Climate Change – A Format for Reasoned Dialogue

George Rebane, PhD – 22 January 2008

The climate change issue has become highly politicized and now floats in the public domain on a froth of emotion whose connection to science grows more tenuous with the passing of each day. Those of us who remain skeptics now carry the scarlet appellation 'Denier' that has been firmly fixed on us by those who loudly proclaim on every street corner that "the debate is over!"

Reasonable skepticism has been exorcised and excised from the public dialogue on the matter by the post-enquiry adherents (PEAs) whose simplistic view catapults them from the notion that IF global warming is indeed a type of real long-term climate change, THEN, of course, it is anthropogenic. And therefore we must accept and apply their prescriptions to counter it and bring the world back into some benign and beneficial equilibrium of yore. The mark of a true PEA is that he dispenses with the IF/THEN argument, its mediating and complex causal beam[1], and accepts the declaration as a confession of faith similar to those confessions which inform and illuminate other religions.

A more constructive basis for a reasoned dialogue would start with acknowledging that climate change must be approached and understood through a sequence of closely related questions. Not long ago I wrote a short piece (*The Question of Anthropogenic Global Warming*) on such questions in response to friends and colleagues who asked my view of the climate change issue. To further explicate my position on the matter I later wrote and posted another piece (*Climate Change Revisited*). I concluded the latter piece with –

> *As a Skeptic trained in science - particularly in the technologies of Bayesian decision theory, modeling of complex* dynamic *systems, and with a degree in physics thrown in – given the evidence I have seen, I am not prepared to join the PEAs, and strongly believe that the climate change debate must be rejoined within the bounds of reason as defined by the teachings of western civilization.*
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> *On the two powerful legs of Occam's razor and falsifiability, it was western science that started Mankind's epic march toward understanding the universe. Occam prescribed that if two competing theories* could *each explain the (hopefully repeatable) observations, then we should accept and proceed with the simpler of the two. Falsifiability is the strong prerequisite of a theory that requires it to produce explicit 'true' statements the negation of which by experiment would negate the theory. In short, if what you propose is such that there is no way to disprove it, then your proposal is an article of faith and not of science.*
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> *While not a Keynesian, I am among those in his debt for the oft-quoted reply to a reporter who pointed out an* inconstancy *in Lord Keynes' pronouncements – "When new data is presented to me, I change my mind. What do you do?" Along with many other Anthropogenic Global Warming skeptics, I await the new data.*

[1] The causal beam of an event is the necessary (and often sufficient) specified sequence of precursor events from the converging tree (causal basin) of all such precursors that promote the occurrence of the event in question.

As a consequence I was asked what new data the arrival of which would reduce or eliminate my skepticism about the popular interpretations of climate change. Please note that I would never feel comfortable becoming a PEA, but the kinds of data that would cause me to change my mind are numerous yet specific. The most comprehensive answer I can give to this question is the aim of the present scribbling, and to present it properly I will have to use some of the terminology, concepts, and arguments from the systems sciences. The non-technical reader may have to do a little head scratching to understand, but that is the sad state of this universe – every notion and idea cannot be reduced to a form accessible to everyone through a casual perusal.

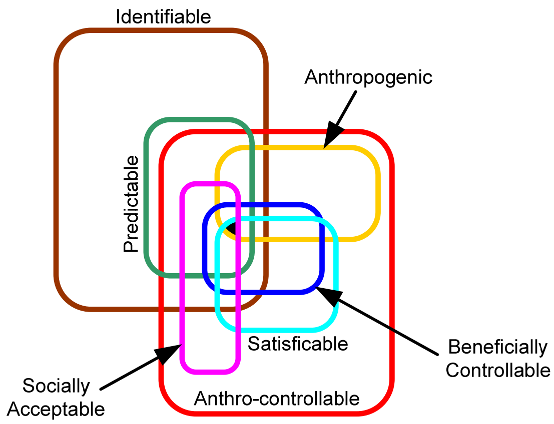
Let's begin by considering (the set of) every kind of significant climate change – these would include global warming, global cooling, the rise or elimination of a critical component of our atmosphere required to sustain agriculture or animal life, the normative amount of cloud cover, the evaporation rate of oceans, changes in ocean currents, volcanic eruptions, vegetation fires, and so on. To form a picture of this, assume that all these kinds of climate changes - currently known and unknown - can be collected into the black (rounded corner) rectangle in the figure below. The number of such climate changes is probably very high and, most certainly, is not known today. The climate change that may be happening now is somewhere in that big rectangle.

The earth's climate is necessarily viewed as a system – a very complex and dynamic system, possibly the largest one on earth. Scientists and engineers qualified in systems theory are really the only ones who command the necessary concepts and have the required tools to profitably work in this field of long-term macro-climate dynamics. These workers use the fruits of other workers on smaller parts of the large problem similar to your physician using the test results from a blood chemistry expert and/or a radiologist to inform his understanding of your comprehensive health picture. The languages they use with each other have a sufficiently large number of common concepts and terms so that communication is possible. I will here attempt to establish enough elements of the language of systems so that the reader may grasp its necessity and application to understanding the climate change issue. The technical reader is asked to forgive some semantical shortcuts.

A Short but Necessary Diversion Through SystemsLand

Since a system is an abstract construct that is defined to consist of these elements and not those, we seek for each such system a compact (as short as possible) set of parameters that for us completely defines the condition or **state of the system** at any point in time. For a climate system some of these parameters or variables may be temperature, humidity, and pressure at a location (latitude/longitude/altitude) – this already gives us a six-dimensional 'state space' and we haven't even included wind (speed/direction), time-of-day, individual gas concentrations, and so on. The elements of our climate system may also include layers of the ocean, layers of the atmosphere, types and locations of land masses and so on, each bringing even more of their own descriptive variables to add to what we call the **state vector** of a system.

All the Kinds of Possible & Significant Climate Changes



Climate Change – A Reasonable View for Reasoned Dialogue

A vector can be thought of as a specifically ordered list of values, one for each variable. A state vector then defines a point in an abstract volume called **state space**. A concrete example of such a vector can be thought of for a point-mass moving in our familiar three-dimensional space represented by the xyz-coordinates that many of us were taught in high school. To consider the complete state of such a point mass at each moment in time, one would have to specify its three spatial coordinates and its velocity components in each of the three directions. The careful reader will correctly say that this requires a six-variable or six-dimensional state vector to completely characterize the state of the point-mass system. The state of the point-mass is in fact moving in 6-space from moment to moment tracing out a path or trajectory in its six-dimensioned state space. With our eyes we may be able to see this system (point-mass) trace out a curvy path in 3-space and note that at any moment it is only moving in one direction defined by the (vector) sum of its three velocity state variables in the x, y, and z directions as they also change over time.

We may ask what it is that makes the system (point-mass) take that curvy path. The answer is that it is responding to some outside influences or inputs – 'outside' in the sense that these influences are not part of the system's state. For our point-mass such outside inputs may be a force field such as gravity, and the system is known to respond to such an input according to Newton's laws of motion and gravitation. In high school we learned how to calculate the trajectory (in state space) of a constant point-mass under the influence of gravity given its starting point in state space which consisted of its three location coordinates and its three velocity components along each of the coordinate directions. The most useful outside influences that we usually seek are purposive influences that allow us to **control the system** – i.e. that allow us to purposively drive the system from one known state to another (target) state over an interval of time. Examples of controls are things as electric light switches, hydraulic valves, ship rudders, a timed push on a playground swing, and so on.

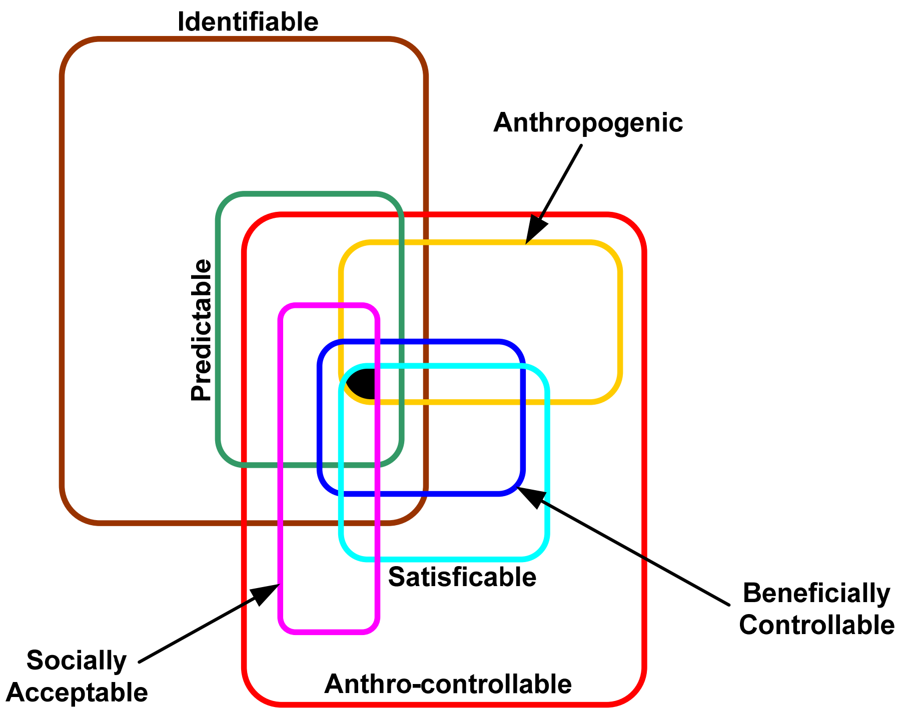
The set of relations or equations that let us compute how the system's state under outside influences or controls is transferred from one point in state space to another point in an interval of time is, surprisingly enough, known as the **system's transfer function**. The form of a system's transfer function can vary from something that can predict 'where a system's state will be' in a one-shot calculation, to a transfer function that must be calculated through a series of iterations over small intervals of time and (state) space. It all depends on the complexity of the system.

