

Trip Report

Apologies for long report. Geophysical boundary conditions must be considered in defining a global climate strategy. The Kyoto Protocol and proposed extensions are an exercise in self-delusion and a prescription for global disaster. Please read Germany, UK, Japan parts (5 pages)!

Germany

My “Dear Chancellor” letter was translated to German and about to be published in a German paper, but, upon advice of John Schellnhuber, science adviser to the German government, I removed the letter from my web site and withheld it from publication in German, instead accepting an invitation to speak with the Minister of the Environment, Sigmar Gabriel. That meeting occurred in June, with Schellnhuber and Stefan Rahmstorf in attendance.

I am grateful for Minister Gabriel’s generosity with his time, and I have no doubt about his sincerity in dealing with climate change. However, we did not come to a common understanding about the implications of geophysical boundary conditions on fossil fuels. The stark policy implication of the data, I assert, is urgency for a moratorium on coal-fired power plants.

Recognition of these boundary conditions is of paramount importance. The Kyoto Protocol was doomed to failure because fossil fuel boundary conditions were not appreciated (see “Japan” below). Post-Kyoto approaches presently being considered are doomed for the same reason.

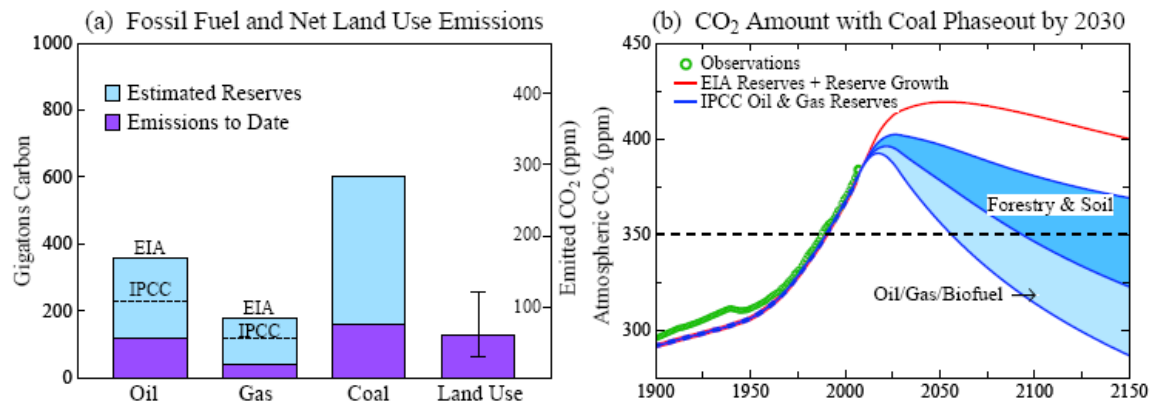


Fig. 1. (a) carbon sources, and (b) CO₂ scenarios if coal emissions are phased out linearly over 2010-2030 period; return below 350 ppm can be hastened via reforestation and carbon sequestration in soil, and further via capture of CO₂ at gas-fired power plants. For details see References 1 and 2.

In the discussion with Minister Gabriel, I returned several times to Fig. 1. We did not disagree about anything in that chart per se. Purple areas in Fig. 1a are emissions to date; reserves (blue) are uncertain. Expert opinion suggests that we are now close to “peak oil”, i.e., remaining oil is about as much as has been used already. Thus reserve estimates labeled IPCC probably are more realistic than those of EIA, the latter including large estimates for undiscovered reserves.

Regardless of actual reserves, Fig. 1b shows that if CO₂ emissions from coal were phased out over the period 2010-2030, and if use of unconventional fossil fuels (tar shale, tar sands) remained negligible, atmospheric CO₂ would peak at 400-425 ppm. In that case improved forestry and agricultural practices, especially reforestation, could get atmospheric CO₂ back beneath 350 ppm within a century or less. During the overshoot phase we might hope that ocean and ice sheet inertia may keep climate impacts tolerable, avoiding the most disastrous effects.

However, if coal use continues or expands (as it is now, see below), CO₂ will be headed to the 500-600 ppm range, or even higher if unconventional fossil fuels such as tar shale are developed. In this “Damn the consequences! Full speed ahead with all fossil fuels!” case (a.k.a., business-as-usual), we will hand our children a planet that has entered a long chaotic transient period with climate changes out of their control, as the planet heads inexorably toward an ice-free state.

A critical fact is the long lifetime of CO₂ emitted by fossil fuel burning. Half of a fossil fuel CO₂ pulse disappears within 20-30 years, mostly into the ocean. However, much of the CO₂, about one-fifth, is still in the air after 1000 years. Because of this long CO₂ lifetime, we cannot solve the climate problem by slowing down emissions by 20% or 50% or even 80%. It does not matter much whether the CO₂ is emitted this year, next year, or several years from now. Therefore, instead of a percent reduction in the rate of emissions, we must identify a portion of the fossil fuels that will be left in the ground, or captured upon emission and put back into the ground.

Mr. Gabriel and I did not disagree about the fact that the dangerous level of CO₂ is very low, indeed, at today’s 385 ppm CO₂ is almost surely already into the dangerous zone. The issue concerns how to keep maximum CO₂ close to 400 ppm, thus retaining the possibility to get CO₂ back below 350 ppm in a reasonable time. I contend that readily available oil (the big pools, being tapped already) inevitably will be used, and this oil-CO₂ will end up in the air, because it is used in vehicles, where CO₂ cannot be captured. Arguing otherwise requires an assertion that Russia, Middle East countries, and others will be willing to leave their oil in the ground.

Mr. Gabriel’s contention (echoed by Prime Minister Brown, see below) is that CO₂ emission goals and a carbon cap-and-trade program will solve the problem, that a carbon cap can be tightened to yield the desired maximum atmospheric CO₂. I reiterated several times that such contention implies that oil-producing countries can be convinced to leave their oil in the ground. We did not resolve this difference. In effect we agreed to disagree, as we were both trying to be cordial. As we left, Mr. Gabriel asked whether I was going to see Chancellor Merkel. I had no such appointment, but I believe it is important that she look at this matter analytically.

The fundamental issue is not widely appreciated, as shown by the fact that governments continue to talk about goals to reduce emission by 20%, 50%, 80% etc. No matter what number is chosen, this approach guarantees failure. It allows coal emissions to continue, new coal plants to be built and unconventional fossil fuels to be developed. “Success” in reaching a carbon emissions goal would not prevent readily available oil from being used – an emissions cap only slows the rate of oil use, with almost no impact on eventual climate change because of the long CO₂ lifetime.

We cannot pretend that a goal for future CO₂ emission reductions will solve the climate problem. If we continue to ignore obvious geophysical facts about the magnitude of fossil fuel reservoirs, our children and grandchildren will have little reason to forgive our obtuseness. The only practical way to keep climate change within tolerable limits is to cut off coal emissions and to have a price on carbon emissions that discourages unconventional fossil fuel (UFF) use.

Note that I am not arguing against a carbon cap. A carbon cap is useful, but insufficient. The danger of carbon caps and percent reduction goals is that they allow self-deception, a pretense that the climate problem is being solved. Unless they are accompanied by phase-out of coal emissions, they have practically no impact on climate change. By the way, a carbon tax (http://www.columbia.edu/~jeh1/mailings/20080604_TaxAndDividend.pdf) is more direct and

effective, in my opinion, but either a cap or tax should be accompanied by 100% dividend, so that people have the resources to buy energy-efficient and carbon-free technologies and will recognize an honest way of dealing with the energy/climate problem.

Coal use with carbon capture should be allowed to compete with other energies, but coal should not be subsidized. Also utilities should not be allowed to use the “capture-ready” subterfuge, which is employed without any real intent of capturing the CO₂. Given other damage caused by coal (<http://www.burningthefuture.org/>), to public health and the environment, and the inescapable fact that fossil fuels are finite and nonrenewable, it is likely that the best path is to move beyond fossil fuels sooner and leave much of the coal in the ground.

