The Limits of Consensus

Michael Oppenheimer,1,2* Brian C. O’Neill,3,4 Mort Webster,5 Shardul Agrawala1,6

The Intergovernmental Panel on Climate Change (IPCC) has just delivered its Fourth Assessment Report (AR4) since 1990. The IPCC was a bold innovation when it was established, and its accomplishments are singular (1, 2). It was the conclusion in the IPCC First Assessment Report that the world is likely to see “a rate of increase of global mean temperature during the next century … that is greater than seen over the past 10,000 years” (3) that proved influential in catalyzing the negotiation of the United Nations Framework Convention on Climate Change. The conclusions of the Second Assessment with regard to the human influence on climate (4) marked a paradigm shift in the policy debate that contributed to the negotiation of the Kyoto Protocol. IPCC conclusions from the Third, and now the Fourth, assessments have further solidified consensus behind the role of humans in changing the earth’s climate.

The emphasis on consensus in IPCC reports, however, has put the spotlight on expected outcomes, which then become anchored via numerical estimates in the minds of policy-makers. With the general credibility of the science of climate change established, it is now equally important that policy-makers understand the more extreme possibilities that consensus may exclude or downplay (5).

For example, the Working Group I (WGI) “Summary for Policymakers” (SPM) of AR4 anticipates a rise in sea level of between 18 and 59 cm by the year 2100 (6), a “model-based range” composed largely of thermal expansion of oceans, melting of nonpolar glaciers, and the gradual response of ice sheets. The range does not include the potential for increasing contributions from rapid dynamic processes in the Greenland and West Antarctic ice sheets (WAIS), which have already had a significant effect on sea level over the past 15 years and could eventually raise sea level by many meters. Lacking such processes, models cannot fully explain observations of recent sea-level rise, and accordingly, projections based on such models may seriously underestimate potential future increases. Although the AR4 SPM recognizes the possibility of a larger ice-sheet contribution, its main quantitative results indicate the opposite: Uncertainty in sea-level rise is smaller, and its upper bound is lower, for the 21st century than was indicated in the Third Assessment Report (7). On the related question of sea-level rise beyond the 21st century, whereas the Third Assessment’s SPM provided a numerical estimate of a potential contribution from WAIS, the AR4 WGI SPM doesn’t mention WAIS at all. This omission presumably reflects a lack of consensus arising from the inadequacy of ice-sheet models for WAIS made so apparent by recent observations.

Nevertheless, alternatives to model-based approaches, such as empirical analysis and expert elicitation, were available for exploring uncertainty in 21st-century (8) and long-term sea-level rise (9), respectively. Such information certainly would have been useful to policy-makers, particularly for WAIS, which contains enough ice to raise sea level by about 5 m.

Setting aside or minimizing the importance of key structural uncertainties in underlying processes is a frequent outcome of the drive for consensus (5, 10). For example, ranges of projected warming and atmospheric composition in AR4 include an amplifying effect of interactions between climate and the carbon cycle. However, the estimated uncertainty in this effect is based largely on models that omit a number of poorly understood processes (11), such as feedbacks on carbon contained in permafrost; changes in marine ecosystem structure; and responses to land-use history, nutrient limitation, and air-pollution effects. These models also share similar assumptions about the temperature sensitivity of carbon fluxes from soils based on experimental results that cannot be reliably scaled to the ecosystem level (12). A fuller accounting of uncertainty would be more appropriate.

Similarly, the narrowing of uncertainty (relative to previous assessments) associated with potential changes in the meridional overturning circulation relies on agreement across models, but the structural uncertainty in all the models means that less may be known than suggested by the numerical estimates (13).

