The Scenario Plausibility Vacuum

Roger Pielke Jr.*

Climate research is a natural fit for the use of scenarios, given its roots in long-term planning and the energy industry and the need to offer projections far into the future. Early scenarios were highly idealized and, for instance, focused on exploring what would happen if carbon dioxide concentrations doubled from their preindustrial levels or increased at a steady rate of 1% per year. The Intergovernmental Panel on Climate Change (IPCC) introduced scenarios not just to explore scientific questions, but to project or predict alternative futures in order to inform decision making related to adaptation and mitigation policy making.

The climate research community uses scenarios to "provide plausible descriptions of how the future might unfold in several key areas – socioeconomic, technological and environmental conditions, emissions of greenhouse gases and aerosols, and climate" (Moss et al. 2010). The *plausibility* of scenarios is a concept that can be defined in a variety of ways (Ramírez and Selin 2014). Plausibility is obviously central to future-oriented scenario planning.

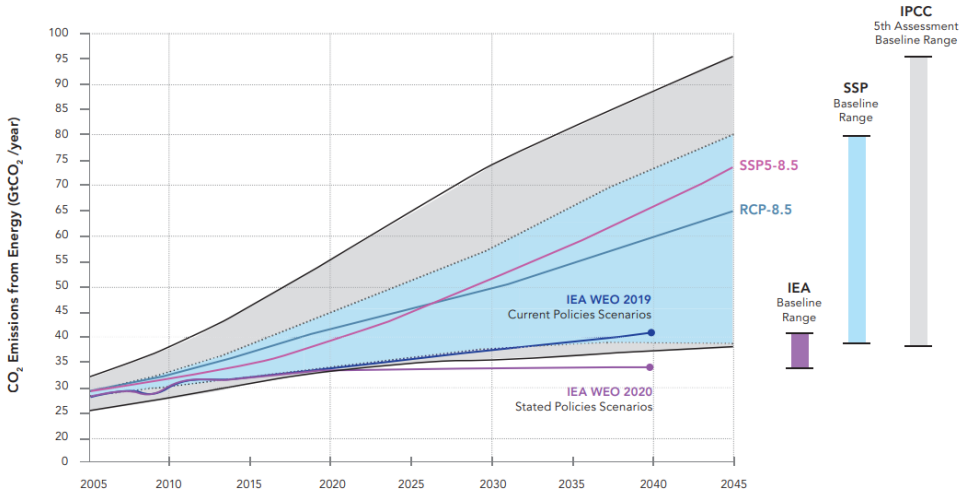
However plausibility might be defined, the IPCC has a design flaw in that across its three working groups no one actually evaluates scenario plausibility. Indeed, in 2008 the IPCC noted of its then-newly developed Representation Concentration Pathway scearnios, "It is an open research question as to how wide a range of socioeconomic conditions could be consistent with a given pathway of forcing, including its ultimate level, its pathway over time, and its spatial pattern" (Moss et al. 2008). More recently, an author of the IPCC AR6 chapter on scenarios noted, "We do not consider the degree of realism of any one scenario."[1] Scenarios are developed and used without consideration of their plausibility.

In climate research and assessment, scenarios are prioritized and adopted for research purposes with no consideration of their likelihood, probability or plausibility. This can lead to confusion and misplaced research effort. For instance, the 2021 IPCC AR6 Working Group 1 report noted that the most commonly used scenarios in climate research have been judged in the literature to be low likelihood, and yet these scenarios made up ore than half of the total references to scenarios throughout the report.[2] Such a disproportionate focus on implausible scenarios has potential to mislead. More generally, in a series of recent papers we have documented that the IPCC, and indeed much of climate research, has focused attention disproportionately on implausible scenarios and has largely ignored much more plausible scenarios (Burgess et al. 2020, Pielke and Ritchie 2021a, Pielke and Ritchies 2021b, Pielke et al. 2021).

