Online Journal of Space Communication

Volume 9
Issue 16 *Solar Power Satellites (Winter 2010)*

Article 3

Global Warming in Perspective Understanding Climate Change in a World of Contradictory Information

John K. Strickland Jr.

Global Warming in Perspective
Understanding Climate Change in a World of Contradictory Information

John K. Strickland, Jr.

Abstract

This article attempts to answer some fundamental global warming (GW) questions in as clear and balanced a way as possible. It touches on the current media and political discussion of the topic, an understanding of which has become integral to understanding the topic itself. This discussion is presented in light of the frequent use of the global warming crisis as an argument against all uses and sources of energy, clean or dirty, by rich and poor. The extremely large untapped energy source represented by Space Solar Power is offered as a potential long-term solution.

Who should we believe?

Many who read about or watch coverage of global warming (GW) on television are reduced to asking: "Who is telling the truth?" since the disagreements even over factual information seem so fundamental and irreconcilable. Scientific authorities are generally more trusted than other sources since science discovered the issue before it became politicized. Most scientists are still treating GW as a scientific issue, hoping that fraudulent claims will sooner or later be uncovered as the scientific process improves and knowledge increases. It is expected that they will themselves go to considerable length to avoid the ultimate scientific dishonor: making false scientific claims or using faked or manipulated evidence, so the great majority are not led astray.

On both sides of the issue, there are others - including a few scientists - who have politicized global warming, and use "cherry picking" to persuade others to their point of view, by withholding opposing evidence and arguments from a discussion. The so-called "Climate-Gate scandal" of late 2009 is a good example of such distortions, although it is becoming clear that some of the charges made against the climatology community under scrutiny are unfair. The good news is that there are ways informed citizens can attempt to tell whether or not an individual author or presenter is being "fair & balanced" in his/her discussion of this and other controversial issues.

- Are both sides of the issue being covered?
- Are rebuttals for both sides given?
- Are actual numbers being used?
- Is raw politics being kept out of the argument?
- Are facts and opinions being separated?

- Is the actual probability of described events discussed?
- Are solutions ever discussed realistically?
- Is "cherry-picking" being used to "enhance" or distort data?

The Context for Climate Change

On earth, climate change is constant. Without any greenhouse effect, the oceans would be frozen and most life on earth would not exist. For this reason, carbon dioxide and methane should not be considered pollutants. The Supreme Court ruling notwithstanding, they are just greenhouse gases. Without CO2, plants would be unable to grow and everyone would starve. Water vapor is one of the most important greenhouse gases, and it has not been labeled as a pollutant.[1] A set of factors that cause climate change have been identified. There may be others still unidentified. The known factors include:

- The Milankovitch Cycles:[2]
    a. Precession cycle of the earth's axis;
    b. Inclination cycle of the earth's axis (obliquity)
    c. Changes in the eccentricity of the earth's orbit
- Natural changes in greenhouse gas levels in the atmosphere.
- Surface brightness or albedo (white: 100%, pure black: 0, avg. 30).[3]
- Human added greenhouse gases in the atmosphere.
- Clouds, fog, aerosols, smoke and dust in the atmosphere.
- Position of the continents (very slow change).
- Very small changes in the solar output (the solar "constant").
- Heat from human use of energy (a very small effect).

The combined totality of the following factors affects the earth's heat balance at every single location on the land surface, ocean and the atmosphere and determines global weather and climate patterns. This is an incredibly complex interactive process that will always be beyond our ability to fully simulate using any number of computers.

- In space: solar insolation (sunlight) is 1.3 kilowatts / meter sq. The average insolation is affected by the orbital eccentricities;[4]
- Surface: solar insolation is 1.0 kilowatts / meter sq. at noon with the sun directly overhead (during summer or at a low latitude).
- Albedo (brightness) of surface site: how much light is reflected back into space. This is affected by the type of surface site: dirt, sand, rock, water, ice, snow, vegetation, etc. and clouds, dust, soot, etc (reflectivity of particles in the atmosphere).[5]
- Latitude of surface sites & Milankovitch cycles.
- Greenhouse gases: trap heat emitted from surface.
- Ocean and geological heat sources and heat flux at the surface.