A system for which a useful transfer function can be discovered is known as an identifiable system, and **system identification** is the collection of very esoteric techniques in control and estimation theory that allows the practitioner to derive such transfer functions which are then used to describe and control the behavior of (parts of) the real world. Furthermore, **a system is observable** to the extent that, through physical measurements, its state variables can be observed or usefully estimated. Finally, it is not possible to purposely control a system without having access to a useful form of its transfer function. And sadly, for many and various reasons, not all realworld systems with known transfer functions are **observable** and/or **controllable**.

With these basic systems concepts under one's belt, it is now possible to progress toward a reasoned examination of the climate change issue. Without an understanding of such basics, one has no choice but join the ranks of PEAs, for they have no ability to conduct an enquiry of the matter, and might as well abandon that course and proceed directly to the adherence of which-ever conclusion that gives them greatest comfort.

Onward to Exploring Earth's Climate as a System

The remainder of this explication of will refer to the figure below entitled 'Climate Change – A Detailed View for Reasoned Dialogue'. Let's first look at the entire set of the types of climate changes introduced in the above figure – this is an unknown large number of climate change types. But of all those we will restrict our interest to only the identifiable types, the ones for which we can write math models and computer programs to calculate their transfer functions. This much smaller set is represented by the brown rounded-corners rectangle. Only such climate changes (CCs) can we ever hope to deal with quantitatively. And by the way, we have no idea today about the population or characteristics of the CCs in that brown rectangle.



Climate Change – A Detailed View for Reasoned Dialogue

Not all the identifiable CCs can be successfully predicted for any useful future interval of time. All currently known general circulation models (GCMs) or climate models are chaotic. This means that their algorithmics are such that small variations (or errors) in their input parameters, or restrictions on the precision of their internal computations will yield wildly varying futures of earth's climate. However, let's assume that some of them might serve us well enough to give 'usable' 50 to 100 year predictions – please keep in mind the word 'assume'. These 'predictable' transfer functions are an unknown subset of all available CC transfer functions. But with courage and fortitude we plow ahead and assume that the CC model(s) we currently believe in are also contained in the green rectangle of predicable transfer functions.

Starting from another point of reasoning, we need attend only that set of CCs which can be influenced by some kind of purposive behavior of humans living on the planet. There is no point in coming up with grand sounding public policies to affect CC if the set of 'anthro-controllable' CCs is empty – i.e. if there exist no types of climate change that Man can influence. We denote the anthro-controllable CCs by the red rectangle. Please note that some of such CCs may not be the ones for which we can develop transfer functions. But again, with hope in our hearts, let's assume that the red rectangle overlaps the green one, and that there exist CCs which are identifiable, predictable, and, now, anthro-controllable.

If they exist, the members of the yellow rectangular subset of anthro-controllable CCs may actually be anthropogenic – i.e. CCs that could have been caused by human activity. Let's again proceed under the assumption that the currently experienced CC is indeed in the intersection (overlap) of the yellow anthropogenic and the green predictable CCs.

For us to continue at this point, we need to suppose that, of the anthro-controllable (red) CCs, there exists a subset of them which are satisficable – i.e. the turquoise rectangle is not empty. Here we must pause for some more elucidation because this is hard stuff. Just because some CCs are anthro-controllable does not of itself guarantee that we can find the applicable control laws or methods to drive the climate from its present state to some specified desirable future state. For example, that we somehow force social behaviors which will drive the earth's temperature (however it is calculated) from its present value to some desired value or range in the future without screwing up some other climate variable(s). Say, we get the temperature right but drive the amount of rainfall in earth's temperate zones to an unacceptable low value (the so-called unintended consequences). Technically, satisficing is finding an 'adequate' behavior of a complex system and is therefore a more achievable goal than attempting to find the control law that transfers current system state to the absolute optimum or very best state, which state may be totally incomputable and/or unachievable in the realworld. Think of satisficing as 'close enough for government work'.

