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Global Warming

Earth is traveling through the vacuum of space where temperature is -441° F. Was it not for the sun, that would be about the temperature outside to night. But as it is, earth is heated by short wavelength radiation from the sun, only half of which manages to pass through our atmosphere to warm land, sea, and sunbathers. The other half of the sun's radiation directed toward our planet never reaches us, it is reflected into space off the top of clouds and the stratosphere.

I believe that the earth has had periods of warming and periods of cooling. I believe that the earth is now in a warming period. I believe rising levels of CO_2 and other greenhouse gases in the atmosphere trap heat from radiating to space are responsible for rapid rise in land and sea temperatures that has spawned excessive climate conditions that are evident today –more hurricanes and typhoons, warmer earth surfaces changing local weather conditions, shrinking sea ice at both poles, melting glaciers, and retreating snow cover in polar regions. I believe that temperature will continue to rise as more greenhouse gases are released.

Do we go forward disregarding the warnings of 18 United States Government agencies, private scientific associations, and 200 national scientific bodies of experts in climatology? They forecast catastrophic irreversible damage to our earth and risk the quality of life for our children and their grandchildren. This raises the ethical choice we must make.

Do we decide to do nothing and let CO_2 accumulate. Do we decide that a climate change resulting in higher global temperature is acceptable and limit the amount of CO_2 in the future to what we believe will maintain it. Do we decide that we want the climate as it now or was in 1994.

All peoples on this earth will be affected by the collective actions of all nations. At the 1972 United Nations Conference on Human Environment in Stockholm, it was agreed that nations would not cause damage to the environment. In the case of climate change, the United States and 150 other countries ratified the Framework Convention on Climate Change in 1992 to stabilize greenhouse gas concentrations at a level that does not endanger humans or ecosystems. Some observers believe we are already at that point. Others propose ways to cool the earth while working to reduce the level of emissions in line with what they were in 1994.

We are not doing such a hot job of reducing CO_2. In 2012 the world released a reported 34 billion tons of CO_2 into the atmosphere and unchecked, it will release more in the years to come. The Massachusetts Institute of Technology estimates that, given current

trends, the concentration of atmospheric CO_2 will increase from 380 ppm today to 500 by 2050, and 800 ppm by the year 2100. A report by the professional services firm PriceWaterhouseCoopers, forecasts that a rise to 750 ppm of CO_2 in the atmosphere will trigger an average global temperature increase of 7.2°F above pre-industrial levels. The natural processes by which CO_2 is removed from the atmosphere and oceans work too slowly to offset current emissions rates.

I suspect that some of you may have doubts that we are experiencing a global warming but many of you who do believe in climate change are damn sure human activities are not playing a part in it. Against those beliefs is the results of over a hundred years of debate in the scientific communities about what variations of CO_2 content in the atmosphere could do to global temperature.

There also seems to be distrust of the data collected by NASA and NOAA. Both agencies collect temperature data for the world to see and use. Yet there are some that believe the data is rigged to conform to some nefarious scheme held by an overwhelming percentage of climate experts who are trying to protect the illusion of dangerous warming so that their sources of funding will not dry up. I for one don't believe NASA or NOAA would risk their credibility by falsifying their data. However, for a variety of reasons there has grown a faction of bloggers who profess their gut disbelief in global warming. Here are a number of their comments with no basis of solid facts:

1. Global warming is a hoax that the United Nations is using in order to gain power by enforcing so many environmental restrictions that developed industrial democracies will be driven to bankruptcy and the world will turn to socialism under its control.
2. Global warming is a lie as proven by leaked emails in 2009, of The University of East Anglia's, Climate Research Unit's attempt to suppress views of scientists who have contrary views of global warming.
3. Atmospheric CO_2 is increasing but temperature over the same period has barely changed.
4. Temperature has not risen in the last 13 years.

Remember, these are bloggers' comments on the internet where they can say anything without the trouble of assembling facts.

5. Climatology guys don't understand why the little ice age ended or why the medieval warm period ended so how can they explain what's happening now.
6. The Chinese Academy of Science has calculated changes in temperature for the past 2,485 years but has not confirmed the rapid rise in temperature in the late 20th and early 21st centuries.
7. Socialists are trying to destroy capitalism.
8. And climate change is based on nothing but computer models using unproven computer generated programs that are always wrong.

Very few bloggers offer evidence or have their views presented in scientific publications. The web site, co2science publishes some interesting papers that are mostly about how to handle CO_2 but not much about whether global warming is fact or fiction. Forbes business magazine (not a science journal) carries articles by Professor Larry Bell at the University of Houston,
Texas youtube.com/climateofcorruption and James Taylor at The Heartland Institute, who both refute Global Warming. They and others like to point out that global temperatures have not increased every year since 1966 while failing to address the facts that every decade since 1970 has been hotter than one before it.