Most media discussions of GW are primarily based on global temperature records. However, this data is very tricky to interpret, since most global temperature graphs combine a set of records from around the globe. Only within the last roughly 300 years do we have absolute and accurate thermometer values. Earlier ones are indirectly extrapolated from other data and compared to present day values of that data. Most graphs use smoothed curves, that present temperature averages for specified periods. Temperature records taken in different locations over similar time periods often conflict.[6][7][8] Short and medium-term climate fluctuations like El Nino / La Nina cycle repeatedly overwhelm long-term events like the current slow warming trend.

The role of greenhouse gases in climate is crucial. The annual exchange of natural CO_2 emission and absorption exceeds the human emissions by about 10 times, but over time these have previously been in balance. Here are some basic large numbers (in metric tons) for comparison:[9]

Total weight of the entire atmosphere:	˜5,300,000,000,000,000 mt-tons
Total weight of all CO_2 in the atmosphere:	˜2,800,000,000,000 mt-tons
Annual exchange of the biological carbon cycle:	˜200,000,000,000 mt-tons/yr
Extra carbon dioxide annually emitted by humans:	˜22,000,000,000 mt-tons/yr
Extra carbon dioxide not absorbed annually:	˜11,000,000,000 mt-tons/yr
Volcanoes emit and geological processes absorb the same amount annually:	˜130,000,000 mt-tons/yr

The oceans, plants and soils are currently absorbing about half of the extra human CO_2 emissions. Note that the unabsorbed CO_2 emissions alone are equal to

1/20th of the entire annual biological carbon cycle in mass and are increasing. However, there is no natural way for the extra annual human emissions, which are now just under 1 percent of all atmospheric CO2, to be absorbed indefinitely. CO2 levels in the atmosphere vary continuously, but often stay within certain ranges with a stable climate. The current CO2 level is 528 parts per million (ppm) by weight of the air, and is now about 387 parts per million by volume of the air (and of the entire atmosphere.)[10]

During the 90,000 year long cold phase of an ice age cycle the CO2 level averages about 180 ppm by volume, but fluctuates more than during a warmer interglacial. During an interglacial (such as the current Holocene), CO2 has usually been about 280 ppm.[11] When an interglacial starts, the temperature rise forces a natural increase in greenhouse gas levels, as the CO2 is driven out of frozen tundra soils and Methane out of peat bogs and similar locations. However, since about 1900, human CO2 emissions have begun to drive (called forcing) the global temperature up, the reverse of the normal cause and effect.

Freeman Dyson, a prominent physicist and the creator of the Dyson Sphere concept, points out that CO2 and methane have a much greater effect where the air is cold and dry, mainly in the Arctic and Antarctic and on high mountains, since water vapor is also a very strong greenhouse gas. Thus global warming tends to make cold places warm, rather than making warm, humid places hotter.[12] This makes average global temperature values, which are about 55 degrees F, a misleading metric. If all we had to measure was temperature, we would not think there is any problem, since global average temperature tends to fluctuate. The levels of carbon dioxide are now about 30% greater than in pre-industrial times and are rising. Even if we could suddenly stop the release of extra greenhouse gases, what has already been released will take a very long time to be absorbed by slow geological and chemical processes. This momentum means that the current warming trend is likely to continue for decades and probably cannot be stopped immediately without human intervention.

Comparisons to Geologic History

We can create a clearer perspective of the scope of currently anticipated climate changes by comparing noteworthy climate trends to episodes in past earth history, many of these events occurring in deep geological time. The Cambrian period marks the start of the Phanerozoic Eon, during which CO2 levels and temperatures fluctuated widely and when eukaryotic and complex, multi-cellular plant and animal life existed on earth.[13]

1. Snowball Earth: 650 million yrs ago (mya)	Very Cold
2. Cambrian: 542-488 (mya), CO2: 7000 ppm	Hot
3. Carboniferous: 360-286 (mya), CO2: 1500-350 ppm	Warm-Cool

