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## **The Kyoto Protocol and Global Warming** **Sallie Baliunas**

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The evolution from fire to fossil fuels to nuclear energy is a path of improved human health and welfare arising from efficient and effective access to energy. One trade-off is that energy use by human beings has always produced environmental change. For example, it has resulted in human artifacts marking the

landscape, the removal of trees from major areas for wood burning, and region-wide noxious air pollution from coal burning. On the other hand, ready availability of energy that produces wealth through the free market system provides ways to remedy or minimize environmental damage from energy use.

With widespread industrialization, human use of coal, oil and natural gas has become the centerpiece in an international debate over a global environmental impact, viz., global warming. Fossil fuels provide roughly 84 percent of the energy consumed in the United States and 80 percent of the energy produced worldwide. An attempt to address the risk of deleterious global warming from the use of these carbon dioxide-emitting fuels is embodied in the Kyoto Protocol and its attendant series of international negotiations. But on scientific, economic and political grounds, the Kyoto Protocol as an attempt to control this risk while improving the human condition is flawed.

### **What Would Kyoto Do?**

Projections of future energy use, applied to the most advanced computer simulations of climate, have yielded wide-ranging forecasts of future warming from a continued increase of carbon dioxide concentration in the air. The middle range forecast of the estimates of the United Nations Intergovernmental Panel on Climate Change, based on expected growth in fossil fuel use without any curbs, consists of a one degree Celsius increase over the next half century. A climate simulation including the effect of implementing the Kyoto Protocol—negotiated in 1997 and calling for a worldwide five percent cut in carbon dioxide emissions from 1990 levels—would reduce that increase to 0.94 degree Celsius. This amounts to an insignificant 0.06 degree Celsius averted temperature increase.

[The jagged line tracks the forecast of increasing temperatures through 2050, based on the Hadley Center's model. The upper straight line is the linear trend fit to the model's forecast temperature rise without implementation of Kyoto, and the lower straight line is the linear trend with implementation.]

To achieve the carbon dioxide emission cuts by 2012 that are required under the Kyoto agreement, the United States would have to slash its projected 2012 energy use by about 25 percent. Why, then, are the temperature forecasts so minimal in terms of averted global warming? The answer is that countries like China, India and Mexico are exempt from making emission cuts, and China alone will become the world's leading emitter of carbon dioxide in just a few years.

Most economic studies indicate that the cost of the Kyoto carbon dioxide emission cuts to the U.S. would amount to between \$100 billion and \$400 billion per year. One major reason these costs are so high is that past U.S. energy policy has been constrained by political influences. For example, substantially expanding the number of U.S. nuclear power plants and reducing the number of coal plants would enable the U.S. to meet both its future energy needs and Kyoto's mandated carbon dioxide emission reductions. But no nuclear power plants have been built in the U.S. in over 20 years, owing to non-technical factors.

Over the same period, renewable energy sources like wind and solar power have been discussed to the point of distraction. But these are boutique energy sources: they produce relatively minute amounts of energy and do so intermittently. While they may be cost-effective in limited locales, they are unreliable for large-scale electricity generation. (As a side note, often overlooked is the enormous environmental footprint that

wind and solar farms would require. For example, to replace a conventional 1000 megawatt coal plant that spans tens of acres would require an isolated, uninhabited area with correct meteorological conditions of roughly 400 square miles on which to place over 2,000 wind turbines, not to mention the associated imprint of high-power transmission lines, roads, etc. Solar panel farms would produce environmental blight and degradation over a similarly sized landscape.)

The Kyoto Protocol also has the potential to worsen international relations. The struggling economies of the world rely on the U.S. to maintain stability and to provide aid and economic opportunity as a trading partner. While the developing nations are exempt from making carbon dioxide emission cuts, the severe economic impact on the U.S. would dramatically curtail its ability to continue to promote international stability and to help improve those nations' economies.

### **What Does Science Say?**

Whereas the economic catastrophe that would occur as a result of implementing the Kyoto Protocol is a certainty, the likelihood of an environmental catastrophe resulting from a failure to implement Kyoto is extremely speculative. The facts in scientific agreement concerning global warming are as follows:

As a result of the human use of coal, oil and natural gas, the air's carbon dioxide content (along with the content of other human-produced greenhouse gases like methane) is increasing. The greenhouse gases absorb infrared radiation and, as a result, should retain some energy near the surface of the earth that would otherwise escape to space. Based on current ideas about how climate should work, the surface temperature should warm in response to the addition of the small amount of energy arising from a benchmark doubling of the air's carbon dioxide content. The main greenhouse effect is natural and is caused by water vapor and clouds. But the impacts of these greenhouse factors are for now greatly uncertain. In other words, the reliability of even the most sophisticated computer simulations of the climate impacts of increased carbon dioxide concentration rests heavily on the use of factors that science does not understand. To put this in perspective, the uncertainties surrounding the use of clouds and water vapor in climate simulations—not to mention other important factors like sea-ice changes—are at least ten times greater than the effect of the variable being tracked, i.e., the temperature rise caused by increased carbon dioxide levels in the air. Finally, in the absence of any counterpoising or magnifying responses in the climate system, the global average rise in temperature is roughly one degree Celsius or less at equilibrium for a doubling of the air's carbon dioxide concentration. That is meager warming for so profound a change in the air's carbon dioxide content. Indeed, it is within the range of climate's natural variability.

