Date of completion: 2 September 2009

"Hail Mary" Technologies to Engineer Earth's Climate*

John Cairns, Jr.

Department of Biological Sciences, Virginia Polytechnic Institute and State University,
Blacksburg, Virginia 24061, USA

*This posting is a simultaneous submission for "Climate Change and You: Putting a Face on Global Warming," EcoRes Forum Online E-Conference #3, October 19-29, 2009. Further information available at www.eco-res.org.

A variety of technologies has been proposed to avoid further increasing Earth's temperature by emissions of anthropogenic greenhouse gases in excess of Earth's ability to assimilate them. The two most popular technological approaches are (1) reflecting solar energy back into space and (2) sequestering and storing carbon so that it will not reenter the atmosphere (e.g., Brahic 2009). These two approaches are among a group of mind-boggling concepts now being referred to as "Hail Mary" technology. [The term "Hail Mary" was first used in American football to describe a forward pass that is made in desperation and that has only a small chance of success.] Humankind is now giving serious consideration to "Hail Mary" technologies that have not been adequately researched to address one component of a much larger problem (e.g., increase in global mean temperature).

You Cannot Do Just One Thing

Humans are not superior to the biosphere – they are a part of the biosphere. However, humans are acting as if they are apart from the biosphere. The biospheric life support system (also called *Gaia* by James Lovelock) has maintained conditions favorable to the genus *Homo* for approximately 2 million years and the species *Homo sapiens* for 160,000-200,000 years. The biospheric life support system is a highly interactive, dynamic system that has evolved over the last 3½ billion years. Therefore, actions have many interrelated consequences – no one activity can be completed in isolation from the effects on other components of the biosphere.

For example, other "Hail Mary" suggestions include using aerosol particles to reflect solar radiation into space or spraying seawater mist from ships toward low-lying clouds to make them brighter so they would reflect more sunlight away from Earth (Tierney 2009). The intent of both approaches is to reduce global heating. However, all these technologies must be considered in the context of what else they would do besides possibly lowering global mean temperature. How many side effects will be identified before the technologies are used on a large scale? Politicians have indicated that global mean temperature should not rise more than 2°C. Since politicians have been reluctant to restrict anthropogenic greenhouse gas emissions, they may be tempted to use one of the "Hail Mary" technologies in a few years.

Global-Scale Experiments

Engineering global climate will be the largest experiment carried out by humankind. How will quality control be carried out on experiments that could have unintended global consequences? In fact, Turney (2008, p. 29) notes: "A recent paper suggests that the odds are only in our favour of keeping below 2°C – with an estimated risk of 28% – if the equivalent level [Greenhouse gases have different heat trapping abilities – it is useful to refer to them collectively as carbon dioxide equivalents.] is kept to 400 ppm; a value of 550 ppm has a 68 to 99% chance of breaching 2°C. It's not very heartening when we add together the heating capability of today's greenhouse gases and find we're at around 460 ppm. We're already beyond a safe level." Furthermore, no global agreement has been reached on reducing greenhouse gas emissions. Every year that passes without a substantive reduction in anthropogenic greenhouse gas emissions increases the probability that a desperate situation will arise that will persuade politicians to use a "Hail Mary" technology. Without an agreement on either the rate or extent of anthropogenic greenhouse gas emission reduction, the crisis could occur at any time.

Hegerl and Solomon (2009) state: "Observations indicate that attempts to limit climate warming by reducing incoming shortwave radiation risk major precipitation changes." The contrast with the promoters of

climate change engineering is stark. They are primarily focused on climate engineering as a commercial, for profit, project, and their information is not primarily published in peer-reviewed, scientific journals. I am not against for profit solutions to environmental crises. What is of concern is both the tunnel vision focus on what the climate engineering will do and the failure to document what else it will do. One Hegerl and Solomon (2009) publication is a perfect example – the "Hail Mary" technology might be effective in reducing global temperature but might not the changed rainfall patterns affect agricultural productivity and wildlife? Even though Hegerl and Solomon (2009) analyzed rainfall patterns, any "unexpected" events should also be the responsibility of the climate engineers (i.e., people and organizations that benefit financially should bear the costs of unexpected [i.e., not studied enough] outcomes). Such a situation could occur in the freshwater of Asia if climate engineering reduced rainfall, which would affect production of food (BBC News 2009). Other problems could occur as well. Should the climate engineers bear the fiscal and ethical responsibility?

"One would think that by now most people would have figured out that climate change represents a grave threat to the planet. One would also have expected from Congress a plausible strategy for reducing the greenhouse gas emissions that lie at the root of the problem" (Editorial 2009). However, climate engineering that produces unexpected climate change would also be a threat to national security (Editorial 2009). Shouldn't this possibility be considered before a climate engineering project is approved? What government agency/agencies should be assigned the responsibility for authorizing and monitoring climate engineering projects?

Role of Scientists

Scientists working for the Intergovernmental Panel on Climate Change (IPCC) have worked for a decade on examining and analyzing an enormous amount of data. Other research investigators, including James Hansen and Susan Solomon, have also carried out research on climate data. The preponderance of scientific evidence and the majority of qualified scientists agree that humans are a major cause of global heating. However, the political system has not made much use of this scientific information. Some members of the US Congress even vigorously denounce global heating science (e.g., Senator Inhofe and Congressman Barton). In addition, substantial lobbying occurs against global climate change science. National Academies of Science or their equivalents in other nations agree that anthropogenic greenhouse gases are a major factor in global heating. However, the news media treat the issue as if an equal number of scientists support each side. The media refer to this situation as balanced coverage, but the impression is that a major disagreement exists within the scientific community on global heating and other aspects of climate change – this situation is far from true.