4. Permian: 286-248 (mya), CO2: 350–3000 ppm	Cold-Hot
5. Mesozoic Era: 248- 65 (mya), CO2: 1800- 800	Hot-Warm
6. Paleocene-Eocene Thermal Maximum: 55 (mya)	Hot
7. Pleistocene Ice EON: ˜3 (mya) - Now	Cold-Cool
8. Holocene Interglacial: 12,000 BC - Now	Mild
9. Climatic Optimum: ˜7000 - 3500 BC	Warm
10. Medieval Warm Period: ˜800 - 1200 AD	Mild
11. Little Ice Age: ˜1400 - 1900 AD?	Cool
12. Current Time: 1990-2009 AD	Mild-Warm

The Cambrian Period, some 542-488 million years ago, was one of the warmest periods in earth history with very high sea levels. CO2 levels were about 7500 ppm, 20 times higher than current levels of 387 ppm. Probably no glaciers or ice existed anywhere on earth except on very high mountain peaks.[14]

During much of the Mesozoic Era, 225-65 million years ago, it appears that few to no continental glaciers existed anywhere on earth, largely because land areas were not near the poles. Ocean levels were hundreds of feet higher, with shallow "inland" seas overlapping the continents. Conditions during the late Jurassic period duplicate somewhat the maximum GW which could occur naturally today, with CO2 levels at 2500 ppm. Dinosaurs, tropical plants and sea life including giant marine reptiles and shellfish were abundant.[15]

Jurassic conditions are a good example to show that human-caused "runaway greenhouse effect" is unlikely. Additional human fuel use will make the earth warmer, but cannot raise the CO2 or ocean water level much beyond the Jurassic levels. Even if we used up all fossil fuels, we could not now create a runaway greenhouse effect like the one that occurred long ago on Venus; thus, the current global warming process does not threaten to destroy civilization or life. To do so, most or all of the carbon in the earth's carbonate (limestone and dolomite) rocks would have to be converted to CO2. In 500 million to 1 billion years or more, the sun's gradual increase in luminosity of 10% per 100 million years will eventually create a run-away greenhouse, similar to that on Venus. Therefore, the earth's biome will eventually be doomed, unless a way is found to protect ourselves.

The Paleocene-Eocene Thermal Maximum event (PETM) during the early Cenozoic Era is a good analogy to today's GW event. It was either a massive release of marine methane hydrates or perhaps a huge flood basalt event as the

North Atlantic was being born, about 55 Million years ago, at the end of the Eocene. Something caused the release of an extra 230 million tons of CO_2 per year for about 15,000 years, once again raising CO_2 levels to about 2500 ppm, creating the PETM. Redwood trees were growing at 80 degrees North. The Arctic Ocean surface was about 70 degrees F. Many kinds of early mammals went extinct due to the heat, and others spread to new habitats. All glaciers would probably have been melted during this time. It took the earth about 200,000 years to recover from this event, which was followed by the almost as warm Eocene Optimum.[16]

We are still living in an "Ice Epoch", (the Pleistocene), which has already lasted for about 2.5 million years. Continental glaciers, other than in Antarctica and maybe Greenland, began with the start of the Pleistocene. During it the earth has experienced a series of 55,000 year ice age cycles, then, 8 cycles ago, the more severe 100,000 year cycles began, alternating between glacial periods and short inter-glacial periods. In addition, throughout the Pleistocene, the global climate average has grown steadily colder. This Ice Epoch continues because both Poles have permanent ice caps. The South Pole is in the center of Antarctica, and the North Pole is in the Arctic Ocean. Without the surrounding continents, ocean currents would quickly move the trapped polar pack ice away from the North Pole, preventing a north polar ice cap from forming.[17]

How do you make an Ice Age (Ice Epoch)? First move continents to enclose an ocean basin around a polar area to trap cold water that can cause the formation of an ice cap, or place a continental area on top of a polar area to allow a continental glacier to accumulate, (takes millions of years at a few inches per year). Assure that plants and shellfish have used up most of the CO_2 in the atmosphere and converted it into plant tissues, fossil fuels and limestone. These conditions have only existed for a very small minority of earth's history, as in the present Pleistocene, 300 million year ago in the late Carboniferous and Early Permian, and a shorter period in the Ordovician. All these events occurred during the Phanerozoic Eon, the age of multi-cellular life (all of Geologic time since the Pre-Cambrian). Since three quarters of the earth's surface is water, the chances are that only one pole or neither pole will be covered or surrounded tightly by land at a given random time, assuring that ice epochs are rare.[18]

We are now nearing the end of the current and latest Interglacial: the Holocene, which started about 12,000 BC. (Each interglacial lasts about 10,000-12,000 years).[19] The Holocene has had one of the most stable climates of any interglacial. Each glacial period lasts about 90,000 years, with a single glacial cycle time of about 100,000 years. CO_2 levels cycled from ˜180 to ˜280 ppm during the glacial period. A few experts disagree and believe that the Holocene will continue (assuming pre-industrial greenhouse gas levels). If it continues, this would break the pattern of the last 800,000 years of eight 100,000-year glacial cycles. Since greenhouse gas levels are no longer pre-industrial, this is now a moot question.

The Holocene Climatic Optimum occurred from 8000 to 4000 Y.B.P (Years Before Present). This, the warmest part of the Holocene, happened when civilization was just beginning.[20] CO_2 levels were probably about 300 ppm.[21] Interglacials typically begin rapidly with the warmest temperatures and then cool steadily until the next ice cycle begins. The stable Holocene climate may have helped Neolithic farming settlements survive. The last glacial melt-off phase over the present Hudson's Bay area ended by about 6000 BC, possibly creating the Global Flood Mythology. The year 2004 was about 1/2 degree warmer than during the Climatic Optimum as a global average.

The Medieval Warm Period (MWP) was from 800 - 1200 AD. Many Northern European societies grew and prospered during this period. A Scandinavian population boom at this time helped to create the Viking Age due to lack of extra farmland in Scandinavia. The Vikings reached southern coastal Greenland and tried to farm instead of fishing and hunting. European cities grew and trade flourished. The year 2004 was 1/5 degree warmer than the MWP average. CO_2 levels were probably around 280-300 ppm.

The Little Ice Age which directly followed the MWP may or may not have been a warning of the impending end of the Holocene. It started after 1400 and lasted until about 1900 or later. The peak (coldest period) was in the 1600's, coinciding with the Maunder minimum, an unusual period of low solar activity with no sunspots. We do not know if these events are related. After it began, the Greenland colonists starved to death when they could no longer farm on southern Greenland. Finland lost one third of its population to starvation.[22] The Little Ice Age is an example of climate changes for which we have not yet proven specific causes. Since it apparently lasted right up to the early part of the 20th century, there is the possibility that unknown natural factors could still be operating to cause part of the current warming. On the other hand, climate models seem to agree that the amount of extra heat from greenhouse gases matches the current amount of warming seen. This is why assumed causes and projections for the current global warming can't be absolutely proven.

Evidence for Global Warming

What kinds of evidence exist for Global Warming? The evidence is very strong and from multiple sources and disciplines, but not perfect. The exact amount of human responsibility cannot be measured, since we cannot measure the natural effects accurately enough and cannot separate them from the anthropogenic effects. Humans probably cause 50% or more of the current climate changes, estimated between one-third and two-thirds. We may or may not be still emerging from the little Ice Age, which ended about a century ago but could still be hiding a major climate change factor.

Some examples of independent global warming evidence include the facts that:

1. Alpine Glaciers are melting globally as measured by retreat of glacier and volume of ice;
2. air, sea, and ground temperatures are rising globally and Arctic Permafrost is melting;
3. Arctic Sea Ice (floating pack) cover is being lost;
4. changes are occurring in plant and animal annual cycles;
5. a slow increase in sea level but not a rapid rise is occurring;
6. the Greenland Continental glaciers are losing mass;
7. loss of floating ice shelves in both the Arctic and the Antarctic continues; and
8. the overall Keeling annual CO2 concentration curve recorded on Mauna Loa is visibly an accelerating curve, not a straight line.

How fast is the warming? The PETM event released excess CO2 at 230 million metric tons/yr for 15,000 years (above the normal amount of 130 m mt/y that is absorbable by the normal Geological Carbon Cycle. (The total natural release during the PETM was thus 360 million mt/y). We are now releasing excess CO2 more or less 100 times faster (22 billion mtons/yr) and could reach PETM conditions in only 150 years, with about a 1% increase in CO2 per year.

