Environmental Research Letters

**COMMENT**

Comment on ‘Quantifying the consensus on anthropogenic global warming in the scientific literature’

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**Keywords:** climate change, survey methods, consensus

**Abstract**

Cook et al’s highly influential consensus study (2013 Environ. Res. Lett. 8 024024) finds different results than previous studies in the consensus literature. It omits tests for systematic differences between raters. Many abstracts are unaccounted for. The paper does not discuss the procedures used to ensure independence between the raters, to ensure that raters did not use additional information, and to ensure that later ratings were not influenced by earlier results. Clarifying these issues would further strengthen the paper, and establish it as our best estimate of the consensus.

The consensus paper by Cook et al (2013) generated a lot of interest. Consensus is not proof, but occasional stock takes of the state of scientific knowledge are useful for identifying fruitful new research avenues and potential paradigm shifts. Agreement, or perceived agreement, about the extent and causes of climate change has no bearing on rational choices about greenhouse gas emission reduction—those are driven by the trade-offs between the impacts of climate change and the impacts of climate policy—but it does affect the public perception of and the political debate on climate policy, as does the integrity of climate research.

Cook et al (2013) estimate the fraction of published papers that argue, explicitly or implicitly, that most of the recent global warming is human-made. They find a consensus rate of 96%–98%. Other studies[6] find different numbers, ranging from 47% in Bray and von Storch (2007) to 100% in Oreskes (2004)—if papers or experts that do not take a position are excluded, as in Cook et al. If included, Cook et al find a consensus rate of 33%–63%. Other studies range from 40% in Bray and von Storch (2007) to 96% in (Carlton et al 2015). Cook et al use the whole sample. Other studies find substantial variation between subsamples. Doran and Zimmerman (2009), for instance, find 82% for the whole sample, while the consensus in subsamples ranges from 47% to 97%. Verheggen et al (2014) find 66% for the whole sample, with subsample consensus ranging from 7% to 79%. Figure 1 shows these estimates; see also table A1 in the appendix.

Measuring ‘consensus’ is, of course, not easy—the human brain always reinterprets information presented. Different studies may have different objects of consensus. This is illustrated by Carlton et al (2015) who ask four different questions—about the impact on climate change of human activities, greenhouse gases, carbon dioxide, and the Sun—and find four different results for the consensus rate (90%, 96%, 89%, and 71%, respectively). Other survey studies ask slightly different questions again. Oreskes (2004) and Cook et al (2013) rate abstracts, but where Oreskes finds 75% agreement and 25% no position, Cook has 33% agreement, 66% no position and 1% disagreement. Cook’s raters often disagree with each other about the message of a
paper (Cook and Cowtan 2015) and they disagree with the authors too (Tol 2014a).

These differences notwithstanding, the results by Cook et al (2013) seem to be at the high end in the consensus literature when ‘no position’ is excluded, and at the low end when included. As Cook et al have a sample that is so much larger than in other studies, you would expect its results to lie towards the centre of earlier results. Figure 1 highlights that this is not the case.

It may be that there is a trend in consensus findings, and that study by Cook et al stands out because it is recent. Cook et al (2013) argue that there is an upward trend in consensus but Tol (2014a) shows that this is a trend in composition rather than agreement. There appears to be no trend in the consensus rate across studies. There is no statistically significant trend in the results that include all. There is a statistically significant trend in the results that exclude ‘no position’, but this trend disappears if the 1996 Bray and von Storch estimate is omitted. See figure A1 in the appendix.

The problem may lie in the methodology of Cook et al (2013)—although earlier papers are not above criticism either (Peiser 2005, Duarte 2014). Reusswig (2013) praises Cook et al but Legates et al (2015) and Tol (2014a) question its data and methodology (Bedford and Cook 2013, Cook et al 2014a, Tol 2014b). Dean (2015) notes that the paper omits inter-rater reliability tests. Cook and Cowtan (2015) add these. These methodological exchanges omit the following five points:

1. Cook et al (2013) do not show tests for systematic differences between raters. Abstract rater IDs may or may not be confidential (Queensland 2012, 2014),

Figure 1. Estimates of the consensus on anthropogenic global warming according to Cook et al and other studies (Bray, Oreskes, Doran, Anderegg, Stenhouse, Verheggen) as a function of the sample size; the top panel excludes don’t know/no position, the bottom panel includes don’t know/no position.
but the authors could have reported test results without revealing identities.

2. The paper argues that the raters were independent. Yet, the raters were drawn from the same group. Cook et al. (2013) are unfortunately silent on the procedures that were put in place to prevent communication between raters.