United Kingdom

The approach in the UK involved a number of people. At a dinner for VIPs organized by George Polk, I made the case re coal, that a moratorium on new coal-fired power plants is the essential first action. Lots of work by Matt Philips, more dinners, media coverage of my letter to the Prime Minister, and now a response of the UK government (http://www.columbia.edu/~jeh1/mailings/20080730_UKResponse.pdf):

Key phrases in this response: “For the UK, the starting point...is to recognize the central role of the EU Emissions Trading Scheme (EU ETS), particularly given the EU’s ambition that ‘cap and trade’ should form an integral part of a global climate change deal.” “A key priority for us is therefore to see this scheme strengthened...” The letter continues with sobering self-deception about how mandating ‘carbon-capture-ready’ will solve the coal problem.

This rationalization is almost identical to that of German Minister Gabriel. Any hope that implications of geophysical boundary conditions, when pointed out, would have a quick effect on policy-makers has proven to be unrealistic.

The case of Japan (below) makes the matter even clearer. Any follow-on to the Kyoto Protocol, to have any chance of success, must be dramatically different and account for geophysical facts.

An encouraging footnote: the opposition leader in the UK (Cameron) states that he would impose a moratorium on new coal-fired power plants.

Japan, the Kyoto Protocol, and Beyond

My letter to Prime Minister Fukuda¹ was finished on the plane on the way to 4 July pre-G8 talk at UN University²; the final two paragraphs (suggesting that the G8 leaders write a letter to their grandchildren) were added on the bus ride from Narita Airport. When the letter was hand-delivered to the Prime Minister’s office they first declined to accept it, but relented upon learning that the letter was already discussed in major Japanese newspapers. Thanks to UN University for arranging the media interviews.

The letter to PM Fukuda presents geophysical facts within the letter per se, not in an attachment as in the letters to the UK Prime Minister and German Chancellor. This change was made because the attachments to the earlier letters were either not read or not understood. The geophysical data make it clear that the EU Emissions Trading Scheme would not be effective nor would the broad emissions reduction approach (a la Kyoto Protocol and suggested successors).

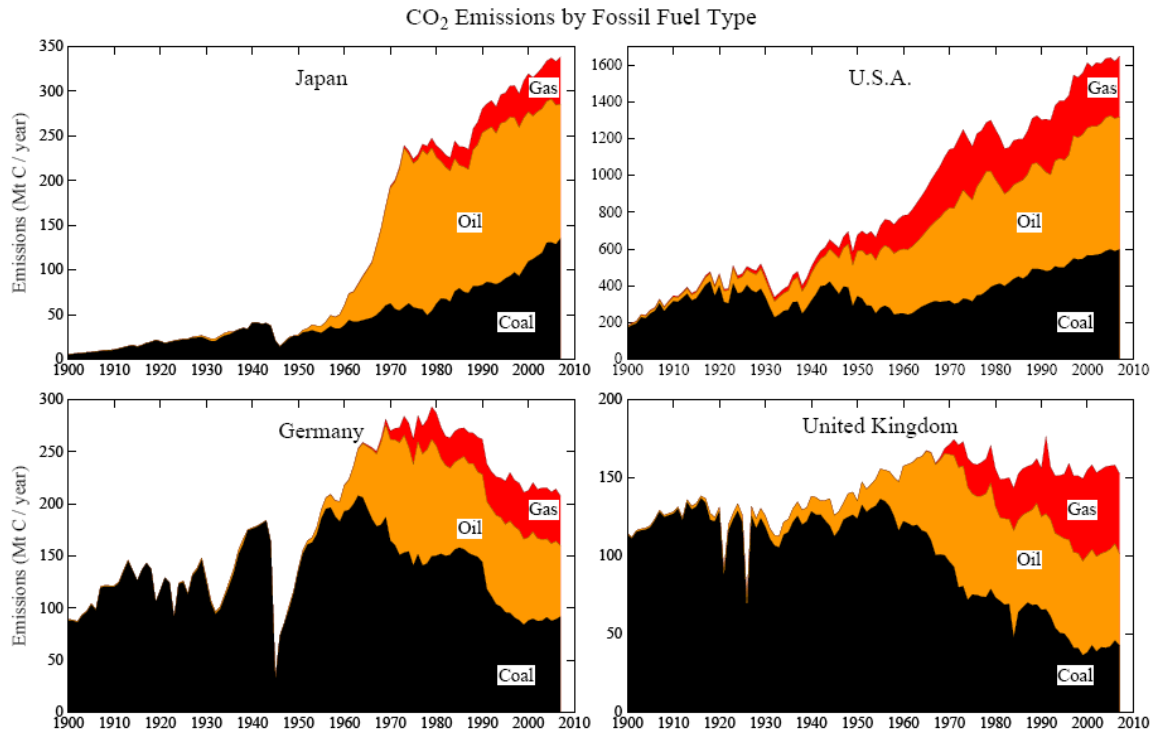


Figure 2. CO₂ emissions by fossil fuel type in four countries. Note the different scales, emissions from the United States being several times larger than those of the other countries.

Figure 2, from the letter to PM Fukuda, shows the importance of coal for CO₂ emissions, even in developed countries. Japan was an ardent proponent of the Kyoto Protocol, accepting a larger emissions reduction requirement than most other countries. But Figure 2 shows that Japan's CO₂ emissions actually increased rapidly, with the increase entirely due to increased coal use.

Japan's total CO₂ emissions are increasing despite the fact that Japan is held up as a role model for energy efficiency. Japan escapes attention in part by buying the right to pollute via the Clean Development Mechanism (CDM) of the Kyoto Protocol. The CDM, however, is a subterfuge and a disaster; it allows emissions of the worst pollutant, coal CO₂, to increase, while supposedly reducing emissions in China and other developing countries. In fact, there is no effective constraint on CO₂ emissions from China.

Germany and the UK reduced their CO₂ emissions in the past quarter century (Figure 2), in both cases via reduced coal use (Germany halted dirty inefficient coal use in East Germany, the UK replaced coal with North Sea gas). If the UK, US and Germany, the countries most responsible on a per capita basis for excess CO₂ in the air today^{1,3}, were to phase out coal emissions, their CO₂ emissions would plummet as peak oil also takes effect. Of course major efforts to develop alternative energies and energy efficiency would be needed, but that approach would have many other merits. And by showing that this approach works, yielding clean air and water, and good jobs, it would become feasible to bring the rest of the world along. But instead, these governments are choosing to build new coal-fired power plants with 50-75 year lifetimes.

