Climate change literature critique

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In my general reading, I came across Michael Lemonick's magazine article [Lemonick10] about the controversy surrounding climate scientist Judith Curry, as well as a leader [Nature10] in *Nature* concerning language choices to express uncertainty. Both pieces make complementary points about the way researchers make and present scientific inferences, and that's a theme that I want to explore in this essay.

Curry is head of the School of Earth and Atmospheric Sciences at the Georgia Institute of Technology. Her research focus and general conclusions have been in keeping with the mainstream consensus about global climate change. However, in recent years she has actively engaged with the loosely defined community of climate skeptics by such means as participating in outsider blogs, like Steve McIntyre's Climate Audit (http://climateaudit.org).

Webster and the hurricanes

As Lemonick recounts, Curry's involvement with the skeptics began with a paper [Webster05] for which she is a co-author. In it, Webster et al. examine relationships between sea surface temperature (SST) and the prevalence and strength of tropical cyclones (commonly, hurricanes). The authors divide their data (from the years 1970-2005) into sets representing activity in the various oceans:

- East Pacific
- West Pacific
- Southwestern Pacific
- North Atlantic
- North Indian
- South Indian

While all the ocean basins except the Southwest Pacific show upward trends in SST over the period, the data on strength and number of tropical cyclones show no such trend—with the exception of the North Atlantic. The authors reason, in measured terms:

> The observation that increases in North Atlantic hurricane characteristics have occurred simultaneously with a statistically significant positive trend in SST has led to the speculation that the changes in both fields are the result of global warming. (p. 1846)

Lemonick writes that Curry her co-authors were criticized by the outsider community for the quality of the data before 1970 that they relied on. (A full recap and assessment of all reactions to the work is outside the scope of this paper.) I can't speak knowledgeably to that specific criticism, although it's worth noting that the paper does discuss some of the issues with collecting data on intensity. Over the years, workers have relied variously on satellite and aircraft

reconnaissance to get the numbers. And in fact the paper limits itself to the analysis of data post-1970.

However, I do find the presentation and analysis of the cyclone strength and quantity information lacking, in certain respects. First, Figure 3 (which backs up the speculation quoted above) presents the number of hurricanes and the number of hurricane days as five time series plots (combining the South Indian and Southwest Pacific into a series for the Southern Hemisphere); data are plotted for each year 1970-2004, as well as a five-year "running average"[1]. There are so many overlapping curves in the figure that it's difficult to see what's going on, especially when the figure is reproduced in grayscale. Second, Figure 4 presents hurricane intensity (as measured by the Saffir-Simpson scale). The global data are binned into three series—Category 1, Categories 2 and 3, and Categories 4 and 5—and are aggregated into seven pentads spanning the 35-year period 1970-2004. Part A of the figure shows the series as absolute counts, while Part B shows them as relative percentages. I do not understand the need for Part B, which is not much more than a rescaling of the data in Part A; Part A shows quite clearly the upward trend in Category 4 and 5 cyclones that the authors want us to note.

Third, and most important, the binning of the data underscores how sparse it is, and seems somewhat arbitrary. The greatest magnitude is approximately 105 Category 1 storms for the 1970-1974 pentad. No justification is given for combining data for Categories 2 and 3 and 4 and 5. No test statistics are presented to back up the claim that the rising trend in the strongest cyclones is statistically significant.

Words for uncertainty

In any event, it was criticism from the skeptics that led Judith Curry to an examination of her own stance toward climate science as published by the mainstream, in particular the Intergovernmental Panel on Climate Change (IPCC), and her approach to communicating with the general public. As Lemonick writes,

> the central issue that concerns Curry also happens to be the key problem in translating climate science into climate policy. The public at large wants to know whether or not climate is warming, by how much and when, and they want to know how bad the effects are going to be. But the answers scientists give in papers and at conferences come couched in a seemingly vague language of confidence intervals and probabilities. The politically charged nature of the issue seems to have made some scientists reluctant to even mention anything to the public about "uncertainty"... (p. 81)

[1] I've always known this statistic as a "moving average." The endpoints of this series, as plotted, lead me to wonder whether a different computation is presented.