*Author for correspondence. E-mail: omichael@princeton.edu
Like models of physical processes, conclusions drawn on the basis of socioeconomic models may also be subject to premature consensus. Estimates of the costs of mitigating emissions come primarily from models that omit endogenous technical change, a poorly understood process. This omission could cause a significant bias, not only in mitigation costs, but also in the stringency of near-term mitigation that may be justified for a given damage function or stabilization target (14–16). Similarly, the conventional use of the range of emissions described by the IPCC Special Report on Emissions Scenarios (SRES) marker scenarios as a key determinant of uncertainty in projecting climate change, sea-level rise, impacts, and mitigation costs may be misguided. The SRES scenarios were intended to be representative of scenarios available in the literature at the time they were produced, with no explicit goal of spanning the full range of uncertainty. The SRES assessment made no attempt to judge whether emissions pathways outside the range it covers could plausibly occur. In fact, pathways outside that range were known at the time, and more have been developed since the publication of SRES (17).

To be sure, the underlying IPCC chapters detail the limitations and uncertainties associated with such conclusions. But the caveats are often cryptic or lost entirely in the highly influential SPMs. This inevitably leads to an anchoring by both policy-makers and scientists around any numerical estimates that are reported in these summaries.

Ignoring the implications of structural uncertainty in models of key aspects of the climate system is reminiscent of the way assessments treated the uncertainty in ozone photochemical models. Projections of ozone depletion were made from 1974 onward based on improved understanding of gas-phase chemistry (18). Knowledge of stratospheric chemistry was then transformed by the report in 1985 of large, seasonal Antarctic depletion (the “ozone hole”); the validation in 1987 of its origin in halogen photochemistry; and subsequent identification of depletion at the mid-latitudes and in the Arctic (19, 20). Various heterogeneous chemical reactions, discounted by most researchers years before and absent from nearly all model simulations (21), were shown to be the missing photochemical processes required to explain observed depletion. Their potential implications were of concern to some scientists (22), but this structural uncertainty was generally downplayed in assessments until the ozone hole was reported.

Avoiding Premature Consensus

The IPCC has made progress over four assessment cycles in its treatment of uncertainties. However, this progress is limited and uneven across its Working Groups. Several additional modifications to the current practice could reduce the risk of ignoring or underemphasizing critical uncertainties.

First, given the anchoring that inevitably occurs around numerical values, the basis for quantitative uncertainty estimates provided must be broadened to give observational, paleoclimatic, or theoretical evidence of poorly understood phenomena comparable weight with evidence from numerical modeling. In areas in which modeling evidence is sparse or lacking, IPCC sometimes provides no uncertainty estimate at all. In other areas, models are used that have quantitatively similar structures, leading to artificially high confidence in projections (e.g., in the sea-level, ocean-circulation, and carbon-cycle examples above). One possible improvement would be for the IPCC to fully include judgments from expert elicitations (23), as Working Group II has sometimes done. Beyond this, increased transparency, including a thorough narrative report on the range of views expressed by panel members, emphasizing areas of disagreement that arose during the assessment, would provide a more robust evaluation of risk (24). It would be critical to include this information not only in the chapters, but in the summaries for policy-makers as well.

Second, IPCC should revise its procedure for expert review to guard against overconfidence. External reviewers should ferret out differences between chapters or author subgroups, and a special team of authors could be instructed to examine the treatment of unlikely but plausible processes, perhaps in a separate chapter. Integration of risk assessment across Working Groups in advance of drafting of the Synthesis Report would highlight internal discussions and disagreements. At the end of an assessment cycle, a small external team of ombudsmen should review key problematic issues (of a scientific nature) that may have emerged from the report and should recommend modifications of approaches for handling these areas in subsequent reports.

Third, IPCC could also formalize a process of continuous review of its structure and procedures. A useful example is provided by the history of IPCC emissions scenario development, which included a series of reviews for production of the SA90, IS92, and SRES scenarios (25).

Fourth, and perhaps most important, national governments now need to confront a more fundamental question of how often they need comprehensive assessments of climate change. Addressing the special risks entailed in particular aspects of the climate system, like the ice sheets or carbon cycle, might be better approached by increasing the number of concise, highly focused special reports that can be completed relatively quickly by smaller groups, perhaps even by competing teams of experts. At this juncture, full assessments emphasizing consensus, which are a major drain on participants and a deflection from research, may not be needed more than once per decade.

References and Notes

25. The SA90 scenarios were published in the IPCC First Assessment Report. The IS92 scenarios were published in the 1992 Supplementary Report to the IPCC Assessment.