The Great Global Warming Debate

In the last decade, the debate over GW has become partisan and bitter. Each side accuses the other of deliberate lying and having base motives. Corporate profits, politics and pseudo science are said to account for their actions. Some of those advocating the idea that the earth is warming use smear and intimidation tactics against those who are convinced it is not. In a free society, such ruthless attempts to suppress free speech and personal expression of opinion are crimes. Use of the issue as a political club may be preventing solutions by encouraging some to deny it is real. The use of calculated derogatory terms such as "flat earthers" and "global warming deniers," equating opponents to *Holocaust deniers*, shows the intensity and very political nature of the debate in the public arena, which is floating on top of all the actual scientific evidence.

Who are the players in the GW debate? Dr. Freeman Dyson says one way to view the divergent opinions as a conflict between *naturism* and *humanism*. Naturalists often take anti-human positions: they believe that human civilization is fundamentally antagonistic to nature, which they consider to have a higher value.[23] The international news media is a major purveyor of biased environmental news and opinion. Since about 1970, brazen advocacy journalism has taken the place of getting the facts right. Since 1989, the Society of Environmental Journalists has been training members in propaganda techniques. Some authors take a very dim view of their activities.[24] Business groups are more concerned with the economic impact of climate change and the effect of fixes. The SEJ tend to assign base motives to these groups. There are a wide spectrum of motives - or a combination of them, involved in the debate. The

Pragmatic Greens: are interested in protecting the environment, while with the Ideological Greens - *Naturism* rules: they oppose industry and support a retreat to a "post-industrial" age. Business is interested in prevent coastal flooding and disruption. The E. F. Shumaker ideology: (small is beautiful) - these groups are against all large, centralized energy systems no matter how clean they are.[25]

Here are some examples of bad Global Warming arguments - pro and con:

1. Volcanoes: Claim (con): Many believe that the GW arguments are fake, since they think that volcanoes emit much more CO2 annually than "puny" mankind does. Facts: Actually, on average, mankind emits over 150 times as much CO2 in a year as all of Earth's volcanoes. (Volcanoes: ˜130,000,000 metric tons CO2/yr. Mankind: ˜22,000,000,000 metric tons CO2/yr.) Once in a great while, a single volcanic eruption such as Mt. Pinatubo (Philippines, 1991) will challenge man's emissions rates of Sulfur Dioxide for a few weeks, but this is rare.[26]
2. Glacial Cover Argument: Claim (pro): We are warmer now than the Medieval Warm Period or the Holocene Climatic Optimum. Counter-Claim: (con) The Medieval Warm period was warmer. Facts: The iceman (Otzi) died where there was no glacier in the Tyrolean Alps. Then the glacier developed over him and entombed him for ˜5000 years. If that glacier had melted during the medieval warm period, the body would have been eaten. This is supporting evidence at least that we are having the warmest weather since the Climatic Optimum.
3. Death from Fire or Ice: Claim (pro): Global warming is contributing to deaths from heat waves, so we should take drastic action to stop it. Fact: about 10 times more people die of cold waves than heat waves but these statistics get no media coverage.[27]
4. The Inconstant Sun: Claim (con): Changes in the solar constant are responsible for most of the current amount of global warming observed. Fact: The sun has contributed only about 10-15 % at most of additional heating measured at the surface during the current warming spell. The solar constant IS (constant), it varies less than 1 part in 1000.[28]
5. Slip-sliding Away: Claim (pro): Parts of the Antarctic and Greenland Continental Ice Sheets are being lubricated by melt water which accumulates at their base. This could allow a greatly accelerated glacial flow and rate of physical collapse of the continental ice sheets, instead of melting them from the top down, which could take thousands of years. The fear is that this could result in a very fast rise in sea levels, floating glaciers off their beds, ending in a quick return to Jurassic conditions. Fact: The sheer weight of the 2-3 mile thick continental glaciers would keep most of them from floating or sliding off.