One key question in the debate over global warming is the following: What has been the response of the climate thus far to the small amount of energy added by humans from increased carbon dioxide in the air? This question is important because, in order to prove the reliability of future climate forecasts from computer simulations, those simulations need to prove that they are reliable at explaining past temperature change. They have not yet done so.

In the twentieth century, the global average surface temperature rose about 0.5 degrees Celsius. At first glance, one might think this attributable to human fossil fuel use, which increased sharply over the past 100 years. But a closer look at twentieth century temperatures shows three distinct trends: First, a strong warming trend of about 0.5 degrees Celsius began in the late nineteenth century and peaked around 1940.

Then, oddly, there was a cooling trend from 1940 until the late 1970s. And a modest warming trend occurred from the late 1970s to the present.

[See Chart 2, illustrating surface temperature changes sampled worldwide and analyzed by Cambridge Research Unit (solid line) and NASA-Goddard Institute of Space Studies (dotted line). Both lines show these three distinct phases.]

How do we interpret this data? We know that about 80 percent of the carbon dioxide from human activities was added to the air after 1940. Thus increased carbon dioxide in the air cannot account for the pre-1940 warming trend. That trend had to be largely natural. Then, as the air's carbon dioxide content increased most rapidly, temperatures dropped for nearly 40 years. And it seems that human effects amount at most to about 0.1 degree Celsius per decade—the maximum increase in warming seen after the 1970s.

How, then, does the observed surface-warming trend in recent decades—even assuming it is all due to human activity—compare to the results of climate change computer simulations?

Looking back at Chart 1, climate simulations predict that a smooth, linear rise of at least twice the observed trend should already be occurring, and that it will continue through the next century. Given that the warming trend has been observed to be at most 0.1 degree Celsius per decade from human activities, these future forecasts appear greatly to exaggerate the future warming and should be adjusted downward to, at most, one degree Celsius warming by 2100. That amount of warming would be very similar to natural variability, which humans have dealt with for thousands of years. Indeed, it would likely return climate conditions to those experienced in the early centuries of the second millennium, when widespread warming is indicated by numerous proxies of climate, such as glaciers, pollen deposits, boreholes, ice cores, coral, tree growth, and sea and lake floor sediments. (It is interesting to note that this so-called Medieval Climate Optimum is associated with the settling of Greenland and Iceland, travel by the Vikings to Newfoundland, higher crop yields and generally rising life spans.)

## **New Data**

In addition to what we can deduce from surface temperature data, U.S. leadership in new space instruments and in the funding of global research has yielded atmospheric temperature data that also indicates a lesser human-made global warming trend than is forecast by climate simulations.

According to these simulations, a readily detectable warming of the lower troposphere (roughly 5,000 to 28,000 feet altitude) must occur with the presence of increased atmospheric carbon dioxide concentration. But records from NASA's microwave sounder units aboard satellites show no such trend. These satellite records are essentially global, in contrast with records of surface temperatures, which cover a mere fifth of the planet. And what emerges from them is that while the tropospheric temperature does vary over short periods—for example, with the strong El Niño warming pulse of 1997 and 1998—no meaningful warming trend is observed over the 21-year span of the record.

[See Chart 3, illustrating monthly averaged temperatures for the lower troposphere from instruments onboard NASA satellites. Even taking into account the 1997-98 El Nino event, the linear trend is only +0.04 degree Celsius per decade. Data are from <http://www.ghcc.msfc.nasa.gov/temperature/>.]

It should be noted in passing that there has been a proposed explanation for the lack of a significant human-made warming trend in the lower troposphere. This explanation contends that human-induced global warming is masked because of soot from sulfur dioxide and other human-made aerosols, which cool the atmosphere. But this idea of a widespread aerosol shading effect fails the test by the scientific method, because the Southern Hemisphere—which shows no long-term warming trend at all—is relatively free of aerosols.

In addition to satellite records, we have a radiosonde record from balloons that goes back over four decades. This record obviously lacks the dense spatial coverage of satellite measurements. Nevertheless, it too shows no warming trend in global average temperature that can be attributed to human effects. It records the strong warming in 1976-77 known as the Great Pacific Climate Shift, resulting from a natural, periodic shift in the Pacific—the Pacific Decadal Oscillation—which is so significant that global average temperatures are affected.

