

## **Too Much of a Good Thing (sermon given at Goodloe, 30 Sept 2007)**

Good morning!

It is nice to see such a good turnout. I hope I haven't drawn you here under false pretenses. By titling my presentation, "Too Much of a Good Thing," I may have led you to believe I was going to talk about the dangers of excessive sex. If so I apologize, my topic this morning is global warming, a topic that is as little talked about today in polite society as sex was in the Victorian era. However, the need to discuss global warming is far greater today than was the need to discuss sex in bygone days. There may be some heavy breathing later, but it will most likely be due to anxiety, not exhilaration, because the perils of global warming are all too real.

So what is the "good thing" in my title you ask? It is the global warming caused by the small amounts of so-called "greenhouse gases" in our atmosphere. They trap some of the solar energy incident on Earth and keep it at a comfortable temperature for us humans and the plethora of other life forms around us. Without some global warming the Earth would be cold and uninhabitable, but we can also have too much of a good thing, and that is where we are headed.

As is often the case with ecological systems, small factors can make a big difference. The greenhouse effect comes primarily from small quantities of water vapor, carbon dioxide, and methane. The magnitude of the effect varies significantly from one gas to the other, and with the rate at which they are removed from the atmosphere by natural processes. For example, water vapor has a very strong greenhouse effect but only remains in the atmosphere on the order of months, methane is a strong greenhouse gas, but only remains in the atmosphere for a few years, while CO<sub>2</sub> is the weakest of the three, but remains in the atmosphere for centuries. All three of these gases are being dumped into the atmosphere by human activities, but CO<sub>2</sub> is by far the dominant factor linking humankind and climate change.

CO<sub>2</sub> is a natural component of the atmosphere. Plants can't live without it, and we can't live without plants, so having some in the atmosphere is essential. However, we humans are dumping huge quantities of CO<sub>2</sub> into the atmosphere by burning wood, coal, oil, and natural gas in order to cook our food, heat and cool our homes, fuel our transportation networks, and power our industries. Because of our expanding population and technology we are now in danger of irreversibly destroying our own habitat.

A decade ago a few scientists began pointing out that there was a distinct possibility that we were releasing CO<sub>2</sub> into the atmosphere so much faster than it could be absorbed by the biosphere that we could be setting the stage for drastic climate changes in the decades ahead. At the time the idea was highly controversial and sparked a decade of intense investigation and debate. The debate is over; the scientific community is virtually unanimous in asserting that the average temperature of the earth tracks the concentration of CO<sub>2</sub> in the atmosphere; that current CO<sub>2</sub> levels are now about 50% higher than they

have ever been in the past 630,000 years for which we have data, that they are increasing rapidly, and that our burning of the fuels mentioned above is driving this increase.

So, what does this portend? The Earth's climate system is obviously highly complex, but the basic physics and chemistry is well-known, and climate models have been developed at several research facilities around the world. The models have been successful in re-creating the data from the past when conditions were relatively static, and they have also been able to fit the data in the last fifty years where the changes have been rapid, and the data is extensive. So the good news is that the models, which all give similar results, can predict the future with reasonable reliability, given suitable scenarios describing future human activities. The bad news is that any convenient scenario for future human behavior, like continuing to do things the way we have been, leads to very unpleasant consequences.

The average temperature of the Earth is currently 0.75 C degrees (1.35 F deg) above the pre-industrial level. This is hotter than it has been for 100,000 years, and with the CO<sub>2</sub> level currently being 50% above past levels the expectation is that this temperature rise is going to continue rising to heights never before seen in the past 630,000 years! On the other hand, how important can a change of only a degree or two really be? Let me explain.

The temperature of the Earth is obviously not the same everywhere; it is cold at the poles and warm at the equator, so what does a one degree change in the average mean in terms of these extremes? Here is a simple rule of thumb: a five degree change in the average corresponds to a one degree change at the equator and a twelve degree change at the poles. The essential point is that the changes get magnified at the poles, which is why many of the climate changes observed thus far are most evident at higher latitudes.

In order to understand climate change you need to know a little geography. The Earth is asymmetrical. Most of the land mass is in the northern hemisphere, but the northern polar region is a gigantic ice covered ocean surrounded by land in the form of northern Canada, Alaska, northern Asia, the Scandinavian countries, and Greenland. The northern fringe of these land masses are relatively lightly covered with ice, except for Greenland which is covered by a massive dome of ice.

On the other hand, the southern hemisphere is mostly ocean, except for the massive continent of Antarctica which is more or less centered on the South Pole. Antarctica is covered by a massive ice sheet up to 10,000 ft thick. It also has a unique feature called the West Antarctic Ice Shelf. That is a massive shelf of ice resting on the continent of Antarctica on one side, and a string of islands on the ocean side, i.e., it is suspended above the ocean, not floating in it. If this ice shelf were to suddenly break up and slide into the ocean, sea level would suddenly rise by 22 ft (and not recede). If it melts slowly, the water level rise will be the same, but occur over a longer time period. The Greenland ice cap is comparable in mass, and could add another 22 ft of ocean depth by melting. The ice cap on the continent of Antarctica holds enough water to raise sea level by another 200ft. To put that in perspective, if all that ice were to melt we would be about 60

ft under water here today, and most of the major cities on Earth would be drowned! It has been thought that the melting of the ice caps would be a slow, gradual, process that would take centuries or millennia. Recent research has suggested that it may occur much faster than expected because of critical feedback mechanisms. First, when ice and snow melt, the resulting water absorbs sunlight much better than the ice and snow which are highly reflective. This creates a positive feedback mechanism which will cause the heating to accelerate.

