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Climate change prediction: Erring on the side of least drama?

Keynyn Brysse [a,*], Naomi Oreskes [b], Jessica O'Reilly [c], Michael Oppenheimer [d]

[a] Program in Science, Technology and Society, Office of Interdisciplinary Studies, University of Alberta, Canada
[b] History and Science Studies, University of California, San Diego, United States
[c] Department of Sociology, College of St. Benedict/St. John's University, United States
[d] Department of Geosciences and Woodrow Wilson School of Public and International Affairs, Princeton University, United States

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ABSTRACT

Over the past two decades, skeptics of the reality and significance of anthropogenic climate change have frequently accused climate scientists of "alarmism": of over-interpreting or overreacting to evidence of human impacts on the climate system. However, the available evidence suggests that scientists have in fact been conservative in their projections of the impacts of climate change. In particular, we discuss recent studies showing that at least some of the key attributes of global warming from increased atmospheric greenhouse gases have been under-predicted, particularly in IPCC assessments of the physical science, by Working Group I. We also note the less frequent manifestation of over-prediction of key characteristics of climate in such assessments. We suggest, therefore, that scientists are biased not toward alarmism but rather the reverse: toward cautious estimates, where we define caution as erring on the side of less rather than more alarming predictions. We call this tendency "erring on the side of least drama (ESLD)." We explore some cases of ESLD at work, including predictions of Arctic ozone depletion and the possible disintegration of the West Antarctic ice sheet, and suggest some possible causes of this directional bias, including adherence to the scientific norms of restraint, objectivity, skepticism, rationality, dispassion, and moderation. We conclude with suggestions for further work to identify and explore ESLD.

1. Introduction

Over the past two decades, skeptics of the reality and significance of anthropogenic climate change have frequently accused climate scientists of "alarmism": of over-interpreting or overreacting to evidence of human impacts on the climate system (e.g., Singer, 1989, 2000, 2008; Singer and Idso, 2009; Bradley, 1993). Often it is alleged that the motivation for such exaggeration is to gain media attention and funding for research, suggesting that scientists' human desire for attention and practical need for funding biases them toward exaggerating threats (Michaels, 2009, 2010). Some extreme skeptics have gone so far as to declare global warming a "deception" and even a "hoax" (Inhofe, 2003; Ismail, 2010; Bell, 2011; Jeffrey, 2011). Paradoxically, since the release of the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) such claims have become more frequent, even as the quantity, quality, and diversity of relevant scientific information supporting anthropogenic climate change has vastly increased (Singer and Avery, 2007; Johnson, 2008, 2009; Singer and Idso, 2009; Glover and Economides, 2010; Ismail, 2010; MacRae, 2010; Michaels and Balling, 2009; Surhone et al., 2010; Bell, 2011; Jeffrey, 2011).

Given these gains in knowledge, and that scientists have been making specific projections regarding the likely outcomes of increased atmospheric concentrations of greenhouse gases since the late 1980s, it is possible to begin to assess whether scientists have over- or under-predicted such outcomes. That is to say, it is possible to evaluate claims of exaggeration and alarmism, and to ask whether the available empirical evidence supports such claims or not. If not, it would be timely to consider factors, including social and cultural ones, which might lead scientists to the opposite behavior: not to exaggerate threats and over-interpret their data, but rather to minimize threats and interpret their data in a conservative way.

In this paper, we suggest that such a factor may exist, and that scientists are biased not toward alarmism but rather the reverse: toward cautious estimates, where we define caution as erring on the side of less rather than more alarming predictions. We argue that the scientific values of rationality, dispassion, and self-restraint tend to lead scientists to demand greater levels of evidence in support of surprising, dramatic, or alarming conclusions than in support of

* Corresponding author at: Office of Interdisciplinary Studies, 1-17 Humanities Centre, University of Alberta, Edmonton, Alberta, Canada, T6G 2E5.
E-mail addresses: brysse@ualberta.ca (K. Brysse), noreskes@ucsd.edu (N. Oreskes), jloreilly@csbsju.edu (J. O'Reilly), omichael@princeton.edu (M. Oppenheimer).

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conclusions that are less surprising, less alarming, or more consistent with the scientific status quo. Restraint is a community norm in science, and it tends to lead many scientists (ceteris paribus and with some individual exceptions) to be cautious rather than alarmist, dispassionate rather then emotional, understated rather than overstated, restrained rather than excessive, and above all, moderate rather than dramatic (on community norms, see Bernard, 1927; Conant, 1953; Merton, 1979; Keller, 1985; Harding, 1986; Haraway, 1989). We call this tendency "erring on the side of least drama (ESLD)."

We begin by summarizing available evidence that scientists have been conservative in their projections of the impacts of climate change. In particular, we discuss recent studies showing that at least some of the key attributes of global warming from increased atmospheric greenhouse gases have been under-predicted, particularly in IPCC assessments of the physical science, by Working Group I (Rahmstorf et al., 2007; Pielke, 2008; NRC, 2009; Allison et al., 2009; Garnaut, 2011; Mabey et al., 2011). We also note the less frequent manifestation of over-prediction of key characteristics of climate in such assessments. We then analyze these results in light of our hypothesis of the tendency to err on the side of least drama, and suggest some avenues for future research.