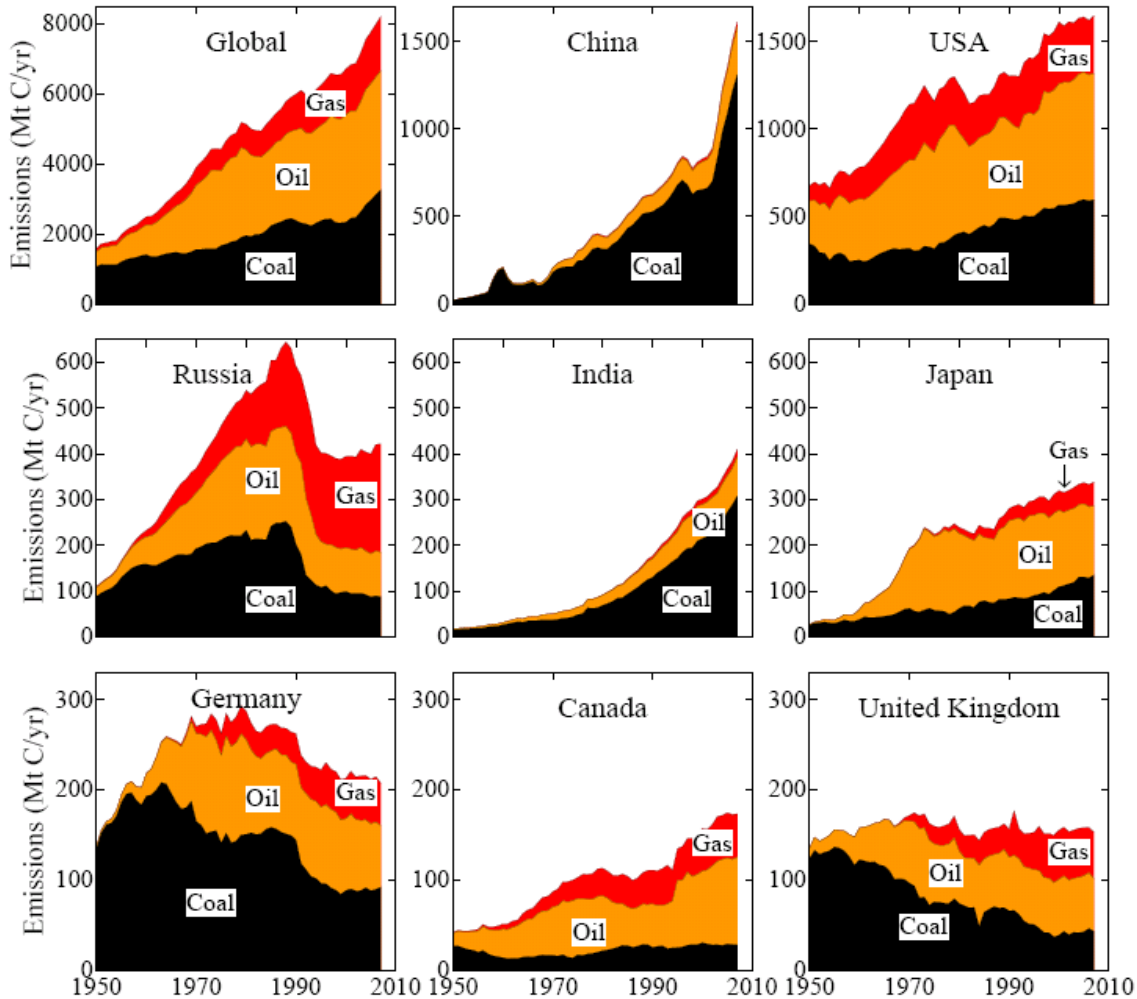


Figure 3. CO₂ emissions by fossil fuel type for the globe and several countries. Note the four different scales.

The global impact of the failure of these countries to provide leadership is revealed in Figure 3. The surge in global CO₂ emissions is mainly a surge in coal use. The surge is mainly in the East, especially China, but the West cannot make a peep about that, because the West is building coal plants itself, has many more on the books, and presents no effective alternatives. In addition, the West is responsible for most of the excess CO₂ in the air today^{1,3}.

Figure 3 also shows that coal use in Russia is modest and not increasing. Thus the common assertion that Russia is a wild card that would prevent successful control of global warming is diminished by realization that the primary requirement is phase-out of coal emissions.

In summary, policy implications of the geophysical boundary conditions include:

- (1) Annual CO₂ emissions, and thus percent reduction of annual emissions, is not an appropriate metric for controlling climate change. Lifetime of CO₂ is so long that slowing CO₂ emissions has little effect on climate change. Instead, we must limit the total fossil fuel CO₂ emission.

(2) Phase-out of coal emissions is the sine qua non for climate stabilization. Oil and gas, the most convenient portable fossil fuels, are sufficiently abundant to carry the world well into the dangerous CO₂ zone, but not irretrievably so. If coal emissions (not necessarily coal use) were phased out promptly (within ~2 decades, which probably would require phase-out in the West within ~1 decade), it would be practical to get back to CO₂ levels lower than the present day amount. Coal is by far the dirtiest of the conventional fossil fuels, providing additional reason to target it for phase-out. Conclusion that the largest pools of oil and gas will be used, and that oil and gas reserves are smaller than coal reserves, does not imply that it makes sense to extract every last drop of oil and gas. Given the need to move beyond fossil fuels in any case, and the need to get back to a safe level of atmospheric CO₂, policy-makers should consider actions that move beyond fossil fuels as rapidly as possible, preferably leaving in the ground the oil and gas that is more difficult to extract or located in environmentally sensitive regions.

(3) Countries cannot be allowed to “buy out” of coal phase-out via supposed reforestation or reduction of non-CO₂ forcings. Sequestration of CO₂ via improved forestry and agricultural practices is needed to reduce atmospheric levels below current levels. If reforestation CO₂ reductions are used up as a trade-off for coal emissions it will be difficult, if not impossible, to get CO₂ levels back below current levels. Similarly, the limited potential for reduction of non-CO₂ forcings is needed to balance the positive (warming) climate forcing due to other non-CO₂ effects, especially expected reduction of reflective aerosols.

(4) Unconventional fossil fuels, including tar shale, tar sands, and methane hydrates, which contain more carbon than coal and other conventional reserves, must not be widely developed.

Nuclear Power

On one of my trips I read a draft of “Prescription for the Planet” by Tom Blees, which I highly recommend. Let me note two of its topics that are especially relevant to global warming.

Blees makes a powerful case for 4th generation nuclear power, the Integral Fast Reactor (IFR). IFR reactors (a.k.a. fast or breeder reactors) eliminate moderating materials used in thermal reactors, allowing the neutrons to move faster. More energetic splitting of nuclei releases more neutrons. Instead of using up less than 1% of the fissionable material in the ore, a fast reactor burns practically all of the uranium. Primary claimed advantages are:

a) The fuel is recycled on-site, incorporating radioactive elements into new fuel rods. The eventual ‘ashes’ are not usable as fuel or weapons. The radioactive half-life of the ashes is short, their radioactivity becoming less than that of naturally occurring ore within a few hundred years. The volume of this waste is relatively small and can be stored easily either on-site or off-site.

b) The IFR can burn the nuclear ‘waste’ of current thermal reactors. So we have a supply of fuel that is better than free – we have been struggling with what to do with that ‘waste’ for years. We have enough fuel for IFR reactors to last several centuries without further uranium mining. So the argument that nuclear power uses a lot of fossil fuels during uranium mining becomes moot.

c) IFR design can be practically failsafe, relying on physical properties of reactor components to shut down in even the most adverse situations, thus avoiding coolant problems of Chernobyl and Three Mile Island, as well as the earthquake problem. The terrorist threat can be minimized by building the reactor below grade and covering it with reinforced concrete and earth.

Wait a minute! If it's that good, why aren't we doing it? Well, according to Blee, it's because, in 1994, just when we were ready to build a demonstration plant, the Clinton Administration cancelled the IFR program. Blee offers a partial explanation, noting that Clinton had used the phrase "You're pro-nuclear!" to demonize rivals during his campaign, suggesting that Clinton had a debt to the anti-nuclear people. Hmm. The matter warrants further investigation and discussion. It's not as if we didn't know about global warming in 1994.

Even more curious is the assertion that Argonne scientists, distraught about the cancellation, were told they could not talk about it (why do I find this easy to believe?). Here too there is no explanation in depth, although Blee notes that the Secretary of Energy, Hazel O'Leary, was previously a lobbyist for fossil fuel companies (my gosh, is everybody in Washington an ex-lobbyist – alligators will go extinct!).

I have always been agnostic on nuclear power. I like to hope that, if our next President gives high priority to a low-loss national electric grid, renewables will be able to take over most of the power generation load⁴. Wind and solar-thermal are poised to become big players. IEA's estimate that renewables will only grow from 1% to 2% (by 2030!) can be dismissed due to IEA's incestuous relation with fossil industries – nevertheless, one must have healthy skepticism about whether renewables can take over completely. Maybe an understatement – I'm not certain.

Blee argues that it made no sense to terminate research and development of 4th generation nuclear power. Was it thought that nuclear technology would be eliminated from Earth, and thus the world would become a safer place?? Not very plausible – as Blee points out, several other countries are building or making plans to build fast reactors. By opting out of the technology, the U.S. loses the ability to influence IFR standards and controls, with no realistic hope of getting the rest of the world to eschew breeder reactors. Blee suggests, probably rightly, that this was a political calculation for domestic purposes, a case of dangerous self-deception.

Bottom line: I can't seem to agree fully with either the anti-nukes or Blee. Some of the anti-nukes are friends, concerned about climate change, and clearly good people. Yet I suspect that their 'success' (in blocking nuclear R&D) is actually making things more dangerous for all of us and for the planet. It seems that, instead of knee-jerk reaction against anything nuclear, we need hard-headed evaluation of how to get rid of long-lived nuclear waste and minimize dangers of proliferation and nuclear accidents. Fourth generation nuclear power seems to have the potential to solve the waste problem and minimize the others. In any case, we should not have bailed out of research on fast reactors. (BTW, Blee points out that coal-fired power plants are exposing the population to more than 100 times more radioactive material than nuclear power plants – some of it spewed out the smokestacks, but much of it in slag heaps of coal ash. See http://www.inthesetimes.com/article/3614/dirty_smoke_signals/ re the effect of this waste on Native Americans in the Southwest, as well as 'Burning the Future', above, re the Appalachians.)

