

The Artificial Intelligence of Geoengineering

Chaos theory proposes that a butterfly flapping its wings in Brazil could cause a hurricane in Texas.¹ Complexity theory compounds the chaos by adding the quantum-like effects of, for example, genome changes in the butterfly to the confusions of supercomputer models. Now, geoengineers want to multiply the complexity with politics. The result is an extreme form of artificial intelligence.

Gaia is complicated. From stratospheric currents to undersea rivers – and from plankton to palm tree emissions and sequestrations – quantifying, qualifying and calibrating planetary systems is at least as challenging as understanding genes or neurons. Despite decades of modeling, we are no more likely to predict next month’s best picnic day than we are to anticipate the proclivities of our DNA or to trace a memory in our cranium. Frustratingly, we have learned to map and manipulate genomes, geographies and memories, but we can’t control the consequences.

The distinction between accurate manipulation and accurate modeling is vital. Scientists and governments do need a much better understanding of what we are doing to ourselves. Reducing GHG emissions is complicated. Not reducing emissions is more complicated. Moving perhaps a billion people from coastal plains to higher ground will be complicated. Responding to extreme hydro-thermal events (floods, droughts, hurricanes, etc.) will be incredibly difficult. Sorting out correctly which crops can grow where around the planet will be hugely critical and hugely complex. That all of these decisions will also be political compounds the problem. Every political opinion will claim “sound science” as its basis. As we have seen through Copenhagen, Cancun, Durban and Doha, truth and transparency are already the victims of irresponsible climate change negotiations. Now, geoengineers are saying that they can help governments address climate change by manipulating planetary systems. This increases the complexity by several orders of magnitude and renders the politics of climate governance still more opaque.

Geoengineering has the trappings of a prudent Plan B until we understand how it compounds complexity. Our historic scientific hubris related to complex systems should be humbling. Consider our immediate experiences with Artificial Intelligence and with human genome analysis...

AI first surfaced in 1956² when many scientists thought they were about to build computers and robots that would match the intellectual capacities of the human brain. There are some interesting parallels: our brain is estimated to have 100 trillion synapses;

the Jeopardy-winning supercomputer has 100 trillion bytes and can perform some operations 100 million times faster than our brains.³ But our brains' 100 billion neurons can individually toggle "states" from 10 to 100 times per second using up as little energy as a 20-watt light bulb. The supercomputer needs 200,000 watts⁴ and has the creative capacity of a doorstop. Although science knows a great deal more about AI and brain mapping than back in the 1950s, we are a long way from modeling our minds.

Science hasn't fared much better with that other paragon of complexity, the human genome. Watson and Crick discovered DNA in the early 1950s – about the same time scientists started talking about artificial intelligence. Since then we have learned that our genome has 3 billion base pairs but barely 22,000 genes. Ten or 20 years ago, genomics researchers assumed that our genome had 100,000 - 120,000 genes and that 97% of our DNA was "junk." Now we theorize that almost all of our DNA has a purpose⁵ but we are no longer certain how DNA and RNA function. In 2012, scientists discovered that there are six molecules other than DNA that are able to store genetic information and pass it on.⁶ We completed the first full map of the human genome 10 years ago, but our understanding of what to do with it isn't exactly bounding ahead like we expected.

At best, we are today with Gaia where we were 60 years ago with artificial intelligence and genomics. The big difference, of course, is that experimental manipulations of a genome or a brain can – more or less – take place one at a time. Experimental manipulations of Gaia can change everything for everybody.

Geoengineering requires a grasp of not only Earth systems but also of anthropomorphic impacts. At the end of 2011, climatologists tell us, we hit a CO₂ level of 390.9 ppm but some parts of the Arctic during its most recent summer topped 400 ppm. We need to know where the GHGs will be if we pursue "business as usual" and we need to know, accurately, the tolerances of Gaia at different GHG levels. Is 450 ppm the upper safety limit... or is it 500 ppm? Should we be forcing emissions down to 350 ppm or back to the pre-industrial 280 ppm? The more variables, the more complexity, the more scientists will disagree. Ultimately, climatologists will offer parameters – low/high estimates – that will give politicians the wriggle-room to determine their level of planetary intervention (through GHG reductions or geoengineering) considered politically acceptable to get the planet (or, perhaps, just themselves) to a safer place.

Here is a sampling of some of the largely-political complexity surprises climatologists got in 2012:

- China has been consistently underreporting its GHG emissions by about 20 % meaning that global emissions are actually 5 % higher than the world thought.⁷
- The UK's vaunted 14 % reductions in GHG emissions between 1990 and 2008 turn out to be erased by its 20 % increase in emissions from outsourcing UK manufactures to Asia – actually, a net 6 % increase.⁸
- India overestimated its forest cover by about 10 %, meaning its CO₂ sequestrations are less than thought.⁹
- Brazil's western State of Rondonia's "fish-bone" road system reduced the rate of deforestation, but inadvertently accelerated biodiversity loss.¹⁰

- UNEP discovered that up to 30% of all timber exports are mafia-controlled and that 90% of tropical deforestation is due to illegal trade – meaning that all forest and timber trade estimates are likely wrong.¹¹
- The US has cut back its GHG emissions to 1992 levels thanks to its natural gas production and consumption but this is balanced out by increased coal exports to Asia.¹²
- The US National Academies predicted that, by 2020, the number of US climate monitoring satellites could drop from 23 to 6, which *The Economist* referred to as “willful blindness.”¹³
- Scientists’ capacity to monitor climate on the Indian subcontinent¹⁴ and throughout the Southern Hemisphere has been declining, we learned, since at least 1992.¹⁵

But, during 2012, climatologists also faced a number of environmental realities that they had not previously assumed...

- The likely temperature-rise, assuming a doubling of emissions, has been adjusted upward from a range of 1.5°- 4.5° C to instead 2°- 4.5° C,¹⁶
- Assumptions that the severity of droughts will increase with temperature-rise are now less certain as scientists work with different measurement tools;¹⁷
- Estimates that the summer Arctic wouldn’t be free of ice until the end of the century is being revised to anticipate summer free ice much sooner, possibly within a decade;¹⁸
- The global water cycle has strengthened by 4 % between 1950 and 2000 – contributing to extreme weather events – which is twice the response projected by current generation global climate models;¹⁹ rainfall intensity has increased by an entire order of magnitude over past projections;²⁰
- Predictions that temperature increases of 1.5° could improve crop yields in temperate zones now seem wrong, and scientists believe that the temperature increase of 0.8° has led to yield losses of between 1% and 3% already;²¹
- The melting of Greenland and Antarctic ice sheets was expected to contribute 0.3 mm of sea level rise per year but is actually contributing 1.3 mm of sea level rise already. Instead of the predicted sea level rise of 1 m by 2100, the real increase could be between 2 and 3 m;²²
- Previously not considered, CO₂ emissions from permafrost could raise temperatures between 0.25° and 1° by the end of the century;²³

The big news from the political and environmental surprises of 2012 is that policies to reduce GHG emissions – regardless of miscalculations – would still have been constructive; conversely, geoengineering initiatives, in light of these same surprises, could have hugely exacerbated our dilemma.

By advancing geoengineering as a postponement of climate change or even as part of a solution, scientists are compounding the complexity – suggesting that geoengineering can fill the gap between two highly-fungible targets: (1) the safe maximum emissions levels;

and (2) the likelihood of governments meeting their emissions level targets. National emissions commitments – and how they are calculated – will be tweakable.

In short, the level of geoengineering intervention will be determined by our uncertain knowledge of Gaia compounded by our politically and scientifically questionable safety calculations and reduction pledges.

The absurdity of all this has forced geoengineers to propose alternative strategies. First, that global geoengineering interventions could be induced gradually so as to assess environmental reactions to any possible disinformation or miscalculations. This represents a kind of elastic or “vertical” intervention process that assumes that relatively rapid adjustments can be made as necessary.

Yet, the form of geoengineering getting the most attention from scientists and policymakers – solar radiation management (SRM) – requires a continuous forcing of sun-blocking sulfates that will remain 20 km or higher aloft an average of two years. Once it’s up there, getting it down won’t be easy. If materials are used that come down faster, the cost could be more stratospheric than the dust and/or we’ll all have to wear bicycle helmets.

Secondly, geoengineers propose that not only could the vertical level of intervention be globally elastic, but also that geoengineering could be selectively introduced “horizontally” – i.e., regionally.

Regional geoengineering adds another layer of complexity. In order to have effective regional interventions, each region must assume that the other regions remain static or, at least, that their emissions are predictable. Further, implementing regions must be persuasive that their interventions will not have spill-over effects or be interpreted as acts of aggression.

But, there is another substantial difference with regional geoengineering. Global geoengineering would morally and politically require global governance. The United Nations would have to understand the proposal and accept the consequences. The likelihood of the UN’s 193 members accepting this is vanishingly minuscule. The US recently voted against signing the Treaty on the Rights of the Disabled because it was seen as a threat to US sovereignty, despite the fact that the Treaty was modeled on the US’s own legislation, the Americans with Disabilities Act.²⁴ Does anyone really think the US is going to allow a UN Treaty governing geoengineering deployment?