3. The paper states that ‘information such as author names and affiliations, journal and publishing date were hidden’ from the abstract raters. Yet, such information can easily be looked up. Unfortunately, Cook et al. (2013) omit the steps taken to prevent raters from gathering additional information, and for disqualifying ratings based on such information.

4. Cook et al. (2013) state that 12,465 abstracts were downloaded from the Web of Science, yet their supporting data show that there were 12,876 abstracts. A later query returned 13,458, only 27 of which were added after Cook ran his query (Tol 2014a). The paper is silent on these discrepancies.

5. The date stamps, which may or may not have been collected (Cook 2013, Cook et al. 2014b), reveal that the abstracts were originally rated in two disjoint periods (mid-February to mid-April; second half of May). There was a third period of data collection, in which neutral abstracts were reclassified.

Unfortunately, Cook et al. (2013) do not make clear what steps were taken to ensure that those who rated abstracts in the second and third periods did not have access to the results of the first and second periods.

It would be of considerable benefit to readers if these issues would be clarified, if at all possible. That would help to convince people that the results of Cook et al. are not just different but better than those in other studies.

Cook et al. (2013) renewed interest in the question how to communicate (climate) science. While several studies show that people respond to cues about the scientific consensus (Guy et al. 2014, Myers et al. 2015, Van der Linden 2015, van der Linden et al. 2014, 2015), other studies show that this effect is dominated in the long run by other factors (Bliuc et al. 2015, Campbell and Kay 2014, Kahan 2015).

Acknowledgments

Oliver Bothe, Collin Maessen, Ken Rice, Bart Verheggen and two anonymous referees had excellent comments on a previous version of the paper.

Appendix A.

![Figure A1. Estimated consensus rates, with and without the ‘no position’ results, as a function of the time of research.](image_url)
Table A1. Details of consensus estimates: lead author, year of publication, year of research, sample size, method, estimated consensus rate, object of study.