Now, a word about how temperatures are collected. There is reported to be 4,138 surface thermometers stationed around the globe...mostly in the USA and Europe that supply the highest and lowest temperature for every day. From that network, up to 100 have been selected to be the most representative. Satellites orbiting the earth beginning in 1979 monitor an equivalent of 127,000,000 thermometers every day by sensing columns of air up to a few kilometers above ground or seas and those data are released for public use. NOAA's ground sensing network and NASA's satellite network have complimentary trends with NASA's data showing little higher temperatures.

You can tell, I have bought into global warming partly due to CO_2, methane, dust, aerosols, nitrous oxides, and water vapor accumulating in the atmosphere and I want to fix it. Keep in mind that burning one ton of coal produces about 2.6 tons of CO_2. I began to think about what was coming out of smoke stacks ten years ago while building structures at power plants to capture heavy metal and acid rain emissions. Many of those plants were burning 50 tons of coal per hour and some were burning two train loads of coal totaling 20,000 tons per day. When I looked at the smoke and steam coming from those stacks, I knew that we should not be putting that stuff into the air we breathe 24/7. I did not know then about the possibility that CO_2 could cause global warming.

In 2006, Paul Crutzen, a Nobel Lauriat for his work relating to the "hole in the ozone" over the South Pole, suggested that release of sulfate aerosols in the stratosphere high above the realm of rain clouds might be used to cool the earth. In March of 2010 David Keith a physicist at the University of Calgary, presented the same idea to a group of promising geoengineers that spraying a mist of sulfuric acid in the stratosphere could reflect away the sun's incoming rays. Calculations showed that reflecting 2% of the sun's rays might cool the planet 4° F. This approach to cooling the earth is still on the table and is probably the least expensive with the shortest lead time. Delivery of reflective materials to the stratosphere every one to four years in amounts equal to the eruption of Mount Pinatubo could possibly provide a grace period of 20 years until major reduction in greenhouse gases can be put in place. There is not yet consensus on the best altitude or latitude for injection of the aerosols. However, the choices are all within the capability of military aircraft such as KC-10 tankers and KC-135 Stratotankers for them to disperse the compounds. Another option is to use artillery pieces or the supply of used 16 inch battleship guns to reach the

required altitudes with aerosols. There is a third approach that you may find more interesting. Think about sending high altitude balloons aloft carrying the aerosols or piping the material up to the balloons when they are in place.

Another plan for cooling the earth is to make rain clouds over the oceans that will scatter the sun's rays back into space. It is proposed to build a fleet of 1,900 large unmanned catamarans propelled by the winds to ceaselessly prowl the oceans while projecting very very small droplets of sea water into the atmosphere to create large white clouds. Those clouds would reflect about two percent of the sunlight normally striking the seas.

Carbon sequestration, capture and storage of CO_2 has gotten a lot of press...it sounds so direct. No messing around with spraying sulfur around, seeding clouds, or growing new forests. Take it right out of the smoke stacks and pump it to some place underground. The first large scale sequestration of CO_2 began in 1996. Norway strips it out of natural gas that it mines and disposes it deep under the North Sea. And in the year 2000, a synthetic gas plant in North Dakota became the first power plant to capture and store CO_2 under ground. I believe the Duke Energy's coal gasifdication plant in Edwardsport plans to pipe CO_2 to western oil fields for fracking. Pumping all that greenhouse gas into the earth or sea has a down side. There is the danger of leaks even though at those extreme depths the gas is in liquid form. Earthquakes, tectonic shifts, or failed components in the injection equipment could let all that high pressure gas back into the atmosphere with explosive results. I'm thinking of the BP experience with their Deepwater Horizon rig in the Gulf. Sequestering CO_2 would not come without a cost. The Intergovernmental Panel on Climate Change estimates that capturing CO_2 would add a penny to a nickel to the cost per kilowatt. I think the real expense would be in pumping that gas down 8,000 feet at a pressure of 6,000 psi or more and that could take as much as 15% of a power plant's output. The Department of Energy in December of 2012 reported that the US has underground storage capacity for 2,400 billion metric tons of CO_2 in depleted oil and gas fields, in underground saline solutions, abandoned natural gas storage sites, and unmineable coal seams. No mention of how to displace whatever is now occupying those cavernous places. That's a lot of storage space and I believe the government should help those who are producing greenhouse gases pay for transporting and storing of the stuff. The government's cost should be low enough to assure the producer sees an advantage to investing in processes that produce no CO_2. Someday our descendants will have to find a way of disposing of tons of CO_2 or release it in a controlled manner.

