Adaptation to Unpredicted Climate Change

Challenges of Pro-Active Adaptation to Projected Climate Change

Background

Efforts to mitigate anthropogenic emissions of greenhouse gases have failed to prevent acceleration in emissions, rising concentrations in the atmosphere, and increasing acidification of the oceans. Because of the impasse in negotiations, emphasis on adaptation has grown in recent years. Mandates for adaptation planning exist at international, national, and local levels. Organizations such as the World Bank, and related international financing organizations, now fund significant efforts at adaptation planning and adaptation actions through vehicles such as the Green Climate Fund and the Adaptation Fund. The Green Climate Fund may expend $100B per year by 2020. The US government, through Executive Order, requires federal agencies to develop and implement adaptation plans. Certain public stock exchanges require listed companies to report their climate risks and the Securities and Exchange Commission has issued guidance on such reporting. Many in the private sector develop climate change adaptation plans and an industry is growing around demands for climate change adaptation services.

Climate Science

To plan correctly for adaptation, an organization must first identify the risks it faces. For this purpose, those involved frequently refer to the results of General Circulation Models (GCMs) that use boundary conditions including possible future atmospheric concentration of greenhouse gases (representative concentration pathways, or RCPs). The newest model results were produced in the Coupled Model Inter-comparison Project phase five (CMIP5), which implemented experiments to support the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5). These model results represent the world's best estimate of what might happen under various possible scenarios of mitigation success (or failure). CMIP5 GCM results for IPCC AR5 vary widely in the magnitude of climate change projected using the various RCPs. The climate modeling community does not attempt to, nor does it advocate, assignment of likelihoods to any of these outcomes.

The Problem

Climate modelers do not advocate use of CMIP results for adaptation planning. Indeed, they caution against such applications since they have no basis for determining which projection is most likely. CMIP5 and AR5 groups carefully label GCM results 'projections' of what might happen to distinguish them from 'predictions' of what will happen. CMIP5 results are not predictions (most likely outcomes) and are not designed for adaptation planning. Despite this limitation, and in the absence of alternatives, the adaptation community frequently (almost invariably) draws upon CMIP projections to characterize future climate to which adaptation planning then responds.

This unintended application of CMIP results is further compromised by another simplification, which results from the nearly incomprehensible plethora of CMIP results. Adaptation planners select particular scenarios; they nearly invariably do not consider the full suite. Examples abound in the literature of adaptation planning based on AR4 and CMIP3 results, which used a different set of boundary conditions (SRES scenarios). Most adaptation exercises draw upon one or two,

and at most three SRES scenarios. Insidiously, these analyses come to be taken for what adaptation is needed, rather than adaptation that might be needed if that scenario holds.

Conditional projections cannot serve as 'best science' for climate adaptation planning, which depends upon risk analysis informed by at least ordinal-scale impact likelihoods. Adaptation efforts should be directed to an expected future, not a future whose likelihood is unknown. Such an expected future is, by definition, a prediction; adaptation needs prediction.

NOAA's Role and Responsibility

NOAA's CPC climate predictions do not extend to time periods relevant to climate adaptation. Experimental decadal forecasts do not demonstrate skill and remain research topics with distant prospects of utility. NOAA's GFDL provides GCM projections for IPCC that are conditioned on RCPs and designed to support climate mitigation policy. Recently developed online analytical tools (LCAT) from the Climate Services Division support modeling of NCDC observational data but eschew predictive applications. Thus, adaptation decisions lack NOAA predictions, although NOAA's climate goal specifically includes support for climate adaptation decisions.

A Fundamental Barrier

Meteorological tradition requires demonstrated skill to accept a *prediction method*. Climatology has inherited a meteorological tradition for determination of predictability that is inappropriate to, and inadequate for, the societal challenge of adapting to climate change. The requirement for demonstrable skill in a conditional analysis of a transient non-linear system where long lead predictions are needed fails the test of utility. The existing system of conditional projections was created for, and is well suited to, informing policy decisions about mitigation. It fails to address the challenge of adaptation and the very failure of mitigation actions necessitates reexamination of the projection/skill paradigm. If climate science cannot inform our expectations, what can?

An Option

Meteorology is not the only science that makes predictions in the context of saving life and property. For example, seismologists forecast earthquake risk from recorded seismicity, mapped records of fault behavior, and strain dynamics. Prediction is inherent in the scientific enterprise, though *traditions of valid prediction differ between disciplines* (e.g. medicine, engineering, seismology, cosmology). Although the traditions differ fundamentally and are not interchanged, each demonstrates service to society.

The projection/skill paradigm is unsuited for the task of adaptation, yet the demands for adaptation press upon science. A scientific response would consider the *possibility* of a different, more useful, paradigm. Creating a new paradigm may be informed by metasystematic examination of existing prediction traditions in the full spectrum of scientific and technical fields (such as the seismology example) to ensure the dialogue is disencumbered of dominant forces inadvertently limiting discourse and options. Such dialogue is needed now and, consistent with its climate goal, NOAA should lead.

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