Hence the lively debate taking place among the scientific community about how to present findings that are uncertain. An IPCC working paper [IPCC05] recommends clearly-defined English language phrases to represent the degree of uncertainty behind a judgment as to the correctness of an analysis, and the likelihood that an outcome will occur in the future (or has occurred in the past). The terminology is matched with corresponding quantitative assessments. For instance,

- Very High confidence denotes a 9 of 10 chance that an analysis, model, or statement is correct; while
- High confidence denotes about an 8 of 10 chance that it is correct;
- Virtually Certain denotes a 99% probability of occurrence; while
- Very Likely denotes a 90% probability.

Where there is potentially lack of expert consensus and/or incomplete data, the document suggests a four-quadrant framework to capture the missing certainty. Authors can characterize an area of study as "High agreement/limited evidence," "Low agreement/much evidence," or "Low agreement/limited evidence."

It is just this dequantification of uncertainties that the *Nature* editorialist [Nature10] takes issue with: "More important still is not to isolate these numbers from the equivalent probabilistic terms, which studies show are often ineffective at representing the intended degree of certainty." (p. 883) Yet I am unconvinced by this argument. The words have to be there, especially to reflect the lack of consensus or corroborating data.

Unfortunately, presenting research findings with quantitative precision, including numerical error bars and statistical confidence intervals, taxes the general public's numeracy. Even more so, most people are hard pressed to make rational decisions about chance outcomes—otherwise, the tour buses to Atlantic City would be running empty. On the other hand, showing results as an unambiguous quantity or steadily upsloping trend line is highly susceptible to skeptical sniping that "natural variation hasn't been accounted for."

The proper balance between clarity of expression and integrity of scientific reasoning has always been vexed; finding the happy medium has never been so critical to science and journalism as it has become today, in the reporting on climate science.

Curry and her critics

Lemonick's *Scientific American* piece gives voice to both sides of the Judith Curry furor. To certain members of the so-called climatology establishment, who face political challenges driven by factors other than cold, hard science, Curry is a cat's-paw of the carpers and deniers. On the other side of the issue, Curry explains that she remains a believer in the scientific consensus that

anthropogenic greenhouse gases are warming the planet, but she refuses to represent the IPCC's work as faultless; furthermore, she favors reform of the process by which the work is done. There is too much of an opportunity for groupthink to cloud the analysis, she claims.

As for myself, I would like to believe that consensus not supported by good science is an insignificant aspect of current global warming research. However, this belief is a matter of my own faith in the scientific method and its practitioners; it is not something I can summon facts and analysis to back it up. We are taught that transparency, objectivity, and replication will ultimately drive out bad science.

I am not persuaded by arguments that a dialogue with skeptics risks political failure or loss of scientific credibility; indeed, such a thesis seems itself to be driven by emotion.

Curry states that some of the most basic facts of climate science are not yet understood with clarity and precision. She specifically cites (and this was a mild eye-opener for me) the measurement of radiative forcing (RF) from CO_2 alone—isolated from positive or negative feedback due to melting ice, increased water vapor, or other effects—and thus the change in global temperature due to a given change in the CO_2 level. [Forster07] cites a global mean concentration (in 2005) for CO_2 of 379 ppm, translating to an RF value[2] of +1.66 [±0.17] W m^{-2} (90% confidence range); according to Stephen H. Schneider (in an interview with Lemonick), this uncertainty of a few percentage points is not enough to significantly skew projections. And yet, the executive summary of Forster et al. can only assert

> Climate model studies... give medium confidence [i.e., a 5 out of 10 chance] that the equilibrium global mean temperature response to a given RF is approximately the same (to within 25%) for most drivers of climate change. (p. 131)

Hardly an unequivocal statement.

We are still in the middle innings of a long-running game in which, as someone wiser than me once remarked, Nature bats last. Whatever the outcome, we owe it to our children that the science we do is communicated clearly to everyone, in whatever terms they can understand.

References

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[2] More precisely, the *change* in RF from the beginning of the industrial era (ca. 1750) to the present.

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