In one analyses we have assessed the alignment of key assumptions – specifically Kaya

* Professor, Environmental Studies Program, University of Colorado Boulder, US / Distinguished Fellow, IEEJ
1 https://www.vox.com/22620706/climate-change-ipcc-report-2021-ssp-scenario-future-warming
2 https://rogerpielkejr.substack.com/p/how-to-understand-the-new-ipcc-report

Identity factors – of the IPCC AR5 scenarios and Shared Socioeconomic Pathway scenarios with observations of these variables and near-term projections of their evolution, as summarized in the figure below (for details, see Burgess et al. 2020).



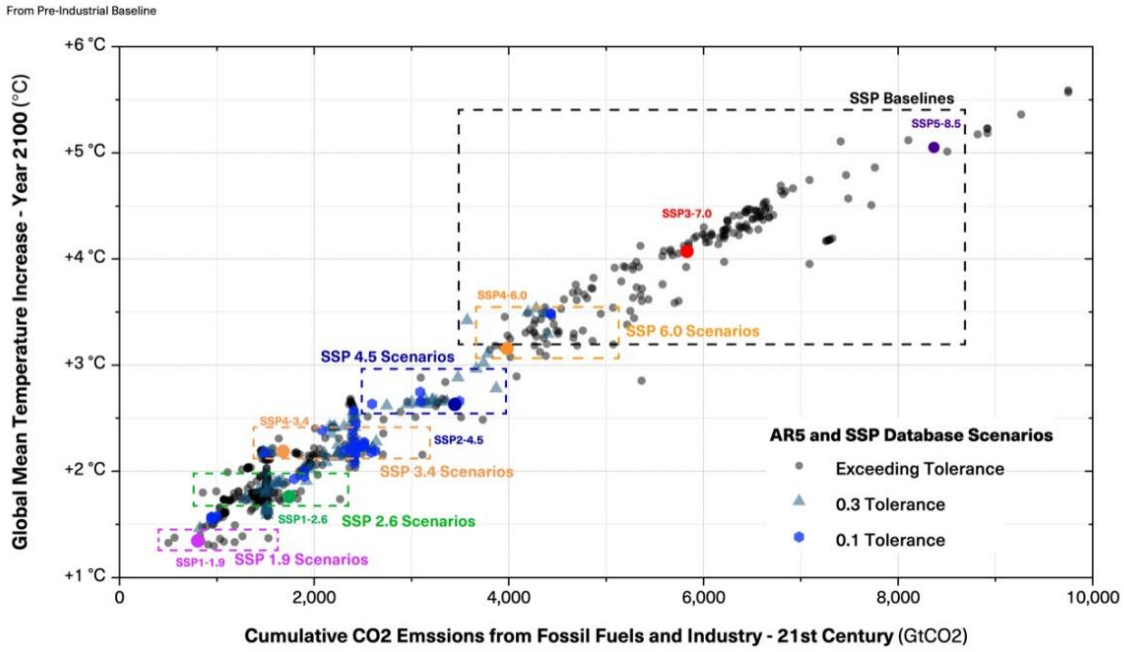
The range of fossil fuel baseline emissions projected by the International Energy Agency in 2019 and 2020 lie almost entirely outside the full range of baseline scenarios for the IPCC Fifth Assessment Report and the SSP scenarios shaping the IPCC Sixth Assessment Report.

We conclude:

> Recent (post-2005) trends and energy outlook projections (to 2040) of global CO_2 emissions are substantially lower than projected by baseline scenarios used in the IPCC's Fifth (AR5) and Sixth (AR6) Assessment Reports, and are well off-track from widely-cited high-emission marker scenarios such as RCP8.5. We show that this divergence owes largely to per-capita GDP and carbon intensity growth slower than projected in baseline scenarios. The gap between observed and projected carbon intensity is very likely to continue to increase throughout the 21st century due to the implausible assumptions high-emission scenarios make about future fossil-fuel expansion

Thus, many scenarios that are at the focus of climate research and assessment have already diverged from real-world trends, making them implausible representations of not just the present, but also the future.