I don't agree with Blee's dismissal of the conclusion of most energy experts that there is no 'silver bullet'; they argue that we need a mix of technologies. Blee sees a 'depleted uranium bullet' that could easily provide all of our needs for electrical energy for hundreds of years. His argument is fine for pointing out that existing nuclear material contains an enormous amount of energy (if we extract it all, rather than leaving >99% in a very long-lived waste heap), but I still think that we need a range of energy sources. Renewable energies and nuclear power are

compatible: they both need, or benefit from, a low-loss grid, as it is more acceptable to site nuclear plants away from population centers, and nuclear energy provides base-load power, complementing intermittent renewables.

BTW, nuclear plants being proposed for construction now in the U.S. are 3rd generation (the ones in operation are mostly 2nd generation). The 3rd generation reactors are simplified (fewer valves, pumps and tanks), but they are still thermal pressurized reactors that require (multiple) emergency cooling systems. France is about to replace its aging 2nd generation reactors with the European Pressurized Reactor (EPR); a prototype is now being built in Finland. According to Blees, OECD ranks EPR as the cheapest electric energy source, cheaper than pulverized coal – that evaluation doubtless presumes use of a standard design, a la the French procedure for its 2nd generation reactors. The prototype in Finland, according to reports, is running behind schedule and over budget – that was also true in the prior generation, yet the eventual standard French reactors have been economical. Current efforts to start construction of 3rd generation nuclear plants in the U.S., so far, do not seem to have achieved a standard design or to have avoided project delays (partly due to public opposition) that drive up costs.

Blees argues that the 4th generation technology basically exists, that the design will be simplified, especially due to the absence of a need for emergency cooling systems. He foresees a standard modular construction of the reactor per se, smaller than earlier generations, which can be built at the factory, shipped to the site, and dropped in the prepared excavation. His cost estimates have this nuclear power yielding cheaper electricity than any of the competition. The system is designed to eliminate long-lived nuclear ‘waste’ and minimize proliferation dangers. There is enough fuel available without further uranium mining to handle electricity needs for several centuries, for whatever fraction of electricity needs cannot be covered by renewable energies. If these claims are anywhere close to being correct, we could phase out use of fossil fuels for electricity generation over the next few decades.

I do not have the expertise or insight to evaluate the cost and technology readiness estimates. The overwhelming impression that I get, reinforced by the ‘boron’ topic below, is that Blees is a great optimist. But we need some good ideas and optimism. The book contains a lot of interesting insights and tidbits, e.g., there is more energy available in the nuclear material spewn out as waste by coal plants than the amount of energy produced by the coal burning. The book will be available in about a month; see his web site www.prescriptionfortheplanet.com

Boron-Powered Cars and Greenwash

Blees properly ridicules FutureGen, commonly dubbed NeverGen, as a greenwash construction of the coal industry, intended to make it look like they were working on cleaning up their horrendous environmental damage.

Blees suggests that hydrogen-powered cars are a greenwash of the oil and auto industries, while they continue to stick us with gas-guzzlers. That charge may be too strong, but it seems fair to say that they have not been looking at alternative vehicles as hard as they should have been. Also I need to point out a possible personal bias: I have been driving a hydrogen-powered car over the past two weeks [a BMW executive recognized me on an airplane and offered a free trial – for the first time I can look my Mercedes-driving lawyer friends on the level, even though it was just a trial – don’t get excited, the hydrogen cars are not for sale, would be very expensive if they were, and there was only one place, in Jersey City boondocks, where I could fill it up].

Blees thinks that there is a superior alternative to hydrogen. Here is the basis of the idea. If a metal is ground into fine enough dust, nanoparticles, it will burn. We could burn iron-dust in our cars, capture the rust-dust, take the rust home, and cook it to drive the oxygen off, thus recovering our initial iron dust, which we then could use to power our car on its next trip. We supply energy at the time of cooking. Iron is just the energy carrier.

So iron dust is an alternative to hydrogen as an energy carrier to power our post-fossil-fuel cars. Iron dust (unlike hydrogen) has the advantage of being non-explosive, but (among other things) it is heavy and gets heavier as rust. Enter a better idea: boron. It is much more energy dense than iron: it takes a quart of boron to match the energy in a gallon of gasoline. A tank (box) of boron would cost a few hundred dollars, but you only need to buy one tankful, when you buy your car. After that you just take the boron oxide to a store, a Seven-Eleven would be happy to serve, and trade it in for a box of boron (anyone can handle this material). Blees figures that processing boron oxide back to boron would cost only tens of cents. Even if he is too optimistic (or if Exxon/Mobil sees to it that he is put 6-foot under – they are not likely to appreciate competition from Seven-Eleven), it should be much cheaper than gasoline. If the processing from B_2O_3 back to B is done with carbon-free electricity, it takes care of the carbon emissions problem. Blees, as you might guess, envisages the energy coming from IFR nuclear plants.

O.K., let's go back a step. It is widely agreed that electric cars can be a solution for a piece of vehicular needs, and plug-in hybrid-electrics are a partial solution for the remaining piece. We should start with those technologies because they are ready to go, and batteries will improve, even though it has been slow going. But we must have something other than gasoline for complementing the electric part. Hydrogen, used in a fuel cell as opposed to being burned in an internal combustion engine, has the great advantage of emitting only water vapor as an exhaust product. Hydrogen could be produced at remote sites where renewable energy, such as wind or solar, is plentiful (or by IFR). But it has technological challenges, as described well in Science a few years ago, and more so in Joe Romm's book, *The Hype About Hydrogen*.

Automakers have been working hard on hydrogen for several years. Some of the technological problems must have been solved. All I can say is that the hydrogen-BMW drove great, better than any car I have ever owned, with enough getty-up for even a Texas cowboy (I am not a Texas cowboy). The car also had a gasoline tank, to avoid stranding with no hydrogen, and at push of a button switched seamlessly between hydrogen and gas.

In dismissing hydrogen Blees relies in part on a note by Tromp et al. (*Science*, 2003) suggesting that hydrogen leakage might threaten the stratospheric ozone layer. But Michael Prather (*Science* 302, 581, 2003) looked harder and found that it is unlikely to be a problem with realistic hydrogen leakage rates. There are greater challenges for hydrogen, though.

Getting the price of hydrogen vehicles down to a reasonable level is a big challenge and there would need to be a distribution system analogous to gas stations, perhaps replacing them. Boron must have challenges too, but maybe less. Blees says the boron must burn in pure oxygen, which requires miniaturization of an oxygen supply system for the car. I wonder if collecting the boron oxide and converting it back to pure boron is as simple as claimed? Also, the product of hydrogen (in a fuel cell) is water vapor, which we do not have to worry about. That is the big draw of hydrogen: zero pollution. I wonder if we can burn boron without tailpipe pollution?

Bottom line: Blees has stimulating, revolutionary vision. The jury is still out on hydrogen vs boron vs something else. But I am confident that there are better alternatives than fossil fuels. It is time to start working much harder on such alternatives.

Global Governance and Captains of Industry

Blees understands the threat posed by climate system inertia and tipping points, and the absence so far of anything approaching an adequate global response to the threat. He does not mince words. Here I try to summarize his views on emissions trading (the Kyoto and proposed post-Kyoto approach) in one paragraph, based more-or-less on direct quotes from his book:

Emissions trading is such an unutterably bogus concept that we should toss it on the slagheap right off the bat. It is a shell game that allows corporations to buy the right to pollute. Futility of carbon trading is obvious from the fact that it is the one climate change amelioration scheme that is agreeable to both politicians and industrialists. Example: an undeveloped nation with a lot of trees and a utility in say Dallas, Texas – the utility blithely belches out massive amounts of pollution from coal-fired power plants, buying the right to pollute from the poor tree-filled nation. Naturally the utility customers both foot the bill and reap the dire consequences. Carbon trading is little more than an unconscionable scam to further fossil fuel business as usual, not any sort of real solution.

Blees' resulting conclusion, paraphrased and summarized, is that corporate greed and the fact that governments are strongly influenced by (if not under the thumb of) corporations can be handled by nothing less than a change in global governance, at least for energy. He proposes GREAT (Global Rescue Energy Alliance Trust). I invite you to read his ideas on this topic.