2. IPCC predictions vs. actual outcomes

2.1. Previous analysis: Rahmstorf and colleagues (2007)

In a 2007 article, Rahmstorf and colleagues compared projections of global mean temperature change, sea level rise, and atmospheric carbon dioxide concentration from IPCC's Third Assessment Report (TAR) with observations made since 1973 and concluded: "Overall, these observational data underscore the concerns about global climate change. Previous projections, as summarized by IPCC, have not exaggerated but may in some respects even have underestimated the change, in particular for sea level" (p. 709). In the TAR, released in 2001, the IPCC predicted an average sea level rise of less than 2 mm/yr, but from 1993 to 2006, sea level actually rose 3.3 mm/yr—more than 50% above the IPCC prediction (Houghton et al., 2001). Furthermore, the temperature change over the period "is 0.33 °C for the 16 years since 1990, which is in the upper part of the range projected by the IPCC (in the TAR)." The underestimate in sea level rise can be traced in part to under-projection of ice loss from Antarctica and Greenland, as discussed in detail later in this paper.

2.2. Previous analysis: Pielke (2008)

In a 2008 paper, Roger Pielke, Jr., expanded this analysis to include the predictions offered by scientists in earlier IPCC assessments (Pielke, 2008). Pielke observed that for sea level rise, actual changes have been greater than forecast in two of three prior IPCC reports, while falling below the median prediction in the First Assessment Report (FAR). Predicted temperature changes, also higher in the FAR than subsequently observed, were in line with observations for the three subsequent assessments, taken as a whole.

Pielke noted that "A comprehensive and longer-term perspective on IPCC predictions, such as this, suggests that more recent predictions are not obviously superior [to older ones] in capturing climate evolution" (2008, p. 206). This is of course true: More observations, model runs, and even greater understanding of individual aspects of a complex system do not necessarily lead to convergence on truth (Oppenheimer et al., 2008). But the relevant question is how the projections have stood up to empirical evidence of what actually has occurred in the natural world during the time period under discussion. Pielke concluded that "Once published, projections should not be forgotten but should be rigorously compared with evolving observations" (2008, p. 206). We agree. When one does this, as both the Rahmstorf and Pielke analyses do, one finds an overall tendency in the most recent three assessments toward either no bias or toward underestimation.

2.3. Previous analysis: NRC (2009)

These conclusions are also supported in a report prepared by the Committee on Strategic Advice on the U.S. Climate Change Science Program, for the titular purpose of *Restructuring Federal Climate Research to Meet the Challenges of Climate Change* (NRC, 2009). The results of the three-year study, commissioned by the U.S. Climate Change Science Program (CCSP) and published in 2009, were consistent with the conclusion that IPCC projections have systematically underestimated key climate change drivers and impacts. This committee found that "The Intergovernmental Panel on Climate Change (IPCC) projections may have been too conservative" in several areas, including CO_2 emissions by various countries, increases in surface temperatures, and sea level rise (p. 12). The key climate metrics of global mean temperature and sea level rise are biased toward underestimation, so far as the evidence in this analysis shows.

2.4. Previous analysis: Copenhagen Diagnosis (2009)

The NRC findings are also consistent with the analysis of an international group of scientists who summarized advances in climate science since the 2007 IPCC Fourth Assessment Report. This analysis, *The Copenhagen Diagnosis* (Allison et al., 2009), reviewed "hundreds of papers ... on a suite of topics related to human-induced climate change" since the drafting of AR4, and, like the NRC report, found that key changes were happening either at the same rate as, or more quickly than, anticipated (p. 5). Among their key findings were that global temperature increases over the past 25 years have been consistent with model predictions (0.19 °C per decade, virtually the same rate as for the 16 years mentioned in Rahmstorf et al., 2007), while other important impacts are proceeding faster than expected, including CO_2 emissions, increased rainfall in already rainy areas, continental ice-sheet melting, arctic sea-ice decline, and sea level rise. The data examined here overlap substantially with those analyzed by the Rahmstorf team, and it is noteworthy that an independent analysis by a different group of scientists comes to much the same judgment.

Among the key findings:

- Rainfall has become more intense in already rainy areas, and "recent changes have occurred faster than predicted" (Allison et al., 2009, p. 15; see also Wentz et al., 2007; Allan and Soden, 2008; Liu et al., 2009).
- Sea level rise has far exceeded predictions: "satellites show recent global average sea level rise (3.4 mm/yr over the past 15 years)—to be ~80% above past IPCC predictions" (Allison et al., 2009, p. 7).
- Surface ocean heat uptake between 1963 and 2003 was 50% higher than expected based on previous calculations. This difference helps explain why sea level rise (from thermal expansion) is also greater than expected (Allison et al., 2009, p. 35; see also Domingues et al., 2008; Bindoff et al., 2007). Studies also show that deep ocean warming is more widespread than previously thought (Allison et al., 2009, p. 35; see also Johnson et al., 2008a,b).
- Summertime melting of Arctic sea-ice has "accelerated far beyond the expectations of climate models" (Allison et al., 2009, p. 7; see also Stroeve et al., 2007). Indeed, using unusually vivid

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