There are several types of Ice Loss and Sea Level Rise risks: The loss of (fresh water) ice shelves and (2) (salt water) ocean ice pack, both already floating on the ocean does not directly cause sea level rise. These kinds of ice may be more sensitive to temperature than continental or mountain glaciers. Shelf ice loss could (3) accelerate flow of the coastal glaciers behind them which does raise sea levels. Pack ice loss would raise the albedo of the Arctic Ocean and make it warm faster. (4) Current satellite data does show that Greenland and Antarctica are continuing to lose mass, partly by melt water.[29] What happens with water at the contact of a continental glacier and underlying rock during a warming episode is not completely understood.

What should public policy related to this risk be based on? The continental glacier collapse scenario is a very low-probability result, which is not supported by most scientists. However, the mechanism is plausible and cannot be entirely ruled out or disproved scientifically. The primary question is then: *On which set of evidence and projections should public policy be based: high or low probability events.* If an event is very low probability but is incredibly catastrophic, such as an asteroid strike, there is some justification for basing policy and action on it, or at least taking it into consideration. This becomes a judgment issue.

What would the worst effects of Global Warming be like, (assuming there is no quick polar collapse)? Assuming that no political or technical effort to stop CO2 emissions works, all the continental ice would gradually melt over many hundreds to thousands of years. This would make sea levels rise hundreds of feet, submerging coastlines globally, some for hundreds of miles inland. Temperate areas would become Tropical, and Arctic areas would become Temperate. Most equatorial areas would not get much hotter.[30] Most polar animal & plant species would slowly go extinct or adapt to temperate conditions.

If current emission rates continue, we could reach conditions similar to the PETM in only 150 years. PETM CO2 levels of 2500 ppm were only 6.5 times higher than current levels of ˜387 ppm by volume. Under such conditions, all glaciers on earth would be melting very fast and sea levels would be rising. Tropical conditions globally would be restrained only by the continued existence of the remaining thick continental glaciers. Temperate conditions would eventually exist on Antarctica, Greenland and Arctic Islands. Predicting how soon all the glaciers would melt under these conditions is very difficult.

How would this impact us? The cost of relocation of coastal cities would be in the many trillions, but it might take place over many centuries, giving time to adapt. Many historical places would be lost under the ocean, but many buildings and cities could be moved uphill. At the same time, vast areas in Canada, Siberia and eventually Antarctica and Greenland would become cropland to grow additional food. Major portions of some countries and low-lying river valley regions, such as the Amazon and the Mississippi basins, would become "inland seas" like those that existed during the Jurassic, with huge new fisheries.

Solutions: Good and Bad

We do need responsible advocacy of alternate energy. Many Green groups have always assumed that alternate energy sources they advocate can replace fossil fuels quickly and easily. This assumption is false. Ground Solar is diffuse and very intermittent. Wind sites are somewhat limited and mostly far from customers in cities, so a lot of new transmission lines are needed to move the power to where it is used. Wind is also intermittent. Both ground solar and wind equipment stands idle more than 75% of the time on average. Cheap methods of electricity storage, needed to make centralized ground solar useful for base load power applications, do not exist yet. Building Pumped Hydroelectric storage is incredibly costly.[31]

Kyoto-Like Solutions are worse than useless. Such "solutions" which would cost advanced countries hundreds of billions of dollars a year, but would produce no measurable results after 1 century, should not be used. If we decide that GW is a problem, we must realize the scale of the problem. It is such a big problem that we better be very careful before deciding on solutions, due to the huge scale of commitment required, so we need to make sure we have the right set of solutions before we start. Wrong solutions could divert resources from the right solutions and prevent their implementation. It also takes energy and cash to build new energy plants. Both of these resources might be in short supply after too much of them have been expended on the wrong solutions.

You can't fool the Market and economics always finds the truth. If alternate energy were easy to harness, it would pay very well and would already have replaced fossil fuel. If we take rash and drastic action, spending money and resources on grossly uneconomic energy systems, we will use up the financial, energy and material resources needed to build the new, non-carbon energy system needed for the 21st Century. Drastically higher energy costs demanded by many national and local politicians could cause high inflation and wipe out many jobs and businesses, even impact costs of existing pollution control.