| Study                              | Year | N   | rate | N   | rate | method                      | object                   |
|-----------------------------------|------|-----|------|-----|------|------------------------------|--------------------------|
| (Bray and von Storch 2007)        | 1996 | 539 | 40.4%| 464 | 46.5%| survey                      | climate scientists       |
|                                   | 2003 | 530 | 53.0%| 461 | 60.9%| survey                      | climate scientists       |
| (Oreskes 2004)                    | 2004 | 928 | 75.0%| 696 | 100.0%| other-rated abstracts       | number of papers         |
| (Milloy 2007)                     | 2007 | 54  | 83.0%| 54  | 83.0%| survey                      | IPCC scientists; more CO₂ implies warming |
|                                   | 2007 | 54  | 90.0%| 54  | 90.0%| survey                      | IPCC scientists; less CO₂ implies cooling |
| (Bray and von Storch 2010)        | 2008 | 370 | 83.5%| 350 | 88.3%| survey                      | climate scientists       |
| (Doran and Zimmerman 2009)       | 2008 | 3146| 82.0%| 2800| 92.1%| survey                      | earth scientists          |
|                                   | 2008 | 2833| 83.8%| 2524| 94.1%| survey                      | USA                      |
|                                   | 2008 | 313 | 80.4%| 277 | 90.7%| survey                      | international            |
|                                   | 2008 | 244 | 90.4%| 235 | 93.8%| survey                      | active                   |
|                                   | 2008 | 2902| 82.8%| 2737| 87.8%| survey                      | non-active                |
|                                   | 2008 | 1749| 88.6%| 1690| 91.7%| survey                      | publishing               |
|                                   | 2008 | 103 | 47.0%| 74  | 65.3%| survey                      | economic geologists       |
|                                   | 2008 | 77  | 97.4%| 79  | 94.5%| survey                      | climate scientists       |
|                                   | 2008 | 47  | 64.0%| 42  | 71.9%| survey                      | meteorologists            |
| (Anderegg et al 2010)            | 2009 | 1372| 65.6%| 1369| 65.7%| public statements            | all                      |
|                                   | 2009 | 908 | 89.8%| 906 | 90.0%| public statements            | 20+ climate papers       |
|                                   | 2009 | 200 | 97.5%| 200 | 97.5%| public statements            | most publications        |
|                                   | 2009 | 100 | 97.0%| 100 | 97.0%| public statements            | most publications        |
|                                   | 2009 | 50  | 98.0%| 50  | 98.0%| public statements            | most publications        |
| (Cook et al 2013)                | 2012 | 11 944| 32.6%| 4014| 97.1%| other-rated abstracts       | number of papers         |
|                                   | 2012 | 29 286| 34.8%| 10 356| 98.4%| other-rated abstracts       | number of authors        |
|                                   | 2012 | 2142| 62.7%| 1381| 97.2%| self-rated papers           | number of papers         |
|                                   | 2012 | 1189| 62.7%| 774 | 96.4%| self-rated papers           | number of authors        |
| (Stenhouse et al 2013)           | 2012 | 124 | 78.0%| 122 | 79.6%| survey                      | climate scientists, climate focus |
|                                   | 2012 | 82  | 71.0%| 81  | 71.7%| survey                      | climate scientists, other focus |
|                                   | 2012 | 26  | 38.0%| 26  | 38.0%| survey                      | climate scientists, not publishing |
|                                   | 2012 | 232 | 71.0%| 229 | 72.1%| survey                      | climate scientists       |
|                                   | 2012 | 61  | 61.0%| 61  | 61.0%| survey                      | meteorologists, climate focus |
|                                   | 2012 | 501 | 57.0%| 496 | 57.6%| survey                      | meteorologists, other focus |
|                                   | 2012 | 641 | 35.0%| 635 | 35.4%| survey                      | meteorologists            |
|                                   | 2012 | 1203| 45.5%| 1192| 45.9%| survey                      | meteorologists            |
|                                   | 2012 | 231 | 73.0%| 229 | 73.7%| survey                      | climate focus             |
|                                   | 2012 | 790 | 62.0%| 782 | 62.6%| survey                      | other focus               |
| Study                  | Year | N    | rate  | N    | rate  | method    | object                                                                 |
|-----------------------|------|------|-------|------|-------|-----------|------------------------------------------------------------------------|
| (Verheggen et al 2014)| 2012 | 800  | 37.0% | 792  | 37.4% | survey    | not publishing                                                         |
|                       | 2012 | 1821 | 52.0% | 1803 | 52.5% | survey    | all                                                                    |
|                       | 2012 | 1868 | 66.0% | 1461 | 84.0% | survey    | all                                                                    |
|                       | 2012 | 388  | 57.0% | 278  | 79.0% | survey    | 3 climate papers                                                       |
|                       | 2012 | 480  | 69.0% | 396  | 84.0% | survey    | 4–10 climate papers                                                    |
|                       | 2012 | 373  | 71.0% | 304  | 87.0% | survey    | 11–30 climate papers                                                   |
|                       | 2012 | 379  | 77.0% | 319  | 91.0% | survey    | 32–300 climate papers                                                  |
|                       | 2012 | 174  | 79.0% | 142  | 97.0% | survey    | IPCC AR4 WG1 authors                                                   |
|                       | 2012 | 1118 | 70.0% | 914  | 85.0% | survey    | IPCC WG1                                                              |
|                       | 2012 | 534  | 71.0% | 438  | 87.0% | survey    | IPCC WG2                                                              |
|                       | 2012 | 120  | 74.0% | 94   | 95.0% | survey    | IPCC WG3                                                              |
|                       | 2012 | 175  | 74.0% | 146  | 88.0% | survey    | focus on attribution, aerosols, clouds                                 |
|                       | 2012 | 88   | 7.0%  | 50   | 12.0% | survey    | unconfined of anthropogenic climate change                             |
|                       | 2012 | 1780 | 69.0% | 1411 | 87.0% | survey    | convinced of anthropogenic climate change                              |
| (Carlton et al 2015)  | 2014 | 698  | 90.4% | 673  | 93.7% | survey    | biophysicists; human activity caused warming                           |
|                       | 2014 | 698  | 95.5% | 675  | 98.7% | survey    | biophysicists; more CO₂ implies warming                                |
|                       | 2014 | 698  | 88.7% | 653  | 94.9% | survey    | biophysicists; CO₂ affects climate                                    |
|                       | 2014 | 698  | 71.3% | 558  | 89.2% | Survey    | biophysicists; sun has not caused warming                              |
References

Anderegg W R L, Prall J W, Harold J and Schneider S H 2010 Expert credibility in climate change Proc. Natl. Acad. Sci. USA 107 12107–9

Bedford D and Cook J 2013 Agnotology, scientific consensus, and the teaching and learning of climate change: a response to Legates, Soon and Briggs Sci. Educ. 22 2019–30

Blisc A M, McGarty C, Thomas E F, Lala G, Berndsen M and Misajon R 2015 Public division about climate change rooted in conflicting socio-political identities Nat. Clim. Change 5 226–9

Bray D and von Storch H 2007 The Perspectives of Climate Scientists on Global Climate Change vol 2007/11 (Geethacht: GKSS) pp 1–132

Bray D and von Storch H 2010 CliSci2008: A Survey of the Perspectives of Climate Scientists Concerning Climate Science and Climate Change vol 2010/9 (Geethacht: GKSS) pp 1–124

Campbell T H and Kay A C 2014 Solution aversion: on the relation between ideology and motivated disbelief J. Personality Social Psychol. 107 809–24