Here is the rub. We do not have time for that, in my opinion. We do need international technology standards and controls of nuclear material, and we could simultaneously work toward better global governance, but progress on climate cannot be held up. We have an emergency: if we are going to avoid climate catastrophes, we must find leadership within governments and industries that exist now. There is no reason to believe the powers that be (I call them the 'captains of industry') will give up their power. But they have children and grandchildren too, which provides some hope that we can find a way to affect them.

Blees' conclusion that emissions trading is an "unconscionable scam" is too strong. However, the 'goals' approach with 'emissions trading' is grossly inadequate. We must make that clear.

Political leaders in countries where I have had interactions (e.g., UK, Germany, Australia – the latter to be discussed in a later note) take the matter seriously, understand we may be nearing tipping points, and are trying to define what they believe is 'politically feasible'. Unfortunately, what they are willing to agree is politically feasible, at least so far, is way too little.

'Captains of industry' are at present the biggest obstacle to solving the problem, but they are also the best hope for solving it. The captains need to cooperate with political leaders in defining rules and incentives that encourage technological innovations and development of clean energy. Those captains who are especially bad actors deserve to have attention drawn to them, in my opinion. The question is whether it is possible to make them rethink their strategy about climate or whether they are incorrigible. Even Scrooge gave up eventually – umm, that was a novel.

Sincere Criticism

After my talks in Washington on 23 June I was bombarded with hundreds of critical e-mails. A few criticisms a day is not uncommon, but this was an increase by two orders of magnitude, as if I had been put on a hit list. Whatever the source, and despite a lot of foul language, the criticisms were sincere, delivered with absolute conviction, often with repeated e-mails.

Range of styles was between that of John Doe Oklahoma⁵ and John Doe Texas⁶. Most of the e-mailers insisted that the sun was the primary cause of climate change, and many claimed that we were heading into an ice age, with the temperature in 2008 already having lost all of the warming of the past several decades. In light of these definitive assertions, and given the availability of both temperature and solar data, it is worth clarifying the situation.

Temperature and Solar Data

Figure 4 updates global and low latitude temperature at seasonal resolution. Red rectangles, blue semi-circles and green triangles at the bottom of the plot show the timing of El Ninos, La Ninas and large volcanic eruptions. Oscillation from El Ninos to La Ninas is the main cause of the big fluctuations of low latitude temperature. These fluctuations are also apparent, albeit muted, in the global mean temperature change.

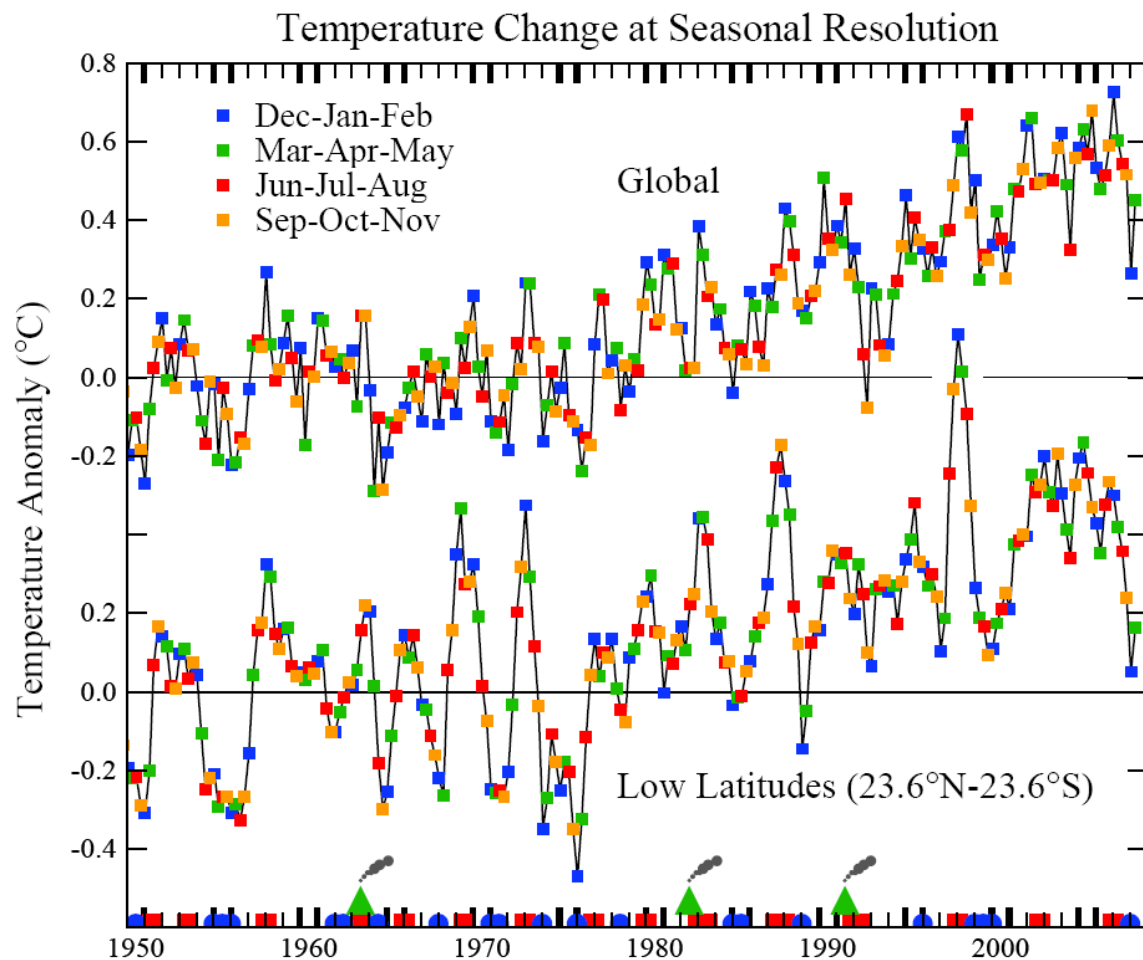


Figure 4. Seasonal-mean global and low-latitude surface temperature, based on an update of the analysis of Hansen et al. (J. Geophys. Res. 106, 23947, 2001).

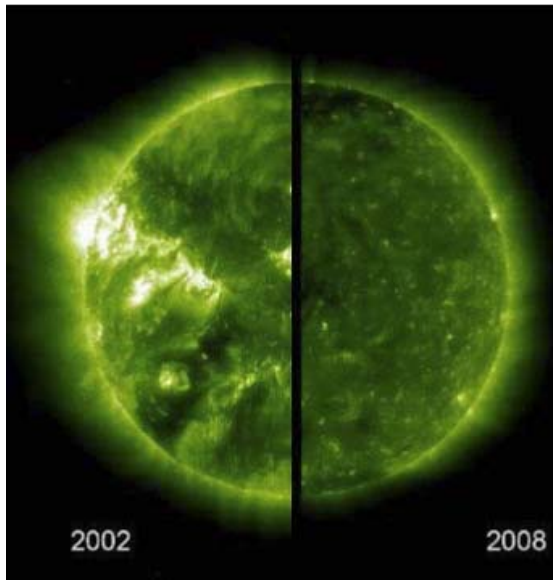


Figure 5. Comparison of the sun at solar minimum (right side, July 2008) and at solar maximum (left, August 2002) as seen in extreme ultraviolet light from SOHO (Solar Heliospheric Observatory). Active regions during solar maximum are producing a number of solar storms. The sun in 2008 is quiet, with no active regions, part of the normal 11-year solar cycle.

The most recent few seasons (Figure 4) have been cool relative to the previous five years, on average $\sim 0.25^{\circ}\text{C}$ cooler. If one takes the recent peak (early 2007) and recent low point (early 2008), the change is about -0.5°C . This drop is the source of recent contrarian assertions that all global warming of the past century has been lost and the world is now headed into an ice age. Figure 4 reveals that it is silly to use a peak and valley as an indication of the trend. Peak to valley drops and rises of $0.3\text{-}0.5^{\circ}\text{C}$ in seasonal mean temperature anomalies are common (Figure 4), usually associated with ENSO (El Niño Southern Oscillation) fluctuations.

