What is this?

Over the past eight years we at MacroVU have been creating a suite of information murals that support education, discussion, and negotiation on the major issues confronting human management of the planet.

These murals can be used individually or as a collection. They can be printed on paper or displayed on large screens in strategy rooms.

They are created on the computer and can be changed and updated rapidly.

They can be linked with clickable buttons to reveal greater detail or a bigger "helicopter" view.

At this moment 20 info-mural projects have been either completed for clients or in draft form:

What does it contain?

This info-mural is a conceptual picture of the risks of the global climate change situation from the perspective of the potential interaction among recently identified tipping points.

It should be studied in conjunction with a another mural entitled "Possible Climate Tipping Point Cascades."

This info-mural was created by Robert E. Horn for as part of a research project at Stanford University.

How do I get a printed copy?
You can print this map out at your local print service bureau.

How do I get updates & revisions and other info-maps in the series?

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Discussion sketch V. 6.9

Climate tipping points -- How shall we address a potentially self-reinforcing, runaway system?

Climate tipping points

Climate tipping points are large, disruptive natural phenomena (usually occurring in a specific region) that could lead to more rapid and abrupt regional and global changes in climate. They are tightly linked by feedback loops that are likely to cause self-reinforcing, accelerating, and potentially irreversible climate changes. The climate tipping points have temperature thresholds (or range of temperatures) beyond which they become a self-reinforcing, runaway process.

Purpose of our set of diagrams

The purpose of our series of diagrams is to bring into focus the kinds of decisions that we must make both individually and together as a group of nations. This diagram focuses on the thresholds for the different tipping points and their uncertainties.

Beyond the IPCC reports

The diagrams go beyond the current IPCC working group reports because the IPCC working groups have to consider only the scientific literature up to a specific date in order to provide a platform on which to build their requirement for consensus. The date is usually about two years before the date of the Assessment Report. The last Assessment Report completed by the IPCC was released in 2007, which means that the most recent scientific literature considered was published in 2005. Since then, climate science has made some progress in beginning to link the tipping points together into an integrated system.

Business as Usual (BAU) scenario and climate tipping points diagram

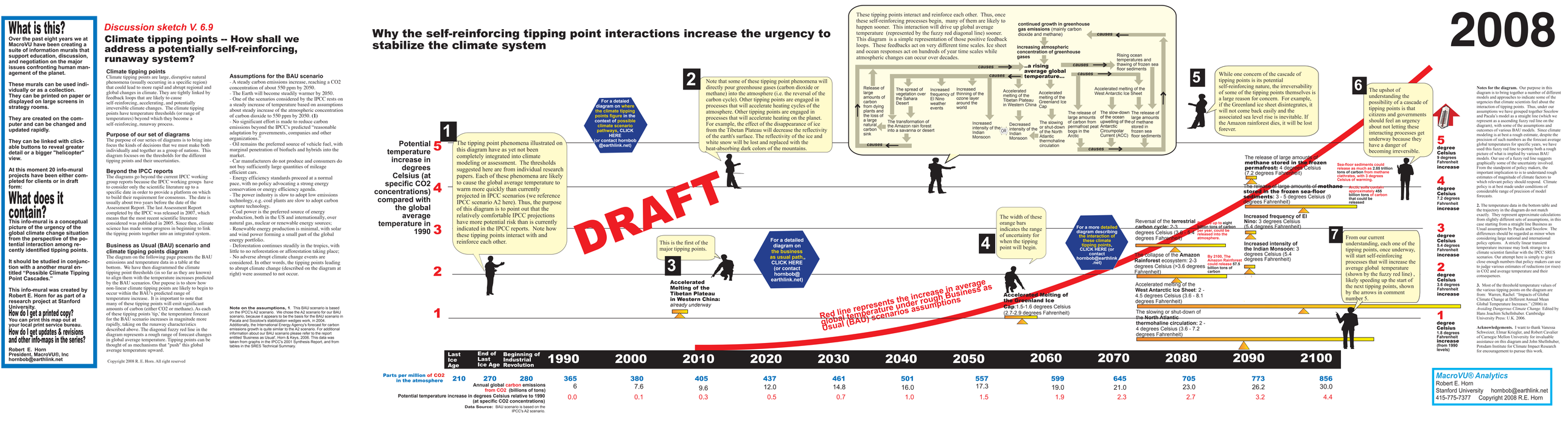
The diagram on the following page presents the BAU emissions and temperature data in a table at the bottom. We have then diagrammed the climate tipping point thresholds (in so far as they are known) to align them with the temperature increases predicted by the BAU scenarios. Our pupose is to show how non-linear climate tipping points are likely to begin to occur within the BAU's predicted range of temperature increase. It is important to note that many of these tipping points will emit significant amounts of carbon (either CO2 or methane). As each of these tipping points 'tip,' the temperature forecast for the BAU scenario increases in magnitude more rapidly, taking on the runaway characteristics described above. The diagonal fuzzy red line in the diagram represents a rough range of forecast changes in global average temperature. Tipping points can be thought of as mechanisms that "push" this global average temperature upward.