Regional geoengineering sidesteps the UN’s moral and legal governance obligations. A “coalition of the willing” such as USA, Canada, China and Russia could construct an independent Polar zone geoengineering strategy. If they are lucky, they could reduce or delay their own climate “emergencies” without addressing the crises their industrialization has caused the rest of the world. If they are wrong, they could unilaterally devastate the planet.

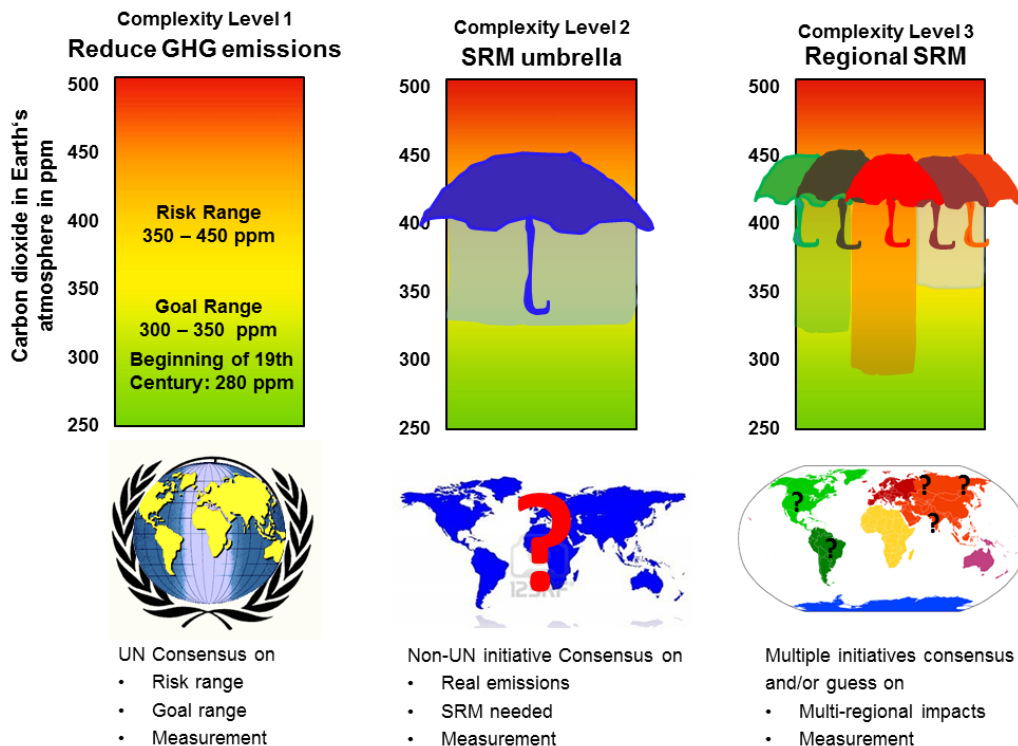
But, for example, if North America hoists an umbrella over that continent, what’s to prevent China from doing the same... Or India responding to China...or from Brazil

protecting its climate? The world's winds and weather could ricochet between umbrellas like a pinball.

Would governments act so unilaterally? The “Hot War” of climate change is not unlike the “Cold War” that dominated global politics from 1945 to 1991. During that period, countries such as the United States, Russia, China, UK, France, India, Israel and Pakistan felt morally-qualified to unilaterally jeopardize planetary security risking nuclear war and exploding more than 450 atmospheric nuclear devices (mostly above international waters) that were ultimately proven to jeopardize the health and well-being of not only their own citizens but of the world.²⁵ The political/scientific complex initially denied the dangers of atmospheric nuclear testing and then tried to underplay the dangers until they were forced into – decades later – a nuclear test ban treaty.

So, the question is whether the “Hot Worriers” of today have learned from the “Cold Warriors” of yesterday. The answer is “No.” At this level of complexity, our intelligence is still artificial. It's time for a geoengineering test ban.

Geoengineering. It's Complicated!



Geoengineers represent SRM (solar radiation management) and other Earth system manipulations as an almost inevitable “Plan B” due to governments’ consistent failure to effectively reduce GHG emissions. Complexity level 1 describes some of the distortions in the present UN-led climate change negotiations.

Complexity Level 1 UN negotiated emission reductions

Via UN negotiation, governments agree to bring their national emissions down to a safe level. The complexity increases when governments...

- Financialize emissions reduction via carbon trading schemes that complicate (or distort) measurement and monitoring;
- Miscalculate (intentionally or inadvertently) full life cycle emissions from purportedly “green technologies” such as biofuels;
- Export emissions (i.e., coal or manufacturing) distorting domestic emissions and/or presumed “consumer benefits.”
- Abuse standards and measurement tools to distort base and projected emissions.

Then, despite UN consensus, the world’s most powerful economic and military force (USA) refuses to join and a second G8 country (Canada) reneges. To date, the pitiful commitments coming out of the Doha meeting have only the EU and Australia (representing 14% of GHG emissions) signing on.