To take stock of where we are, please look at the area in the figure where the turquoise, green, and yellow rectangles overlap – let's call this subset the 'Promising CCs'. Although we have greatly restricted the number of earth's CCs that would satisfy the requirements for an implementable public policy, we are not home yet. Our current CC must also be in the set of 'beneficially controllable' type of CCs – the blue rectangle. I have shown the blue subset to overlap the turquoise subset of CCs with satisficable control policies, for to not have an overlap here would terminate any reasonable basis for continuing the debate about anthropogenic climate change – there would remain nothing that we would want to do about the current CC. But having no fear of more assumptions, we proceed with the next assumption that the beneficially controllable (blue) subset overlaps (here enclosing completely) the CCs that we hope remain in the subset of Promising CCs.

So now we are almost done with our journey through this complex thicket of reasonable, but ever more restrictive, requirements that need to be met before deriving appropriate public policy for countering the widely presumed type of climate change we are experiencing. Any proposed public policy to be considered by a yet-to-be-identified coalition of sovereign nation-states must be socially (and politically) acceptable to each of the assessed major contributors to CC. The types of CCs that will succumb to socially acceptable controls (e.g. reduction of CO_2 emissions, or the so-called carbon footprints) are shown as residing in the pink rectangle. Again we must assume that we can show it to overlap or intersect with the subset of Promising CCs defined above. If that is not the case, for which we have no present proof, then there is no point in continuing this development.

We have now identified the multiple tiered assumptions, all of which must hold, which are necessary to define the residual subset of climate change types, of which our current CC must be a member (the small black area). IF that black area is not empty, AND IF it contains our current CC, THEN, and only then, we might hope to proceed with a specified worldwide policy to attempt a beneficial diversion from the current course of the world's climate. Recall, dear Reader, that today we have not even confirmed that we are on a path deleterious to the foreseeable generations of humans. We simply do not yet have that technology at our disposal. But if, as supposed, we have the ability to affect climate change, we would then also have the ability to affect it in unknown ways in the foreseeable future. Any policy we propose to undertake has to first be shown to do no harm, else we would behave as a chimpanzee alone in the cockpit of a 747 at 30,000 feet and must prepare to accept a similar outcome.

As a footnote, today's informed stand individually and in the aggregate in awe and wonderment of the current accelerating pace of technology that will soon transform, inform, and enable policies, unknown and undreamt, to solve humanity's problems.

I want to conclude by inviting the technical reader to peruse the three published papers referenced below. These are example expositions on the current state of general circulation models, specifically their make-up, validation, and operation. Also included is an academic study of the political froth in which all such government funded efforts are jealously guarded in their execution and positioned in their dissemination.

The basis for abandoning skepticism about the current politically induced panic and one-sided media coverage of anthropogenic global warming (AGW) should now be clear to the open-minded reader. The reasonable AGW proponent must needs successfully walk the rigorous path outlined above to make the case for AGW and any proposal for its beneficent, feasible remedy. Today there are simply too many unknowns to lend scientific credence to the claims of the post-enquiry adherents. I have not gone into the detailed travails that undermine AGW advocates, they are legion and well-documented elsewhere[2] - any of them being sufficient to collapse the whole façade. The inability to undertake such a sequence of arguments is compelling reason enough why this issue cannot be brought out into a face-to-face public debate. In sum, when reason eludes and your arguments are bankrupt, the only recourse is to ignore the merits of your assailants and shout over and over that "the debate is over!".

[2] See for example the posts and references cited on NC Media Watch, Climate Audit, and Watts Up With That.

References:

1. Bao, J.W. (NOAA/Earth System Research Laboratory, Boulder, Colorado), Michelson, S.A (CIRES, University of Colorado, Boulder, Colorado)., 'A MAJOR CHALLENGE IN METEOROLOGICAL MODEL EVALUATION FOR AIR-QUALITY APPLICATIONS', Proceedings of the 14th Joint Conference on the Applications of Air Pollution Meteorology with the Air and Waste Management Assoc , January 2006, (download pdf from here).

2. Archer, C.L., et.al. (Bay Area Air Quality Management District, San Francisco, California), 'COMPARISON OF SIMULATED OZONE GENERATED WITH GROWTH-AND-CONTROL VS. UNIFORMLY-REDUCED EMISSION INVENTORIES IN CALIFORNIA', January 2006, (download pdf here)

3. Lahsen, M. (CIRES, University of Colorado, Boulder, Colorado), 'Seductive Simulations? Uncertainty Distribution Around Climate Models', 2005, *Social Studies of Science* 35/6(December 2005) 895–922. (full text of article downloadable from here)

About the Author George Rebane is a career developer of complex systems for military and commercial use. He holds degrees from the University of California in physics (BS), control & estimation (MSE), and dynamic systems and machine intelligence (PhD). He is a Registered Professional Engineer in the State of California. He has managed three technology companies and holds numerous patents in a number of areas including financial engineering. His doctoral research contributed to advances in machine learning, cognition, and planning & control. He lives in Nevada County and is currently Director of Research for the Sierra Environmental Studies Foundation.