Carlton J S, Perry-Hill R, Huber M and Prokopy L S 2015 The Campbell T H and Kay A C 2014 Solution aversion: on the relation between ideology and motivated disbelief J. Personality Social Psychol. 107 809–24

Cook J 2013 Query re request for Cook et al data: University of Queensland, personal communication (www.sussex.ac.uk/Users/rt220/Cook31July.png)

Cook J and Cowtan K 2015 Reply to Comment on ‘Quantifying the consensus on anthropogenic global warming in the scientific literature’ Environ. Res. Lett. 10 039002

Cook J, Nuccitelli D, Green S A, Richardson M, Winkler B, Painting R, Way R, Jacobs P and Skuce A 2013 Quantifying the consensus on anthropogenic global warming in the scientific literature Environ. Res. Lett. 8 024024

Cook J, Nuccitelli D, Skuce A, Jacobs P, Painting R, Honeycutt R, Green S A, Lewandowsky S, Richardson M and Way R G 2014a Reply to ‘Quantifying the consensus on anthropogenic global warming in the scientific literature: a re-analysis’ Energy Policy 73 706–8

Cook J, Nuccitelli D, Skuce A, Way R, Jacobs P, Painting R, Honeycutt R, Green S A, Lewandowsky S and Coulter A 2014b 24 Critical Errors in Tol (2014) — Reaffirming the 97% Consensus on Anthropogenic Global Warming (Brisbane: SkepticalScience, University of Queensland)

Dean B J F 2015 Comment on ‘Quantifying the consensus on anthropogenic global warming in the scientific literature’ Environ. Res. Lett. 10 039001

Doran P T and Zimmerman M K 2009 Examining the scientific consensus on climate change Env. 90 22–3

Duarte I L 2014 Comment on ‘scientists’ views about attribution of global warming’ Environ. Sci. Technol. 48 14057–8

Guy S, Kashima Y, Walker I and O’Neill S 2014 Investigating the effects of knowledge and ideology on climate change beliefs Eur. J. Social Psychol. 44 421–9

Kahan D M 2015 Climate-science communication and the measurement problem Political Psychology 36 1–43

Legates D R, Soon W, Briggs W M and Monckton of Brenchley C 2015 Climate consensus and ‘misinformation’: a rejoinder to agnotology, scientific consensus, and the teaching and learning of climate change Sci. Educ. 24 299–318

Milloy S 2007 Global Warming’s Sensible Consensus Canada Free Press (http://canadafreepress.com/article/723)

Myers T A, Maibach E, Peters E and Leiserowitz A 2015 Simple messages help set the record straight about scientific agreement on human-caused climate change: the results of two experiments PloS ONE 10 e0133103

Oreskes N 2004 Beyond the ivory tower: the scientific consensus on climate change Science 306 1686

Peiser B 2005 The letter science magazine rejected Energy and Environment 16 685–7

Queensland U o 2012 Institutional Approval Form for Experiments on Humans Including Behavioural Research ed University of Queensland vol 201200639, personal communication (www.climataudit.info/correspondence/foi/queensland/cook%20consensus%20Documents%20released%20under%20RTI.pdf)

Queensland U o 2014 UQ and climate change research Press release (www.uq.edu.au/news/article/2014/05/uq-and-climate-change-research)

Reusswig F 2013 History and future of the scientific consensus on anthropogenic global warming Environ. Res. Lett. 8 031003

Stenhouse N, Maibach E, Cobb S, Ban R, Bleistein A, Croft P, Bierly E, Seitter K, Rasmussen G and Leiserowitz A 2013 Meteorologists’ views about global warming: a survey of american meteorological society professional members Bull. Am. Meteorol. Soc. 95 1029–40

Tol R S J 2014a Quantifying the consensus on anthropogenic global warming in the literature: a re-analysis Energy Policy 73 701–5

Tol R S J 2014b Quantifying the consensus on anthropogenic global warming in the literature: rejoinder Energy Policy 73 709

van der Linden S 2015 The conspiracy-effect; exposure to conspiracy theories (about global warming) decreases pro-social behavior and science acceptance Personality and Individual Differences 87 171–3

van der Linden S L, Leiserowitz A A, Feinberg G D and Maibach E W 2014 How to communicate the scientific consensus on climate change: plain facts, pie charts or metaphors? Clim. Change 126 255–62

van der Linden S L, Leiserowitz A A, Feinberg G D and Maibach E W 2015 The scientific consensus on climate change as a gateway belief: experimental evidence PloS ONE 10 e0118489

Verheggen B, Strengers B, Cook J, Van Dorland R, Vringer K, Peters J, Visscher B and Meyer L 2014 Scientists’ views about attribution of global warming Environ. Sci. Technol. 48 8963–71