The recent La Niña was strong, but tropical temperatures in mid-2008 have returned nearly to ENSO neutral conditions and global temperature is heading back to the high level of the past few years. The low temperatures in the first half of 2008 lead us to estimate that the mean 2008 global temperature will be perhaps in the range about 10th to 15th warmest year in our record.

A majority of the critical e-mails asserted emphatically that global temperature change is due mainly to solar changes, not human-made effects. They also state or imply that, because of ongoing solar changes, the Earth is entering a long-term cooling period (following the warming of the past 30 years, which they presume to be due to increases of solar energy). One e-mail virtually shouted: “THE SUN IS GOING OUT!”

Images from SOHO (Figure 5) might be the basis for that conclusion. The sun is inactive at the present, at a minimum of the normal ~ 11 year solar cycle. The solar cycle has a measureable effect on the amount of solar energy received by Earth (Figure 6). The amplitude of solar cycle variations is about 1 W/m^2 at the Earth’s distance from the sun, a bit less than 0.1% of the $\sim 1365\text{ W/m}^2$ of energy passing through an area oriented perpendicular to the Earth-sun direction.

The Earth absorbs $\sim 235\text{ W/m}^2$, of solar energy, averaged over the Earth’s surface. So climate forcing due to change from solar minimum to solar maximum is about $\frac{1}{4}\text{ W/m}^2$. If equilibrium climate sensitivity is 3°C for doubled CO_2 ($\frac{3}{4}^{\circ}\text{C}$ per W/m^2), the expected equilibrium response to this solar forcing is $\sim 0.2^{\circ}\text{C}$. However, because of the ocean’s thermal inertia less than half of the

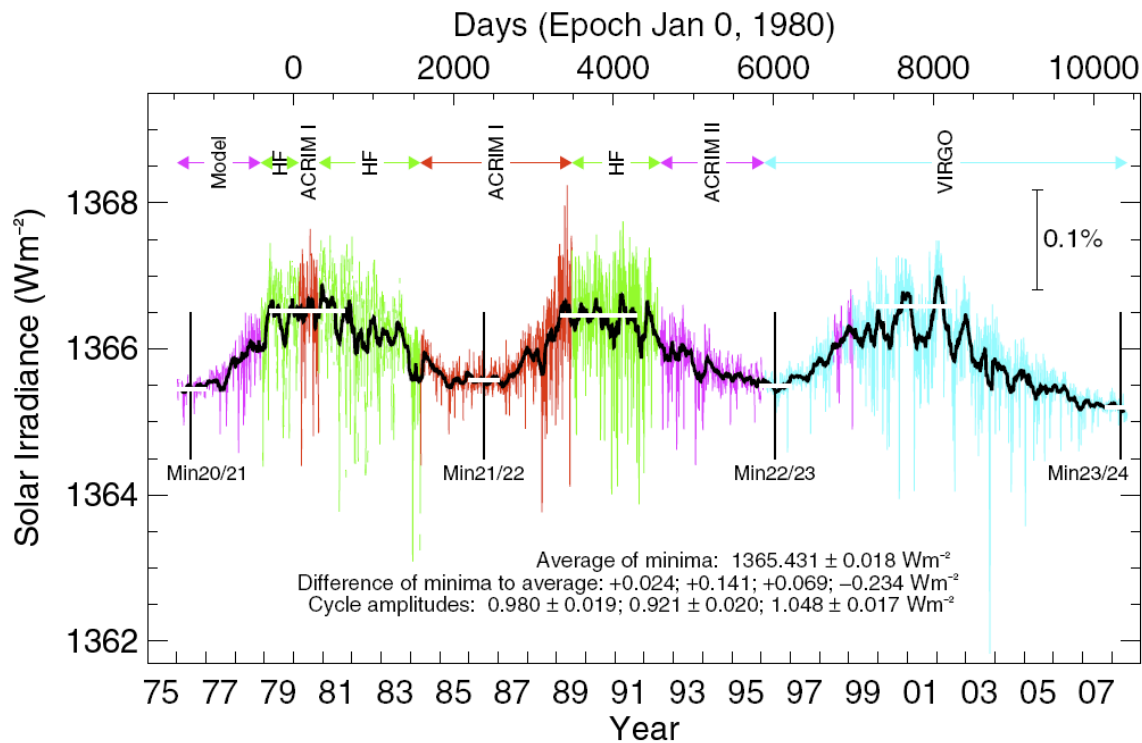


Figure 6. Solar irradiance from composite of several satellite-measured time series based on Frohlich & Lean (1998; <http://www.pmodwrc.ch/pmod.php?topic=tsi/composite/SolarConstant>)

equilibrium response would be expected for a cyclic forcing with ~ 11 year period. Thus the expected global-mean transient response to the solar cycle is less than or approximately 0.1°C .

Is there some way that the small variations of energy coming from the sun could be amplified, so that the ‘solar exponents’ are actually correct and the sun is driving our climate changes? There are indirect effects of solar variability, e.g., solar radiation varies most at ultraviolet wavelengths that affect ozone. Indeed, empirical data on ozone change with the solar cycle and climate model studies indicate that induced ozone changes amplify the direct solar forcing (J. Geophys. Res. 102, 6831, 1997; *ibid* 106, 77193, 2001), but the amplification is by a factor of one-third or less.

Other mechanisms to amplify the solar forcing have been hypothesized, such as induced changes of atmospheric condensation nuclei and thus changes of cloud cover. However, if such mechanisms were effective, then an 11-year signal should appear in temperature observations (Figure 4). In fact a very weak solar signal in global temperature has been found by many investigators, but only of the magnitude ($\sim 0.1^\circ\text{C}$ or less) expected due to the direct solar forcing. So the sun is only a minor contributor to the temperature fluctuations in Figure 4.

The possibility remains that the sun could be an important cause of climate change on longer time scales. (The source of nuclear energy at the sun’s core is essentially continuous, in fact increasing at a rate of about 1% in 100 million years, which is a negligible rate of change for our purposes. But the photosphere, the upper layers of the sun, can slightly impede or speed the emission of energy as the strength of magnetic fields fluctuates.) Perhaps the normal solar cycle evidenced in Figure 6 is about to be interrupted. Sunspots seemed to nearly disappear for a long period in the 17th century, which may have contributed (along with volcanic eruptions) to the

“little ice age”. And the current solar minimum is already longer than the previous two (Figure 6). Perhaps the e-mailer who shouted “THE SUN IS GOING OUT!” is correct!

Fortunately, we can compare quantitatively the climate forcing due to the sun (if its irradiance does not recover from its present minimum) and the forcing due to human-made greenhouse gases. Solar irradiance seems to be slightly less at its current minimum than in earlier minima (Figure 6), but, at most, the decrease from the mean irradiance of recent decades is $\sim 0.1\%$ yielding a climate forcing of about -0.2 W/m^2 . The current rate of atmospheric CO_2 increase is $\sim 2 \text{ ppm/year}$, yielding an annual increase of climate forcing of about $+0.03 \text{ W/m}^2$ per year.

Thus if the sun remains “out”, i.e., stuck for a long period in the current solar minimum, it can offset only about 7 years of CO_2 increase. The human-made greenhouse gas climate forcing is now relentlessly, monotonically, increasing at a rate that overwhelms variability of natural climate forcings. Unforced variability of global temperature is great, as shown in Figure 4, but the global temperature trend on decadal and longer time scales is now determined by the larger human-made climate forcing. Speculation that we may have entered a solar-driven long-term cooling trend must be dismissed as a pipe-dream.

How Science Works

One of the books about Richard Feynman (can't find it now) has a story something like this. When he started to work at Los Alamos on the Manhattan project he was essentially a post-doc. In an early meeting, led by one of the physics giants of the first half of the century, they were discussing possible interpretations of some data. One possibility was described and seemed to Feynman to be clearly correct, but they continued to go through many alternative suggestions and Feynman was getting more and more antsy: why didn't the leader restate the evidence for the logical interpretation? Eventually the leader stood up and said something to the effect “o.k., it seems that so-and-so's explanation is still best, let's get to work.”

Analysis of complex problems depends upon being able to assimilate many imperfect sources of information. With a new idea or improved data, scientists have to reevaluate interpretations with an open mind. Sometimes this yields modification of understanding, and (very, very seldom) sometimes a dramatic change (Einstein was disgusted with media that, he said, portrayed science as if it were continually beset by revolutions, like the small southern European republics).