In a follow-on analysis we have identified the subset of scenarios that are consistent with observations and near-term projections (Pielke et al. 2021). We find that about 10% of IPCC AR5 and SSP scenarios meet our most stringent criteria of plausibility. Under less stringent criteria ~27% of AR5 scenarios and ~39% of SSP scenarios meet our criteria of plausibility. The figure below summarizes the analysis of plausible scenarios (for details, see Pielke et al. 2021).



The figure shows that the scenarios most consistent with trends and near-term observations project a median warming in 2100 of ~2.2 degrees Celsius., in-line with SSP 3.4 scenarios. The analysis further underscores the implausibility of the more extreme scenarios, such as SSP 6.0 and greater.

Recent rends and near-term projections of carbon dioxide emissions offers optimism that a worst-case scenario for the next several decades is likely a long-plateau in emissions and approximately 3°C of warming by 2100. This perspective is supported by the envelope of scenarios identified in the figure above as plausible. Of course, the future is uncertain and contingent on policy choices. Decision makers around the world could choose to intentionally grow carbon dioxide emissions, but that currently seems highly unlikely.

Deep decarbonization remains an enormous challenge, and net-zero carbon dioxide emissions by 2050 – a common policy goal – remains outside the envelope of even the plausible scenario trajectories, and thus its achievement will require additional policy efforts. However, the world sits in an enviable position to take on this challenge, at least as compared to where IPCC baseline scenarios – and some of the public discourse of recent years – projected the world to be in 2021. To support deep decarbonization, climate research should develop, regularly update, and focus on plausible scenarios to inform policy. A focus on plausible scenarios will require that someone take responsibility for addressing the scenario plausibility vacuum.

〈References〉

Burgess, M. G., Ritchie, J., Shapland, J., & Pielke, R. (2020). IPCC baseline scenarios have over-projected CO_2 emissions and economic growth. *Environmental Research Letters*, *16*(1), 014016.

Moss, R. M. Babiker, S. Brinkman, E. Calvo, T. Carter, J. Edmonds, I. Elgizouli, S. Emori, L. Erda, K. Hibbard, R. Jones, M. Kainuma, J. Kelleher, J. F. Lamarque, M. Manning, B. Matthews, J. Meehl, L. Meyer, J. Mitchell, N.a Nakicenovic, B. O'Neill, R. Pichs, K. Riahi, S. Rose, P. Runci, R. Stouffer, D.van Vuuren, J. Weyant, T. Wilbanks, J. P. van Ypersele, and M. Zurek, 2008. Towards New Scenarios for Analysis of Emissions, Climate Change, Impacts, and Response Strategies. Intergovernmental Panel on Climate Change, Geneva, 132 pp.

Moss, R.H., J.A. Edmonds, K.A. Hibbard, M.R. Manning, S.K. Rose, D.P. Van Vuuren, T.R. Carter, S. Emori, M. Kainuma, T. Kram, G.A. Meehl, 2010. The next generation of scenarios for climate change research and assessment, *Nature* 463:747-756.

Pielke Jr, R., Burgess, M. G., & Ritchie, J. (2021, in review). Most plausible 2005-2040 emissions scenarios project less than 2.5 degrees C of warming by 2100. https://osf.io/preprints/socarxiv/m4fdu/

Pielke Jr, R., & Ritchie, J. (2021a). Distorting the view of our climate future: The misuse and abuse of climate pathways and scenarios. *Energy Research & Social Science*, *72*, 101890.

Pielke Jr, R., & Ritchie, J. (2021b). How Climate Scenarios Lost Touch With Reality. *Issues in Science and Technology*, Summer.

Ramírez, R., & Selin, C. (2014). Plausibility and probability in scenario planning. *Foresight*.

Writer's Profile

Roger Pielke Jr.

Professor Pielke founded and served as Director of the Center for Science and Technology Policy Research at the University of Colorado Boulder from 2001 to 2007 and from 2013 to 2016. He was a visiting scholar at Oxford University's Saïd Business School in the 2007-2008 academic year. His interests include understanding the use and misuse of science in areas such as the Covid-19 response, climate change, disaster mitigation, energy policy; and sports governance.