There are other consequences to wrong energy decisions. Energy solution decisions would be made by politicians, not engineers. A tendency exists to create an authoritarian, coercive energy bureaucracy, which would stifle growth and limit energy solutions to those ruled politically correct by the majority party. Food shortages and food price rises (similar to those being caused by the politically motivated ethanol program) are starting to cause starvation in the poor Third world countries that the US supplies or sells agricultural products to.

Then there is the BIG question that the Greens and the Media ignore: What practical things should we be doing about global warming? There is little discussion of practical solutions to Global Warming by the media in the public arena. Energy Conservation only works so far: unless you produce more energy, you will eventually run out. Due to population increase, immigration and new uses for energy, it's use will continue to increase. We should not have to feel guilty when we use energy. If you really want to save energy in a big way, just turn off the sun, which generates energy at 387,000,000,000,000 Terawatts, of which the Earth intercepts 174,000 Terawatts, compared to all human use of about 16 Terawatts. We are just trying to stop global warming, and should not be trying to create "energy guilt".

Global Warming is being treated by advocates and media as the only problem worthy of attention. We can not consider it in a vacuum. There are other big problems, such as hunger, disease, poverty, ignorance, aging. How do you decide how to allocate resources between such big global problems? The possibilities include: (1) How many people would be killed or harmed by each problem right away? (2) How fast is a problem (like Aids) growing or is it static? (3) How many people would be killed or harmed by each problem in the future?[32]

If you want an environmental disaster, try an Ice Age (during the cold cycle), where little or no life exists on the glacier's surface, and the glacial ice continuously scrapes all plant and animal life and soil from millions of square miles for 90,000 years at a time. Our first priority should be to find out if and how soon the current interglacial (the Holocene) might end. We need to be able to calibrate and control the amount of CO2 and methane being emitted in the future, to both prevent Global Warming and also to prevent the next Ice Age cycle from starting if we find that the Holocene is near its end. Then we need to develop the ability to reduce carbon emissions rapidly if (and to the degree) needed.

We should reduce the use of carbon for fuel and energy (but not by collapsing civilization) for these reasons. (1) The Greenhouse Effect is real. The portion of GW caused by carbon fuel use is poorly constrained, but non-zero; probably 1/3 - 2/3 of total. We cannot know what the exact portion is with current data. (2) Petroleum is a unique and precious chemical feed stock resource, and we are burning it all up! (3) The potential future energy deficit poses a huge national security and national economic security issue for any country.

Our future non-Carbon options (that are physically possible now) are those alternates popularly supported, as well as nuclear fission power and space solar power,[33] both very large energy sources which do not create greenhouse gases. Attention to basic economics and materials efficiency is crucial for all options.

Conclusions

Global Warming is a real and significant problem, in spite of short term climate fluctuations. It is a major threat to major parts of the global environment, and it is a future economic threat to civilization. It does not directly threaten the existence of Civilization, Mankind or the Biosphere. So, what should we do about it?

1. Base all decisions on good economics and costs.
2. Develop new, very large energy sources like Space Solar Power which can replace the majority of current carbon based energy.

3. Create a low-cost transportation system using re-usable rockets to Low Earth Orbit which will allow us to afford to launch Space solar components.
4. Continue refining climate models to protect against Global Warming and the possible end of the Holocene.