More importantly, the Arctic is surrounded by major tracts of permafrost, essentially frozen swamps, which contain vast amounts of methane gas (equivalent to over 70 years of CO<sub>2</sub> discharge at our current rate) which would be released. The permafrost is already beginning to melt. Around 1970 we could truck supplies across it to Alaska's northern slope oil fields for 200 days out of the year; now it is solid only 100 days and dropping. The stage is set for a dramatic leap in feedback.

The science is clear. The current abnormal rise in atmospheric concentrations of greenhouse gases is man-made, and can, in principle, be mitigated by dramatic reductions in our burning of fossil fuels and other actions. But, if the major feedback mechanisms described above are allowed to grow, a point will be reached at which these natural feedback processes will take control, and humankind will no longer be able to prevent a catastrophic global heating.

The critical point is projected to occur when the Earth's temperature reaches about 2 C degrees above the pre-industrial level, and, as noted above, it is already up by 0.75 C degrees. The computer models show that to limit our temperature rise to 2 C degrees, we must hold the greenhouse gas concentrations to about 440 ppm CO<sub>2</sub> equivalent. The CO<sub>2</sub> level itself is currently 380 ppm, but when the contributions from the other greenhouse gases are converted to CO<sub>2</sub> equivalents, we find the total greenhouse gas level is already 460 ppm equivalent and rising. Clearly, there is not a lot of time to waste.

This conclusion is supported by the United Nations' Intergovernmental Panel on Climate Change which consists of about 2,000 climate scientists from around the world, by the governments of the UK, the European Union, Germany, Sweden, etc., all of which have the stated objective of keeping the temperature rise below 2 C degrees. The climate models show that if we continue to dump CO<sub>2</sub> at our current rate (and actually we dump more each year) the temperature will rise by 2 C degrees about 2090. Just like hurricane predictions, there is considerable uncertainty in the projections, the crisis point could be reached as soon as 2050, or it might not occur until around 2150, but there isn't the slightest doubt it will occur with our current rate of dumping.

So how are we to deal with this impending disaster? One way to approach the problem is to work backwards from the answer. The climate models indicate that in equilibrium the biosphere can absorb about 10 billion tons of CO<sub>2</sub> per year. Currently we are dumping about 25 billion tons of CO<sub>2</sub> per year, so we need to reduce our emissions by about 60% worldwide to get back into balance.

We are immediately faced with an ethical issue. How are the permissible emissions to be divided amongst the various nations? Currently they are very unevenly distributed. The US is the biggest polluter, responsible for 25% of the total, while China is close behind, and will overtake us in a year or two. However, that is hardly a fair comparison given the differences in our populations. On a per capita basis the CO<sub>2</sub> emissions in tons per person for several countries are roughly: US 20, the UK 10, China 1.7, Bangladesh 0.24, and Ethiopia 0.06.

The only fair way to distribute the allowable emissions is on a per capita basis. The population of the Earth is growing rapidly at present, but is projected to level off at about 9 billion around 2050. Thus, we can easily compute the long term fair-share allowance of CO<sub>2</sub> emissions to be about 1.1 tons per capita per year. This should be compared with the figures I just cited, i.e., 20 for the US and 10 for the UK.

For the industrialized countries this is more than a 90% reduction below their current levels, or about 20% per decade between now and 2050. In view of this the Kyoto goal of a 5.2% reduction by 2012 is pathetic. The UK's announced goal of 60% by 2050 is inadequate. The US has yet to adopt a goal, although several bills are in Congress. The Bush administration has proposed a 20% decrease by 2020 which sounds good, but is a joke because they propose to measure the decrease relative to GDP which means an actual increase in emissions, not a decrease. California has adopted the goal of 80% reduction by 2050, and a similar bill, called the Maryland Climate Stabilization Act is due to be introduced soon. We need to act now to make the Maryland bill as stringent as possible. The science indicates a reduction by 90%, or more, in US greenhouse gas emissions is both feasible and necessary to avoid the 2 degree feedback crisis.

I am not exaggerating when I say that the world has never before faced a problem of this magnitude. The transformation now required of human society far exceeds the demands of WWII, or the worldwide flu pandemic of 1918. It boggles the mind to contemplate the conflict and contention which we will experience in the coming decades as countries compete for increasingly scarce resources. The dislocations populations will experience due to sea level rise, intensified storms, expanding deserts, etc., will tax us all. The moral and ethical issues which will face us will be staggering. The seven principles of Unitarian Universalism have never before been challenged to the degree they will be in the coming decades.

Now is the time for all of us to take action personally to curb our contributions to the problem, and also to demand that our leaders in all walks of life take robust action. Technical solutions exist, but they will only save us if we act promptly. Good intentions alone will count for naught.

That is about as close to hell-fire and brimstone as I dare venture. If you find yourself breaking out in a cold sweat, welcome to the 21<sup>st</sup> century – it's going to be a trip!

Are there any questions or comments?

1 ton carbon = 3.65 tons CO<sub>2</sub>

1.1 tons Co<sub>2</sub> = 2,200 # CO<sub>2</sub> = 110 gallons gasoline