This skewed representation is understandably upsetting for many scientists who serve on climate change committees without compensation. All have a variety of other responsibilities, such as teaching, advising, supervising or serving on graduate committees, writing grant proposals, serving on various academic committees, carrying out their personal research, and so on. Naturally, they are upset to find their scholarly contributions denounced in the news media by politicians. However, the most discouraging aspect must surely be having their publications, which have been accepted, even applauded, by the scientific community, denounced by politicians and ridiculed in the news media. The time they spend, as a public service, on global climate change could have been spent on students, family, or some civic activity.

Should Industrial Civilization Be Saved?

A recent debate between Paul Kingsnorth and George Monbiot (2009) puts the climate engineering question in perspective. Portions of a letter from Kingsnorth to Monbiot state:

> *Yet very few of us are prepared to look honestly at the message this reality is screaming at us: that the civilisation we are a part of is hitting the buffers at full speed, and it is too late to stop it. Instead, most of us – and I include in the generalisation much of the mainstream environmental movement – are still wedded to a vision of the future as an upgraded version of the present. We still believe in 'progress', as lazily defined by Western liberalism. We still believe that we will be able to continue living more or less the same comfortable lives (albeit with more windfarms and better lightbulbs) if we can only embrace 'sustainable development' rapidly enough; and that we can then extend it to the extra three billion people who will shortly be joining us on this already-gasping planet.*

A portion of Monbiot's response reads:

> *But the interesting question, and the one that probably divides us, is this: to what extent should we welcome the likely collapse of industrial civilisation? Or more precisely: to what extent do we believe that some good may come of it? I detect in your writings, and in the conversations we have had, an attraction towards – almost a yearning for – this apocalypse, a sense that you see it as a cleansing fire that will rid the world of a diseased society. If this is your view, I do not share it.*

I strongly recommend reading the entire exchange (Monbiot 2009).

My Personal Perspective

I have children and grandchildren and have chaired 74 graduate committees and served on many others. I am sad and dismayed at what we have left for posterity. Still, humankind had over 200 years to use its intelligence more effectively and has failed to do. I concur with Kingsnorth that his message had to be said. I also fear that Monbiot (2009) was prophetic when he stated: "However hard we fall, we will recover sufficiently to land another hammer blow on the biosphere." I agree that the human population is well beyond Earth's carrying capacity for it. The total biocapacity of Earth is 5.1 acres/person, and the total ecological footprint is 6.7 acres/person. This measurement results in an ecological deficit of -1.6 acres/person or a percent overshoot of 31% (2005 data from World Population Balance at www.WorldPopulationBalance.org). Earth is a finite planet with approximately 33.6 billion acres of biologically productive land and water. Whatever our emotions, millions, possibly billions, will suffer, even die.

Brown (2009) remarks: "The throwaway economy is on a collision course with the earth's geological limits. Aside from running out of landfills near cities, the world is also fast running out of the cheap oil that is used to manufacture and transport throwaway products. Perhaps more fundamentally, there is not enough readily accessible lead, tin, copper, iron ore, or bauxite to sustain the throwaway economy more than another generation or two." Of course, such actions are very damaging to the biosphere. Earth is losing species very rapidly due to a multiplicity of causes, including habitat fragmentation and loss. These species collectively constitute the biospheric life support system that maintains conditions on Earth that favor humans. In short, more than one crisis is brewing (e.g., Prugh 2009), and, if nothing is done now, humankind may well face multiple crises simultaneously and be greatly tempted to use a "Hail Mary" climate engineering technology.

Conclusions

If humankind does nothing effective to address the multiple, interactive problems, which may soon pass various tipping points that will place various complex systems into instability, the situation will probably be beyond its control. Humans have been addicted to the conviction that a technological solution is available for every problem despite the fact that technology has actually caused, directly or indirectly, the problems. Wiser use of technology is essential, especially if it accompanies major changes in human behavior and lifestyle.

Acknowledgments

I am indebted to Darla Donald for transcribing the handwritten draft and for editorial assistance. Walter Youngquist, Peter Leigh, and Paula Kullberg called useful references to my attention.

LITERATAURE CITED

BBC News. 2009. Water crisis to hit Asian food. 18Aug http://news.bbc.co.uk/2/hi/asia-pacific/8206466.stm.

Brahic, C. 2009. Most effective climate engineering solutions revealed. New Scientist 28Jan http://www.newscientist.com/article/dn16495-most-effective-climate-engineering-solutions-revealed.html.

Brown, L. R. 2009. Throwing out the throwaway economy. Earth Policy Institute 20Aug http://www.earth-policy.org/Books/Seg/PB3ch06_ss4.htm.

Editorial. 2009. The climate and national security. New York Times 18Aug http://www.nytimes.com/2009/08/18/opinion/18tue1.html.

Hegerl, G. C. and S. Solomon. 2009. Climate change: Risks of climate engineering. *Science* 325(5943):955-956.

Monbiot, G. 2009. Should we seek to save industrial civilisation? Monbiot.com 18Aug http://www.monbiot.com/archives/2009/08/18/should-we-seek-to-save-industrial-civilisation/.

Prugh, T. 2009. Less stuff, or more blood. *WorldWatch* 22(5):30-36.

Tierney, J. 2009. The Earth is Warming? Adjust the thermostat. New York Times 11Aug http://www.nytimes.com/2009/08/11/science/11tier.html.
Turney, C. 2008. *Ice, Mud and Blood: Lessons from Climates Past*. Macmillan, Hampshire, UK.