REFERENCES

1. Dyson, Freeman, "Heretical Thoughts About Science And Society," Edge (August 8, 2007), p. 3, http://www.edge.org/3rd_culture/dysonf07/dysonf07_index.html.
2. NOAA, "Astronomical Theory of Climate Change," http://www.ncdc.noaa.gov/paleo/milankovitch.html, (last updated: Apr 6, 2009).
3. Budikova, Dagmar, "Albedo" Encyclopedia of Earth, http://www.eoearth.org/article/Albedo, (last updated: March 19, 2008).
4. Wikipedia, "Insolation," http://en.wikipedia.org/wiki/Insolation, (last updated: Oct. 12, 2009).
5. Budikova, Dagmar, 2008.
6. Spencer Weart, "The Discovery of Global Warming," The Modern Temperature Trend, American Institute of Physics 2008, http://www.aip.org/history/climate/20ctrend.htm.
7. ScienceDaily, "Researchers Question Validity Of A 'Global Temperature'," (March 18, 2007), Reference: C. Essex, R. McKitrick, B. Andresen: Does a Global Temperature Exist?; J. Non-Equil. Thermod. vol. 32, p. 1-27 (2007), http://www.sciencedaily.com/releases/2007/03/070315101129.htm.
8. National Center for Policy Analysis, "Researchers Question Validity of a "Global Temperature", March 21, 2007, http://www.ncpa.org/sub/dpd/index.php?Article_ID=14329.
9. Zyvex Corp, "Constants and Conversion Factors Useful in Nanotechnology", January 1, 2001, http://www.zyvex.com/nanotech/constants.html.
10. Royer, Dana L., Robert A. Berner & Jeffrey Park, "Climate Sensitivity Constrained by CO2 Concentrations Over the Past 420 Million Years," Nature, 446, 530-532 (29 March 2007), http://www.nature.com/nature/journal/v446/n7135/ abs/nature05699.html.
11. Royer, Dana L., Robert A. Berner & Jeffrey Park, 2007.
12. Dyson, Freeman, 2007, p. 3.
13. Monte Hieb, "Climate and the Carboniferous period," Plant Fossils of West Virginia 2009, http://www.geocraft.com/WVFossils/Carboniferous_climate.html.
14. Wikipedia, "Cambrian," http://en.wikipedia.org/wiki/Cambrian, (last updated: Oct. 10,2009).
15. Hieb, Monte, 2009.

16. Wikipedia, "Paleocene-Eocene Thermal Maximum," http://en.wikipedia.org/wiki/Paleocene%E2%80%93 Eocene_Thermal_Maximum, (last updated: Oct. 4, 2009).
17. Wikipedia, "Pleistocene," http://en.wikipedia.org/wiki/Pleistocene, (last updated: Oct. 19, 2009).
18. Hieb, Monte, 2009.
19. Dyson, Freeman, 2007, p. 4.
20. Dyson, Freeman, 2007, p. 5.
21. Wikipedia, "Holocene Temperature Variations," (image source - Global Warming Art), http://commons.wikimedia.org/wiki/File:Holocene_ Temperature_Variations.png, (last updated: Aug. 23, 2009).
22. Wikipedia, "Little Ice Age," http://en.wikipedia.org/wiki/Little_Ice_Age, (last updated: Oct. 17, 2009).
23. Dyson, Freeman, 2007, p. 5.
24. Horner, Christopher C., "Red Hot Lies: How Global Warming Alarmists Use Threats, Fraud, and Deception to Keep You Misinformed," Regnery Publishing Inc, Washington, DC, 2008.
25. Nelson, Julie A., "Economics for Humans", The University of Chicago Press, Chicago, 2006, p. 37.
26. USGS, "Volcanic Gases and Their Effects," http://volcanoes.usgs.gov/hazards/gas/index.php, (last updated: Dec. 1, 2008).
27. CO2 Science, "Health Effects (Temperature - Hot vs. Cold: North America", http://www.CO2science.org/subject/h/summaries/ namericahotvcold.php, (last updated: Oct. 5, 2005).
28. Wikipedia, "Solar Variation," http://en.wikipedia.org/wiki/Solar_variation, (last updated: Oct. 10, 2009).
29. NASA, "Greenland's Rising Air Temperatures Drive Ice Loss at Surface and Beyond," Feb. 21, 2008, Ref: Dorothy Hall http://www.nasa.gov/centers/goddard/news/topstory/2008/ greenland_temps_prt.htm.
30. Dyson, Freeman, 2007, p. 3.
31. Strickland, John K, Jr., "Advantages of Geosynchronous Solar Power Satellites for Terrestrial Base-load Supply Compared to other Renewable Energy Sources," in Solar Power Satellites, a Space Energy System for Earth, Glaser, Peter E., Frank P Davidson & Katinka Csigi, Editors, Wiley/Praxis, London & New York, 1998.
32. Dyson, Freeman, 2007, p. 2.
33. National Security Space Office, "Space-Based Solar Power As an Opportunity for Strategic Security", Phase 0 Architecture Feasibility Study Report (October 10, 2007), http://www.nss.org/settlement/ssp/library/nsso.htm.