The oceans cover 69% of the earth's surface so maybe they could help without causing any inconvenience to us humans. Russia seriously considered an outside-the-box idea to build a dam across the Bering Strait in 1956. It had been kicked around by individuals for some time that such a dam could be managed to control the earth's climate by warming the arctic waters to the benefit of all mankind but mostly for benefit of

Siberians. Times change. Now creating oceanic foams is being considered as a way to cool the earth for the benefit of all its peoples.

Now consider a couple terms connected to global warming that are new to some of us. A-l-b-e-d-o is the term applied to the percentage of sun's heat reflected away from earth. To be expected, the Albedo effect is much higher from snow fields and glaciers than from and oceans and dark landscapes. Okay, so here is another one. S-p-a-r-g-i-n-g is a term well known to the brewers trade and means injecting gas into a liquid to form microbubbles.

A paper presented in 2010 by Russell Seitz, a Harvard physicist suggests that sparging air in the oceans to form microbubbles (about one five-hundredth of a millimeter in diameter) would improve the albedo to four times that of the oceans' present ability to reflect the sun's rays back into space. And by adding hydrosols, the same small round aerosols as proposed for release into the stratosphere, the tiny bubbles will have a life of days to do their work rather than minutes as they rise to the surface. Work is underway to prolong the life of microbubbles by natural means as it is imperative that ocean water not be made more acidic with aerosols. Since water has such a large share of the earth's surface, a fourfold increase in its ability to reflect sun light is very important.

Four Brits at the Department of Chemistry, University College London are taking a different look at this technology. They are proposing to permit microbubbles to rise enhancing the water's albedo and after reaching the surface to burst and launch micro seasalt particles aloft to increase the number of cloud droplets thus increasing the reflectivity of stratocumulus clouds. Better sea water Albedo and more reflective clouds. A one-two punch that could be delivered by roughly 10,000 ocean ships already plying the sea lanes and several thousand operating or abandoned oil rigs fitted with sparging equipment.

Fertilizing the oceans with iron to stimulate biological productivity of ocean blooms which have an affinity for CO_2 has been advanced. A well formed bloom that gobbles CO_2 and dies only to sink to the bottom is still on the table but without many customers since investors tried it off the coasts of Alaska and Argentina in the hopes to improve fishing. Didn't help fishing and gaumed up the water.

Terrestrial albedo deserves mention. Athenians long ago learned that if they whitewashed buildings they would remain cooler, a practice still followed today.

Some thought has been given to covering the world's deserts with 67,000 square miles of white reflective plastic sheets every year until 2070. I don't think that idea is going anywhere nor is painting all human structures white. Restoration of forests, clearing trees from uninhabited snow covered areas, changes in grassland and crops to improve their albedo are on the table but so far none have come close to producing enough results to halt the steady increase in CO_2. But don't give-up on earth bound fixes, how about thousands upon thousands of artificial trees with leaves that are 1,000 more efficient than natural leaves in absorbing CO_2. Interesting but I'm not investing any money in it until I know how they plan to harvest the crop.

What would spaceman Buck Rogers and Doctor Heuer do? One thing they might do is fall back on a plan seriously proposed in 2004. Dr. Gregory Benford proposed the placement of a concave Fresnel lens 600 miles in diameter in orbit at the Lagrange point about a hundredth of the distance from earth on a line to the sun. There the gravity of earth balances the gravity pull of the sun so objects placed there stay stuck between sun and earth. Similar plans were suggested in 1989 and 1997. Thousands of plastic sheets about 1/8 inch thick would be sub-assembled on frames and either shot or transported to the Lagrange point for assembly by robots. The lens would reduce sunlight destined for the earth by about 1%, enough to keep global temperature stable until we stabilize emissions and reduce them to late 20^{th} century levels. Oram Palti holds a US patent for such a sun shield of 100,000 sq km to shade the earth.

I am most encouraged by the work being done at universities, US government research centers, and industrial corporations to develop ways of recycling CO_2 into a product or as an energy source. The goal of these programs is to reduce the cost of energy required to chemically and or biologically convert CO_2 into either commercial products that are inert and long-lived. Purdue's effort is being led by Professor Clifford Kubiak. It is divided between breaking down CO_2 into organic products by photochemically splitting it into CO and O_2. And, utilizing CO_2 to produce methanol fuel.

These are just a few technological offerings from perhaps 2 dozen being floated around by world scientists and engineers as ways to limit or reduce greenhouse gases in the atmosphere. Some are less of a challenge than others. It will not be easy to get the world's nation to agree on one plan for managing our earth's temperature.
Sounds like April fool? Its not. All of these ideas have promise. They only sound way out because that's where the problem is. We can not fix it in a laboratory, machine shop, or law office.

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