Being objective is not sufficient for scientific success, especially for a topic as complex and diverse as global climate. One also needs some training in core sciences such as physics, mathematics, etc., experience in examining how the real world behaves, and a mind capable of putting it together. The “laws” of science are only descriptions of reality as it has been observed, descriptions to be changed or refined as better data and knowledge develop.

Our understanding of the Earth's climate, in particular, depends foremost on the Earth's history: how past climate changed in response to changing boundary conditions. I rate observations of ongoing climate change and processes today, processes on the ice sheets, in the oceans, etc., as the second most important source of knowledge about climate change. Climate models rate only third, in my opinion. Models are a tool that helps us understand the other two, i.e., climate history and on-going climate phenomena. Models are a representation of reality, one that helps

us combine different factors, evaluate relative importance, and try to understand interactions. As we make progress we add more processes to the models and improve representations of others.

Here is the strange part: within the many irate e-mails that I received after my 23 June talk was a common theme – the writer stating flatly that he would prove my fraudulence by exposing flaws in our climate modeling (the frequency of this theme made me wonder whether a bounty for such had been offered!). Now I am receiving messages demanding that I fess up to having made wrong projections of climate change in the 1980s. Oddly, the “errors” they point out are results I considered to be the most interesting and useful. What we have here, it seems, is a failure to understand how science works.

Their criticisms emphasize (1) the magnitude of global mean warming over the past 20-30 years, and (2) the amount of Southern Hemisphere warming, especially of the ocean around Antarctica. To understand what we learn from observed climate change, and from comparison with simulations, one must understand what the models contain.

Our 1980s climate model had sensitivity 4°C for doubled CO_2 . Real world climate sensitivity was estimated to be $3\pm 1.5^{\circ}\text{C}$, so we realized that our model was within the high side of the likely range. That is fine – the practical approach is to put in the ‘physics’ at our disposal and then use the resulting model, being aware of its sensitivity – and it is usually possible to estimate how results would differ for an alternative sensitivity.

An original aspect in our modeling then (J. Geophys. Res., 93, 9341, 1988) was the fact that we made the first “transient” simulations, i.e., including time-dependent greenhouse gas amounts using measured or estimated greenhouse gas changes for the past and several scenarios for the future. Our simulations covered 1958-2030, which was not easy, given that we had only a single old computer, one that had been discarded by the census bureau.

We were able to make long simulations by using an atmospheric model with coarse resolution and a simple representation of the ocean, the latter including uptake of heat perturbations as a passive tracer with mixing rates calibrated by observations of ocean tracers. This model would be expected to do a good job of simulating heat uptake, and also mean surface temperature change if the model’s sensitivity is right, but no ocean dynamical feedbacks were included.

Actual global warming over the past 2-3 decades is at a rate close to that in our 1988 paper for scenario B, the scenario closest to actual climate forcings. The slightly larger warming rate in the model (Figure 2 in Proc. Natl. Acad. Sci. 103, 14288, 2006) is consistent with the fact that the model sensitivity (4°C for doubled CO_2) is somewhat higher than real-world sensitivity ($\sim 3^{\circ}\text{C}$ for doubled CO_2) inferred from paleoclimate data and more recent models.

As for the relatively small observed warming of the Southern Ocean in recent decades, this characteristic is obtained in our more recent models that include ocean dynamics (e.g., Clim. Dyn. 29, 661, 2007). Observations are not good enough to be sure how large the Southern Ocean warming has been on the century time scale. However, contrary to the assertion of people sending me critical e-mails, observed temperature changes provide no basis for doubting that there will be polar amplification of warming in the Southern Hemisphere, as well as in the Northern Hemisphere – paleoclimate data make that amplification abundantly clear. And it is important that we develop the ability to understand and simulate well the unfolding Southern

Ocean dynamical response, because it will affect the stability of ice shelves around Antarctica and eventually the ice sheets that determine future sea level change.

The public, however, is not presented a realistic picture of how science works on such matters. Instead public discussion of global warming is befogged by contrarians, whose opinions are given a megaphone by special interests that benefit by keeping the public confused. Some of the contrarians were once scientists, but now they behave, at least on the topic of global warming, as lawyers defending a client. Their aim is to present a case as effectively as possible, citing only evidence that supports their client, and making the story appear as favorable as possible to their client. The best, the most articulate, are sought out by special interests, and even by much of the media, because the media likes to have “balance” in its coverage of most topics – and especially this topic because special interests have influence on the media.

The barrage of e-mails that I have received from the public highlights another aspect of the global warming story: it is now very political. The people sending these messages are not generally scientists, even though in many cases they parrot “scientific” statements of contrarians. In their opinion these matters should be discussed in you-tube “debates” between scientists and contrarians. My guess is that scientists may not fare very well in such a format.

It is this situation that has created what I call a huge gap between what is understood about global warming, by the relevant scientific community, and what is known about global warming, by those who need to know, the public and policy-makers. Nobody ever asks me what I mean by “the relevant scientific community”. If they did, I would say: people who know what they are talking about (which may cause a bit of consternation, but this is no time to mince words).

Is there any way out of this situation? Continuing real world climate change and the scientific method will eventually make things clear. Unfortunately, because of inertia of the climate system and climate tipping points, it is extremely dangerous to wait for real world events to be so large that they overwhelm special interests and their contrarian lawyers.

Here is one suggestion: the next President should ask the National Academy of Sciences to provide him a prompt assessment of the situation. After all, Abraham Lincoln established our Academy for just such purpose. Interestingly, at the beginning of the current administration, in early 2001, the President asked the Academy for a (albeit limited) assessment of global warming, apparently under the belief that the Academy would be critical of the most recent report of the Intergovernmental Panel on Climate Change. Well, the Academy’s report did have some criticisms, but, with clarity and authority, it reiterated the reality of global warming, the predominant role of humans in causing the warming, and the need for a policy response to minimize climate problems. The administration was apparently so taken aback that they never asked the Academy again for any broad advice on the topic. It does not do much good to cry over that tragedy – now is the time to figure out the best way forward from this point.

¹ Letter to Prime Minister Fukuda:

http://www.columbia.edu/~jeh1/mailings/20080703_DearPrimeMinisterFukuda.pdf

² 4 July 2008 talk at UN University: http://www.columbia.edu/~jeh1/2008/Tokyo_20080704.pdf

³ Global warming: The East-West Connection, J. Hansen and M. Sato, in preparation.

⁴ Boone Pickens has to install some of his own transmission line in Texas to carry energy from his windmill farm due to the absence of an adequate grid (presently some windmills in Texas are turned off, because there is no way to get the electricity to users).

⁵ Dr. Hansen,

Did you get my prior *four* messages? I am getting the impression you do not want to reply to me. Why are you ignoring me? The text is below.

I saw the article on Fox News where you were quoted as saying:

"Special interests have blocked the transition to our renewable energy future," Hansen writes in an opinion piece posted on the institute's Web site. "Instead of moving heavily into renewable energies, fossil fuel companies choose to spread doubt about global warming, just as tobacco companies discredited the link between smoking and cancer. Methods are sophisticated, including funding to help shape school textbook discussions of global warming."

"CEOs of fossil energy companies know what they are doing and are aware of the long-term consequences of continued business as usual," Hansen continues. "In my opinion, these CEOs should be tried for high crimes against humanity and nature."

I would like to hear back from you regarding these other scientists. If you have FACTS to refute them, PLEASE tell me!

OK, here are quite a number of scientists talking about this. I challenge you to listen carefully to each scientist. Each of them gets their credentials listed as they speak. One of the men in the videos below said that when he tried to present facts proving global warming is a farce, the pro-global warming group started calling him names instead of having a reasonable dialogue.

Al Gore Snow Job – from the Heartland Institute

<http://www.youtube.com/watch?v=DRaeEIN5Sh8>

This is a group of five videos. Do them in order. There are scientists here doing the ice core analysis.

They have the **MOST** credibility of the all! Then there are some that have done extensive analysis. I have put all of them here, but you can see the link to the next one at the end of each video.