Complexity Level 2 – the global SRM umbrella:

Despite geo-engineers’ distrust of governments – and without taking away any of the real or potential distortions in complexity level 1 – they propose upping the complexity by an order of magnitude through global solar radiation management. This allows governments to:

- Weaken emissions reduction efforts because there is a relatively inexpensive (and entirely theoretical) Plan B techno-fix;
- Sidestep commitments to other countries by claiming SRM to be a global benefit;
- Further manipulate emissions measurements and targets by varying the amount of SRM and/or its predictable impacts.

Most importantly, in governance terms, the cost and high-tech nature of geoengineering shifts control from the UN consensus policy environment to the very governments that refused or reneged or distorted their international obligations under complexity level 1.

Complexity Level 3 – multiple SRM umbrellas:

While the world’s recent Cold War experience makes clear that individual governments are unilaterally prepared to take control of planetary systems and make life and death decisions on behalf of the global population, the politics of deploying a global SRM umbrella are deeply indelicate and even powerful governments – according to geoengineers – might prefer to put up regional umbrellas that would elicit less resistance. Even the theory of regional umbrellas massively increases the complexity beyond levels 1 and 2. For example...

- The distinction between regional and global SRM interventions can be in the eye of the beholder;
- Powerful nations can still avoid global adaptation/mitigation commitments to others by claiming SRM as an international benefit;
- If one regional SRM is accepted then additional regional SRMs are possible – multiplying distortions;
- Militarization of SRM is inevitable – one regional SRM being deployed defensively to act against the implications of another.

Most alarmingly, acceptance of regional SRM deployment allows governments to avoid the need for UN consensus. Once again, with complexity level 3, geoengineers are granting more powers to the very governments that caused – and have thus far failed to address – climate change.

Realistic responses:

Recognizing that geoengineering's effectiveness is uncertain at best and it facilitates responsibility-avoidance, the following initiatives are possible:

- Ban geoengineering;
- Accepting that national governments hide – and are likely to continue to hide – their emissions and lie about their commitments, establish an independent, broadly-supported and representative civil society oversight body (or a kind of environmental Russell Commission) with the right, agreed by governments, to comment on all phases and aspects of intergovernmental climate change negotiations.
- Put an end to the financialization of emissions management through trading, outsourcing, and subsidies;
- Cut GHG emissions directly and deeply;
- Strengthen planetary systems measurement and monitoring through both satellites and ground-based initiatives;
- Increase the global and local transparency of all climate-related programs, measurements and technologies through a UN technology assessment facility as proposed at Rio +20.

SRM wars: Both unilateral global geoengineering initiatives and unilateral regional geoengineering initiatives represent a direct threat to global security and invite – almost require – responses from other governments. Especially, ocean and solar radiation management (SRM) interventions will start an escalation of meteorological experimentation that could quickly spin out of control. Geoengineering experimentation, then, is a transgression of the ENMOD (Environmental Modification) treaty of the 1970s and governments and/or the United Nations should immediately bring this concern before the International Court of Justice. In keeping with the geoengineering moratorium adopted by member governments at the UN Biodiversity Convention in 2010 and until the court makes its decision, no experimentation – outside of laboratories – can be allowed.

¹ Jon Agar, *Science in the 20th Century and Beyond*, Polity Press, 2012. The theory was first floated in 1979.

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³ *Ibid.*

⁴ *Ibid.*

⁵ Alok Jha, “Breakthrough study overturns theory of ‘junk DNA’ in genome,” *The Guardian*, September 5, 2012.

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⁸ Ulrich Hoffmann, “Some Reflections on Climate Change, Green Growth Illusions and Development Space,” *UNCTAD discussion paper no. 205*, December 20, 2011.

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- ¹⁷ John Sullivan, "Link between warming and past droughts questioned," *News at Princeton*, January 3, 2013, <http://www.princeton.edu/main/news/archive/S35/72/30Q24/index.xml?section=topstories>.
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- ²⁰ Michael Le Page, "Climate downgrade: Extreme weather," *New Scientist*, November 14, 2012.
- ²¹ Michael Le Page, "Climate downgrade: Food production hit," *New Scientist*, November 14, 2012.
- ²² Michael Le Page, "Climate downgrade: Sea level rise," *New Scientist*, November 14, 2012.
- ²³ Michael Le Page, "Climate downgrade: Planetary feedbacks," *New Scientist*, November 14, 2012.
- ²⁴ Jim Abrams, "Republican opposition downs UN disability treaty," *AP*, December 4, 2012: <http://bigstory.ap.org/article/republican-opposition-downs-un-disability-treaty>.
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