year on record and NOAA recently announced that the 1st quarter of 2015 was the hottest 1st quarter ever. With evidence now of a new El Nino, 2015 is likely to surpass 2014. The evidence of actual global warming is now indisputable. Even the U.S. Senate recently voted 98 – 1 that climate change is happening.

Global warming of 0.85° C may not seem large. However, a

global temperature increase of 4° C (7.2° F) is about the difference between temperatures today and those in the last ice age when much of central Europe and North America were covered with kilometers of ice.

Claims of Global Warming Pause: Some climate skeptics claim that there has been no global warming in the last 15 years. But climate scientists have pointed out such claims are deceptive since (1) temperatures in 1998 were exceptionally high because of a strong El Nino, (2) a series of La Nina events has cooled sea water surfaces in the tropical Pacific since 2000 and (3) the ocean has absorbed over 90% of the earth's warming. Moreover, a recent NOAA report finds that, after making necessary corrections in ocean temperature readings, the rate of warming from 2000 to 2014 is basically identical to the rate that occurred from 1950 to 1999. NOAA has also found that each of the last three decades has been successively warmer than any preceding decade since 1850, and that recent years have been the warmest with 2014 taking the record. The global temperature charts from 1880 to the present show a steady increase in global warming over that time.

Human Activity as the Cause: As for humans as the cause, the evidence is that the main greenhouse gas, carbon dioxide (CO_2) increased in the atmosphere from 280 parts per million (PPM) in 1750 to over 400 PPM in 2014. NOAA announced on May 6, 2015 that "[f]or the first time [based on air samples taken from 40 global sites], the monthly global average concentration of [CO_2] surpassed 400 PPM in March 2015." As the earth receives ultraviolet energy from the sun, the infrared energy it reflects back into space is trapped by the band of CO_2 and other greenhouse gases and reflected back to

earth, causing it to warm. Earth's temperature has increased as the level of CO_2 has increased. There is a clear link between the two.

Other green house gases include mainly methane and water vapor. Methane is 34 times more effective than CO_2 in trapping heat but it endures in the atmosphere for only about 12 years while CO_2 lasts for hundreds of years. Water vapor, which also traps heat, has increased in the atmosphere mainly because warmer air holds more water.

The main source of both CO_2 and methane is the burning of fossil fuels by humans. Coal plants account for 44% of atmospheric CO_2. Cars and trucks account for 30% and deforestation, 20%. Methane is also produced by landfills, incineration, rice agriculture and cattle. Some comes from natural sources such as wetlands. Huge releases of methane are threatened by future melting of the Arctic permafrost and the breaking down of methane hydrates located on the continental shelves.

Since 3000 BC, "natural forces" of the planet and the solar system (these include changes in the tilt of the earth's axis and the earth's orbit patterns around the sun, and the level of solar irradiance) have all actually been working in favor of a cooling of the earth. Consequently, the increase in earth's temperature can only be explained by human-caused greenhouse gases, which have overwhelmed the natural forces.

Results of Global Warming: Sea Level Rise: One of the biggest consequences of global warming is the actual and threatened rise of sea levels. Measurements show global average sea levels rising five

inches over the past century but the rate increased substantially toward the end of the 20th century. We have seen pictures of drivers negotiating wet streets in some parts of southern Florida at high tide. The science panel of the N.C. Coastal Resources Commission recently released information about sea level rise along our coast, which estimates that by 2045 the rise at Duck could be between a low of 4.4 inches and a high of 10.6 inches. South of Cape Hatteras the rise is expected to be less with a high of 6.8 inches estimated at Wilmington. A group of ninety sea level experts has estimated that with "business as usual," worldwide sea levels could rise by as much as 3.9 feet by 2100 and 9.8 feet by 2300. The National Climate Assessment stated that a rise of 6 feet by 2100 could not be ruled out. A rise of only three feet would put New York, Miami and New Orleans in peril, along with many other cities around the world.

Sea level rise is caused both by the fact that warmer water expands and by the melting of the Greenland, Arctic and Antarctic ice sheets. Melted completely, the West Antarctic sheets would increase sea levels by about 16 feet. The Pine Island Glacier in West Antarctica is now in irreversible melt. The Greenland ice sheet alone, which is 1.2 miles thick and is roughly the size of western Europe, would increase sea levels by another 23 feet. The Greenland sheet has recently experienced unprecedented melting and it is expected that summers will be ice-free in the Arctic before the end of the century. The ultimate potential for sea level rise is mind boggling: during the dinosaur age when there were no glaciers, sea levels were 600 feet higher than they are today.

But all of the above about sea level rise may be too conservative according to a paper just issued in July 2015 by James

Hansen and 16 other climate scientists. Their research indicates that the Greenland, Arctic and Antarctic ice melting may be happening at a nonlinear rate, not at the linear rate
used by the IPCC. They believe that the melting is occurring 10 times faster than the IPCC estimated. This higher rate of melt may block the oceans' "overturning circulation," which in turn, may trigger "large scale [ice] disintegration with sea level rise of at least several meters," as opposed to one-meter by 2100, (which was the latest IPCC forecast) and at least 10 feet 50 years from now.

Other Consequences of Global Warming: Other adverse effects of global warming include: (1) intolerable heat. In the Southeastern U.S. average residents have experienced over the past 30 years about 8 days each year with temperatures of 95° or more. With business as usual, this will increase to 17 – 52 days by mid-century and 48 – 130 days by century end.