Assumptions for the BAU scenario

- A steady carbon emissions increase, reaching a CO2 concentration of about 550 ppm by 2050.
- The Earth will become steadily warmer by 2050.
- One of the scenarios considered by the IPCC rests on a steady increase of temperature based on assumptions about steady increase of the atmospheric concentration of carbon dioxide to 550 ppm by 2050. **(1)**
- No significant effort is made to reduce carbon emissions beyond the IPCC's predicted "reasonable adaptation by governments, companies and other organizations."
- Oil remains the preferred source of vehicle fuel, with marginal penetration of biofuels and hybrids into the market.
- Car manufacturers do not produce and consumers do not buy sufficiently large quantities of mileage efficient cars.
- Energy efficiency standards proceed at a normal pace, with no policy advocating a strong energy conservation or energy efficiency agenda.
- The power industry is slow to adopt low emissions technology, e.g. coal plants are slow to adopt carbon capture technology.
- Coal power is the preferred source of energy production, both in the US and internationally, over natural gas, nuclear or renewable energy sources;
- Renewable energy production is minimal, with solar and wind power forming a small part of the global energy portfolio.
- Deforestation continues steadily in the tropics, with little to no reforestation or afforestation taking place;
- No adverse abrupt climate change events are considered. In other words, the tipping points leading to abrupt climate change (described on the diagram at right) were assumed to not occur.

Note on the assumptions, 1. This BAU scenario is based on the IPCC's A2 scenario. We chose the A2 scenario for our BAU scenario, because it appears to be the basis for the BAU scenario in Pacala and Socolow's stabilization wedges work, in 2004. Additionally, the International Energy Agency's forecast for carbon emissions growth is quite similar to the A2 scenario. For additional information about our BAU scenario please refer to the report entitled 'Business as Usual', Horn & Keys, 2006. This data was taken from graphs in the IPCC's 2001 Synthesis Report, and from tables in the SRES Technical Summary.

Why the self-reinforcing tipping point interactions increase the urgency to stabilize the climate system



Last Ice Age	End of Last Ice Age	Beginning of Industrial Revolution	1990	2000	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100
Parts per million of CO2 in the atmosphere	210	270	280	365	380	405	437	461	501	557	599	645	705	773	856
Annual global carbon emissions from CO2 (billions of tons)				6	7.6	9.6	12.0	14.8	16.0	17.3	19.0	21.0	23.0	26.2	30.0
Potential temperature increase in degrees Celsius relative to 1990 (at specific CO2 concentrations)				0.0	0.1	0.3	0.5	0.7	1.0	1.5	1.9	2.3	2.7	3.2	4.4

Data Source: BAU scenario is based on the IPCC's A2 scenario.

Notes for the diagram. Our purpose in this diagram is to bring together a number of different models and approaches to indicate some of the urgencies that climate scientists feel about the interaction of tipping points. Thus, under our assumptions we have grouped together Socolow and Pacala's model as a straight line (which we represent as a ascending fuzzy red line on the diagram), with some of the assumptions and outcomes of various BAU models. Since climate modeling is at best a rough estimate, despite the precision of such numbers as the forecast average global temperatures for specific years, we have used this fuzzy red line to portray both a rough picture of what is implied by various BAU models. Our use of a fuzzy red line suggests graphically some of the uncertainty involved. From the standpoint of policy makers, the important implication to is to understand rough estimates of magnitude of climate factors to which relevant policy should respond. Climate policy is at best made under conditions of considerable range of precision of model forecasts.

2. The temperature data in the bottom table and the trajectory in the diagram do not match exactly. They represent approximate calculations from slightly different sets of assumptions, in this case starting from a straight line Business as Usual assumption by Pacala and Socolow. The differences should be regarded as minor when considering large national and international policy options. A strictly linear transient temperature increase may look strange to a climate scientist familiar with the IPCC SRES scenarios. Our attempt here is simply to give close enough numbers that policy makers can use to judge various estimates of reductions (or rises) in CO2 and average temperature and their consequences.

3. Most of the threshold temperature values of the various tipping points on the diagram are from Warren, Rachel. "Impacts of Global Climate Change at Different Annual Mean Global Temperature Increases." (2006) in *Avoiding Dangerous Climate Change*. Edited by Hans Joachim Schellnhuber. Cambridge University Press: U.K. 2006.

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