[See Chart 4, which illustrates the seasonal average temperature anomaly sampled worldwide for the lower troposphere as measured by radiosonde instruments carried aboard balloons. Although a linear trend of +0.09 degree Celsius per decade is present if fitted across the entire period of the record, the trends before and after the abrupt warming of 1976-1977 (straight horizontal lines) indicate no evidence of significant human-made warming. Data are from <http://cdiac.esd.ornl.gov/ftp/trends/temp/angell/glob.dat>.] Furthermore, the Pacific now seems to have shifted, perhaps in 1998-99, back to its pre-1976 phase, which should produce cooler temperatures, especially in Alaska and in the global average.

Thus according to our most reliable data, when compared to the actual measurements of temperature over the past four decades, computer simulations overestimate to some degree the warming at the surface and decidedly exaggerate warming in the lower troposphere. And given that the models have overestimated past warming trends, they presumably also exaggerate the warming to be expected in the future. This inaccuracy is not surprising. Computer simulations of climate must track over five million parameters relevant to the climate system. To simulate climate change for a period of several decades is a computational task that requires 10,000,000,000,000,000,000 degrees of freedom. And to repeat, such simulations require accurate information on two major natural greenhouse gas factors—water vapor and clouds—whose effects we do not yet understand.

Finally, it should be mentioned that in looking for natural factors influencing the climate, a new area of research centers on the effects of the sun. Twentieth century temperature changes show a strong correlation with the sun's changing energy output. Although the causes of the sun's changing particle, magnetic and energy outputs are uncertain—as are the responses of the climate to solar changes—the correlation is pronounced. It explains especially well the early twentieth century temperature increase, which, as we have seen, could not have had much human contribution.

[See Chart 5, illustrating the change over four centuries of the Sunspot Number, which is representative of the surface area coverage of the sun by strong magnetic fields. The low magnetism of the seventeenth century, a period called the Maunder Minimum, coincides with the coldest century of the last millennium, and there is sustained high magnetism in the latter twentieth century. See also Chart 6, showing that changes in the sun's magnetism—as evidenced by the changing length of the 22-year or Hale Polarity Cycle (dotted line)—closely correlates with changes in Northern Hemisphere land temperature (solid line). The sun's shorter magnetic cycles are more intense, suggesting a brighter sun during longer cycles. Lags or leads between the two curves that are shorter than 20 years are not significant, owing to the 22-year time frame of the proxy of brightness change. In this chart, the record of reconstructed Northern Hemisphere land temperature substitutes for global temperature, which is unavailable back to 1700.]

## **Conclusion**

Two conclusions can be drawn about global warming and human energy use:

No catastrophic human-made global warming effects can be found in the best measurements of climate that we presently have. The longevity, health, welfare and productivity of humans have improved with the use of fossil fuels for energy, and the resulting human wealth has helped produce environmental improvements beneficial to health as well.

In light of some of the hysterical language surrounding the issue of greenhouse gases, it is also worth noting that carbon dioxide, the primary greenhouse gas produced by burning fossil fuels, is not a toxic pollutant. To the contrary, it is essential to life on earth. And plants have flourished—agricultural experts estimate a ten percent increase in crop growth in recent decades—due directly to the fertilization effect of increased carbon dioxide in the air.

It is good news, not bad, that the best current science offers little justification for the rapid cuts in carbon dioxide mandated by the Kyoto Protocol. This science indicates that human-made global warming is relatively minor and will be slow to develop, affording us an opportunity to continue to improve observations and computer simulations of climate. These will serve to better define the magnitude of human-made warming, and allow development of an effective and cost-effective response.

Given this science, what is impelling the Kyoto Protocol's international momentum? One strong factor is the "Precautionary Principle" in environmental regulation. This principle disallows an action that might harm the environment until the action is certain to be environmentally harmless. It is antithetical to science in practice, because it sets the impossible goal of proving harmlessness with certainty. In addition, a policy of "doing something" is promoted as "insurance" against possible risk to the earth. This idea of insurance as a prudent hedge is wrong on two counts, notwithstanding the lack of scientific evidence of significant human-made warming. First, the actuarial notion of insurance is that of a carefully calculated premium, paid against a reasonably well-known risk in outcome and probability of outcome. But in the case of human-made global effects, the risk, premium and outcomes cannot be well defined. Second, the notion that implementing the Kyoto Protocol is effective insurance ignores the fact that the actual averted warming that would result is inconsequential. Indeed, the underlying basis for current international negotiations is the Rio Treaty of 1992,

which specifically states that concentrations of greenhouse gases in the atmosphere, not emissions, be stabilized. In order to stabilize the air's concentration of greenhouse gases, emissions would have to be cut some 60 to 80 percent.

For the next several decades, fossil fuels are key to maintaining Americans' way of life and improving the human condition. According to the scientific facts as we know them today, there is no environmental reason we should not continue using them.