(2) Simultaneous droughts (with associated forest fires) in areas already drought-prone and floods elsewhere: with hotter days, the sun will evaporate into the atmosphere more water from certain areas and that water will produce floods elsewhere. Studies show that drought-prone areas such as California, the southwestern U.S. and the plains states will see even more droughts. Expansion of droughts will, of course, adversely affect food supply as the world tries to feed nine billion people by 2050.

(3) Adverse effects on global health: as the earth warms, tropical diseases will spread to parts of the world not now affected by them.

Avoiding Catastrophic Global Warming: Climate scientists believe that a serious effort to control global warming would require that the temperature increase from 1880 to 2100 not exceed 2° Celsius (3.6° **F)** of which the 0.85 degrees has already occurred. (Some scientists, including James Hansen, believe that the 2-degree objective is insufficient and that it should actually be one degree.) Achieving the 2-degree temperature goal would require that new CO_2 emissions by century end not exceed 1 trillion tons. But, at current rates, that level of emissions will occur within 30 years. The IPCC has found that achieving the 2-degree goal would require reducing CO_2 emissions by 40 – 70% by 2050 and to virtually zero by 2100. Even if this goal is met, the Risky Business Report found that "Climate change over the next few decades is already a done deal." Reducing CO_2 emissions is not about reducing temperatures in the near term but about preventing even more serious damage 50 -100 years from now.

Acknowledgment of the Problem: Many companies and business people have acknowledged the global warming problem. The business plans of more than two dozen of the largest companies, including the five major oil companies, forecast that they will be required to pay a price for carbon pollution. ExxonMobil has openly acknowledged that carbon pollution from fossil fuels contributes to climate change. Several companies in SEC filings have stated that the adverse impact of warmer climate on agricultural products may hurt profits. The CEO's of 43 companies with combined sales of $1.2 trillion last year have promised to reduce the carbon output of their companies and have urged world leaders to forge a strong carbon reduction agree at the Paris meeting, which occurred in December 2015. Large investors have asked 45 of the largest energy companies about threats to their stock values arising from reductions

in fossil fuel use. The Pentagon is studying the vulnerability of its more than 7000 bases.

Actual and Necessary Actions: Actions to combat global warming include mandatory green house gas emission limits sometimes consisting of "cap and trade" systems and carbon pricing mechanisms. The U.S. used a cap/trade system on sulphur dioxide to control acid rain. But the use of such systems in California and Europe has been thought not to work very well.

The U.S. has committed to reduce greenhouse gas emissions 28% below the 2005 level by 2025 and China has committed that its emissions will peak by 2030. The EPA's recently-announced proposed regulations regarding coal-fired power plants require existing plants to reduce emissions 32% below 2005 levels by 2030 and the requirements for new coal plants essentially make them nonviable. The new rule would also require electric utilities to invest more quickly in renewable sources, increasing to 28% from 22% the amount of capacity that would be supplied by renewable sources. States must submit initial versions of their plans by 2016, final versions by 2018 with full implementation by 2022. Some would say, however, that such actions are insufficient.

Another "solution" discussed has been to impose a price on carbon so as to cause further emissions from fossil fuel sources to be more costly. Citizens Climate Lobby (CCL) has a "carbon fee and dividend" plan that would impose a $15/ton price on carbon to be increased by $10 per year until CO_2 emissions have been reduced to 10% of their 1990 level. Its plan would distribute to citizens on a monthly basis all of the funds collected. CCL has also produced a

study that shows the plan would dramatically reduce CO_2 emissions, would produce 2.2 million jobs in the first ten years and would phase out coal use by 2025. Other studies show that a carbon tax would cut emissions and could create 2.7 million jobs, reducing the unemployment rate by 1.5%. It has also been pointed out that, with the drop in gasoline prices of over $1/gallon a carbon tax imposed now would be painless since even a $25/ton carbon tax would increase gasoline prices by only 25 cents.

Conservative commentators have endorsed a carbon pricing system in part because it would not involve an increase in the size of government. Conservative economist, Douglas Holtz-Eakin has said, "I'd be shocked if people supported anything other than a carbon tax – that's how economists think about it." Economist William Nordhaus has said that without "an effective policy of carbon pricing, we will get virtually nowhere in slowing climate change."

Actions by many persons and entities are being announced on a daily basis. On July 27, 2015, Hillary Clinton announced as a goal if she becomes President to produce 33% of the nation's electricity from renewable sources by 2027, up from 7% today and more than the 20% that President Obama has called for by 2030. Clinton called for installing ½ billion solar panels by 2020, a sevenfold increase from today, and to generate "enough energy from carbon-free sources within 10 years of her inauguration to power every home in America."

And on July 28, 2015 big box retailer Target announced a plan to put solar panels on 2/3rds of its stores in North Carolina and, in doing so, to join other big box retailers who have done the same or have similar plans.

Our global warming problem is like an automobile driver noticing on a trip that the gauge has been showing a steady increase in temperature. In that situation, most drivers would stop promptly to investigate before smoke starts billowing from underneath the hood. With global warming we have seen the temperature steadily increasing. Like the driver, we should stop now and take action to slow and halt global warming.