<http://www.youtube.com/watch?v=fr5O1HsTVgA&feature=related>

<http://www.youtube.com/watch?v=fD6VBLlWmCI&NR=1>

<http://www.youtube.com/watch?v=gZS2eIRkcR0&NR=1>

<http://www.youtube.com/watch?v=dIbTJ6mhCqk&NR=1>

<http://www.youtube.com/watch?v=v2XALmrq3ro&NR=1>

Here is a response to one of the videos above. It is interesting in that it has a song, pretty pictures, and plays on your emotions. It does not present even ONE **fact**.

http://www.youtube.com/watch?v=7ztHHZBodTU&watch_response

Here are several more videos made by scientists about global warming.

In this video Carbon Dioxide CO₂ is a necessity! Also, CO₂ is a RESULT of temperature rise, not a CAUSE!

http://www.youtube.com/watch?v=iMDi_u0dcig&feature=related

Global Warming Hoax exposed. Polar Bears are NOT in danger at all!

<http://www.youtube.com/watch?v=WKAC4kfHruQ&feature=related>

From Fox News – who I doubt you believe in ...

<http://www.youtube.com/watch?v=aKOSiYWwcio&NR=1>

Even CNN!

<http://www.youtube.com/watch?v=WtFDpmn7mM0&feature=related>

Nobel Peace Prize? Even the Czechoslovakian president is skeptical!

<http://www.youtube.com/watch?v=FEqF8IsZ9M0&feature=related>

CNN and several others again ... listen to ALL of it ... as you know, global COOLING was the big story in the 70's! Then look at the CO₂ explanation again. Sorry, this is a poor quality film, but the facts are there.

<http://www.youtube.com/watch?v=lo-Tb7vTamY&feature=related>

Direct refutation of Al Gore on CO₂ causing global warming.

<http://www.youtube.com/watch?v=XDI2NVTYRXU&feature=related>

The global warming swindle. This one is one of the best at exposing the attitudes of the global warming crowd and they refuse to listen to reason!

<http://www.youtube.com/watch?v=xzSzItt6h-s&feature=related>

Climate Change – is CO₂ the cause?

<http://www.youtube.com/watch?v=FOLkze-9GcI&feature=related>

<http://www.youtube.com/watch?v=vN06Jsi-SW8&NR=1>

<http://www.youtube.com/watch?v=iCXDISLXTaY&NR=1>

<http://www.youtube.com/watch?v=bpQGGFZHSno&feature=related>

“Why CO₂ cannot be blamed on global warming.” This is one of the computer modeling scientists for the case for global warming!

<http://www.youtube.com/watch?v=rTUDWy6T050&feature=related>

If you have listened carefully to these scientists, several of them have said, “The temperature on earth rose significantly *before* the CO₂ rose – about 800 *years before*! In other words, the temperature caused the CO₂, not the other way around! This shoots down one of Al Gore’s most powerful arguments! And, this is significant, anyone wanting to force us to buy carbon credits is just lining the pockets of scam artists! WC Fields is right, “There is a sucker born every minute.” And the UN is the biggest sucker of them all.

There are **hundreds** more films available!

What I have seen in ALL of the films supporting global warming is a lot of catastrophic pictures, a heart-jerking song, a lot of ‘computer models’ which – as you will have seen to be faulty if you watched all of the videos – show dramatic problems coming. But when asked some of the more pertinent questions, the ones touting global warming have no answers. Notice, in one of Al Gore’s films he calls anyone stupid who

does not believe in global warming. They did the same with evolution! They are shoving lies down our throat! If you watched all the videos, you will see *plenty* of evidence that global warming is a huge lie. It is nothing but propaganda!

John Doe Oklahoma

⁶ I realize you don't have enough intellectual integrity to acknowledge it now, but YOU are the one who admitted lying to Congress about so called 'anthropogenic global warming'...and now you want to put oil company execs on trial for telling the truth about it?...what kind of kindergarten fairy land are you living in, Jimmy?...I've been doing my level best for the last 2 years to tell people what a fraud you and your ilk are by using things like the Milankovich variations as well as showing them the actual temperature readings for the last 10 years showing that the earth is actually in a mild cooling cycle...and I don't get paid a dime from ANY oil company...or from anybody at all for that matter...I've also been telling people that you were basically bribed to lie about AGW and that you don't even have a degree in climatology...so your biggest enemy is ME, buddy boy...not the oil companies...I am completely impartial and have no economic stake in the argument one way or the other...which gives me a lot more credibility than you...now I know you aren't familiar with the 1st Amendment to the US Constitution which guarantees free speech and THAT is the reason that you thought you could browbeat the clowns in Washington into putting oil company execs 'on trial' for daring to question your self proclaimed omniscience...so you just keep sounding off like some closet Hitler and spewing your lies about AGW and calling for kangaroo courts...in the meantime, I will continue to trash your professional reputation and your pretended manhood with the truth...I told you in an email over a year ago I was going to do this...and I always keep my word when dealing with incipient nazis like you...I will destroy you, Jimmy...do not doubt it...the science and the facts are on my side...and if public opinion polls are any indication, most of the American people are as well...and they do not take kindly to your attempts to suppress the truth or to bully and oppress those of us who have the audacity to disagree with you...you see, Jimmy, you are so naive about things like this that you don't even realize that you have just shit yourself by calling for oil execs to be prosecuted...if the truth were on your side, you wouldn't have to do that...the facts would speak for themselves without any bullying on your part...but now that your so called scientific 'consensus' about AGW has been shown for the fraud that it is, support for your position is melting away like snow in late spring...and you know it...which is the real reason that in your panic, you said what you said about oil execs...so you just keep it up, Jimmy...keep trying to throw your weight around...and I will softly and gently use facts and graphs to gradually persuade people that you and AGW are a fraud and a hoax...and you can be damn sure I will outlive you and win this war...you made the mistake of either ignoring or underestimating me over a year ago...and I'm willing to bet you a British knighthood you will do so this time as well...please do...you're coming off as some kind of half-assed mini tyrant...which is exactly what I had hoped for...and you didn't disappoint me...you wanted war, Jimmy...and now you've got it...for the rest of your short and pitiful life
John Doe Texas

Dr. Hansen:

Since you admitted before Congress that you had lied about being 'muzzled' by the Bush Administration vis-a-vis your ongoing attempts to persuade people that 'global warming' constitutes a danger to mankind and the planet, why should anybody believe anything you say about it? Evidently you are laboring under the self induced delusion that the 'end justifies the means'...or is it simply that you think that the solutions to what you profess to believe should be implemented 'by any means necessary'?...Giving you the benefit of the doubt, that you do actually believe what you claim to, I challenge you...and your so called scientific expertise...and your integrity...to state publicly and categorically that you believe that an anthropogenic increase in atmospheric carbon dioxide is the primary CAUSE of 'global warming'...no equivocations or qualifying your assertions...say it once and for all, Dr...so that people will know EXACTLY what you believe and why...state it based on your prestige as a NASA scientist...one who is willing to put his scientific reputation and that of NASA on the line by stating it as FACT...that way those of us who know that the exact opposite is true will be able to point to you as the lying political fraud that you are...I don't intend to hold my breath waiting for that to happen...but when it becomes apparent that you won't do so due to the lack of courage of your own convictions, you may rest assured that I will do all within my power to destroy you professionally and personally...it is time you and your cronies understood that you simply do not possess the requisite intelligence to con the American people with your so called 'consensus' about 'global warming'...much less that its cause is primarily anthropogenic... By your blatantly false assertions that you were 'muzzled' by the Bush Administration, you have presumed to question the honor of a President who I not only respect but worked for as a fellow USAF veteran...I take umbrage and vehement offense at your vile and self serving arrogance...watch your back, Jimmy boy...you've made a LOT of enemies with your whiny little prevarications...me among them...and I have a long, long memory...just for the record...I have just as many degrees in climatology as you do...none...all I have as a resume enhancer is being the only person ever kicked out of the Mensa Society...and that done by YOUR political bedfellows...so you might say I am well motivated to grind your lying ass into the dirt and utterly destroy you as a scientist...and as a man...and I don't think that the latter will be too difficult at all given the diminutive nature of your testicles...you've been warned, Dr...so either clean up your act and begin telling the truth about CO2 and causality vis-a-vis 'global warming'...or spend the rest of your life with people like me up your ass till the day of your ultimate demise.
John Doe Texas (a year earlier)