So What do We Do Now?

"Toward a Synthesis Take on the Take-home Messages"

Fossil fuel consumption and other human activities may drive atmospheric concentrations of greenhouse gases far beyond the range experienced by previous civilizations. This anthropogenic perturbation of the Earth system has already committed future generations to considerable climate change, with potentially profound and irreversible effects on ecosystems and human society. Humankind is moving towards a risk management approach to control the large-scale geochemical experiment caused by anthropogenic CO_2 emissions. Designing a scientifically sound and economically viable risk management strategy is a nontrivial task because the Earth system can change abruptly (in an irreversible bifurcation response), and with very subtle early warning signs, once a certain forcing threshold limit is crossed.

Decisions to mitigate the pace and eventually the extent of climate change will likely be framed in terms temperature change or greenhouse gas concentration targets. These targets might well be determined in large measure by the boundaries of "dangerous interference with the climate system", but the policies will be implemented in terms of mechanisms whose success over time can be evaluated (for example, emissions targets and timetables). See G8 statement, Sense of the Senate Resolution, Kyoto design, state and city initiatives, etc….

Abrupt climate change, abrupt impacts of perhaps gradual change, and changes in the frequency and/or intensity of extreme events will play important roles in designating what is meant by the adjective "dangerous". Uncertainty about the processes of abrupt change is therefore an impediment to climate policy in this context because it casts doubt on the location of the critical boundaries *and* on the attribution required to connect the policy levers that target. It inserts uncertainty into our ability to link, for example, successfully holding temperature increases below a specific threshold to the potential of actually reducing the likelihood of "dangerous interference."

Our understanding of the mechanisms of various types of abrupt change is fraught with large and deep uncertainties. Sometimes competing explanations exist. Careful delineation of the effects of abrupt change on the metrics and numeraires that decision-makers will use to evaluate "dangerous" is difficult at best and speculative in many cases. The long-term decision process will need this information if it is to be confident in the efficacy of its chosen long-term objectives.

This profound uncertainty makes policy responses vulnerable to type I errors (responding incorrectly to something that is not there). Perhaps more importantly, responses are also vulnerable to type II errors (not responding to something that is there). Meanwhile, the research community itself might be vulnerable to type III errors (spending too much effort focused on the wrong type of abrupt change (one that is, for example, less sensitive to small warming). It follows that expected utility analyses will not be particularly helpful in devising a policy response strategy. A risk management

approach to the policy problem is, instead, more appropriate. Such an approach would support the design of long-term policy to avoid crossing critical thresholds of dangerous climate change (as noted above, likely denominated as concentration or temperature targets and implemented as emissions targets) while near-term policy is framed as a hedge against the costs of policy adjustments that will be implemented either to keep the likelihood of crossing the thresholds low or to maintain the feasibility of specific concentration or temperature limits. The adjustment process must be predictable and transparent, so the connections of the boundaries of abrupt change to the temperature long-term policy targets (and thus the dimensionality of the possible type I and type II errors in the adjustment process) must be more clearly understood and articulated.

A recent workshop hosted by the Aspen Global Change Institute in July of 2005 confirmed the applicability of a risk management to the policy issues posed by abrupt climate change, especially if the research community can begin to associate the thresholds of abrupt change with the decision-maker's policy targets, begin to order their likelihoods (at least relatively) along the policy target domain, and provide more thorough descriptions of their impacts on economic activity, human health, ecosystem services, and other important "numeraires" in a dynamic context that will evolve over time. Doing so will provide information about the risks of each (likelihood times consequence) contingent upon the trajectory of the decision-makers chosen state variable.

Table 1 offers some of the more detailed conclusions offered by the participants at the workshop. Several more fundamental insights emerged:

(a) focusing so much attention on the weakening or collapse of the MOC may be a type III error;

(b) there are other possible sources of abrupt change (as indicated in Table 1);

(c) confident and timely detection and prediction is especially difficult; and

(d) successfully truncating distributions of uncertain parameters like climate sensitivity, if it were well founded, would help define appropriate near-term policies as part of long-term response strategies.

The entries recorded on Table 1 support these conclusions, but the gaps and red-shaded boxes (where low confidence conclusions are presented) recorded there also lead to research needs where the payoff could be high. These include: