

## Is there agreement amongst climate scientists on the IPCC AR4 WG1?

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**ABSTRACT.** An online poll of scientists' opinions shows that, while there is strong agreement on the important role of anthropogenically-caused radiative forcing of CO<sub>2</sub> in climate change and with the largest group supporting the IPCC report, there is not a universal agreement among climate scientists about climate science as represented in the IPCC's WG1. The claim that the human input of CO<sub>2</sub> is not an important climate forcing is found to be false in our survey. However, there remains substantial disagreement about the magnitude of its impacts. The IPCC WG1 perspective is the mean response, though there are interesting differences between mean responses in the USA and in the EU. There are, also, a significant number of climate scientists who disagree with the IPCC WG1 perspective.

The issue of whether scientists agree about the causes of climate change has persisted in discussions of climate science in general and in the development of policy to respond to the threats implied by climate variability and change. We have undertaken a poll of scientists' opinions in which authors of climate papers in the journals: *Geophysical Research Letters* (2007), *Atmospheric Chemistry and Physics* (2007), *Climate of the Past* (2007), *the Journal of Atmospheric Science* (2007) and *the Journal of Climate* (2007), and authors of presentations (oral and poster) in the 2007 AGU and 2007 EGU General Assemblies, as provided in online schedules for these events, were invited to express their opinion. While this polling does not follow the randomized selection of individuals to poll as used to completely sample a population (see, for example: The American Association for Public Opinion Research, guidelines for research) it is a valid approach to assess whether a significant set of climate scientists agree or disagree with the perspective of the role of humans within the climate system as reported by the 2007 Intergovernmental Panel on Climate Change's (IPCC) Fourth Assessment Report (AR4), as represented by the content of the Working Group 1 (WG1) report.

However, as there is no currently available information on the complete community of 'climate scientists', the poll cannot be tested for statistical significance. In the absence of such information, the methodology adopted was the only practicable means of attempting such a poll. It should be recognised, however, that the methodology is not strictly statistically formal and the results should be viewed accordingly.

The initial results of the poll are presented below, with an invitation to climate scientists to participate online if they have not already responded. This follow-up response will permit a further examination of the findings of the poll.

In our poll, there were 140 responses out of the 1807 who were contacted by the first author. The authors participated along with poll specialist David Jepson (Bsc Hons) in writing the polling questions (see Table 1 for the questions), but had no knowledge of who participated in the polling. It is interesting to note, however, that among the respondents were a substantial number of senior scientists and leading figures in climate science, whose support and interest in the poll were much appreciated. It is important to recognize that we are not presenting the results as representing anything other than the views of those who responded as we have no way to assess the relationship of the responders with the total relevant population.

The results are quite informative. No scientists were willing to admit to the statement that global

warming is a fabrication and that human activity is not having any significant effect on climate [0%]. In total, 18% responded that the IPCC AR4 WG1 Report probably overstates the role of CO<sub>2</sub>, or exaggerates the risks implied by focusing on CO<sub>2</sub>-dominated Anthropogenic Global Warming (AGW), to a greater or lesser degree. A further 17% expressed the opinion that the Report probably underestimates or seriously underestimates the consequences of anthropogenic CO<sub>2</sub>-induced AGW and that the associated risks are more severe than is implied in the report. The remaining 65% expressed some degree of concurrence with the report's science basis, of which the largest group [47% of all respondents] selected option 5. The exact response rates are given in Figure 1.

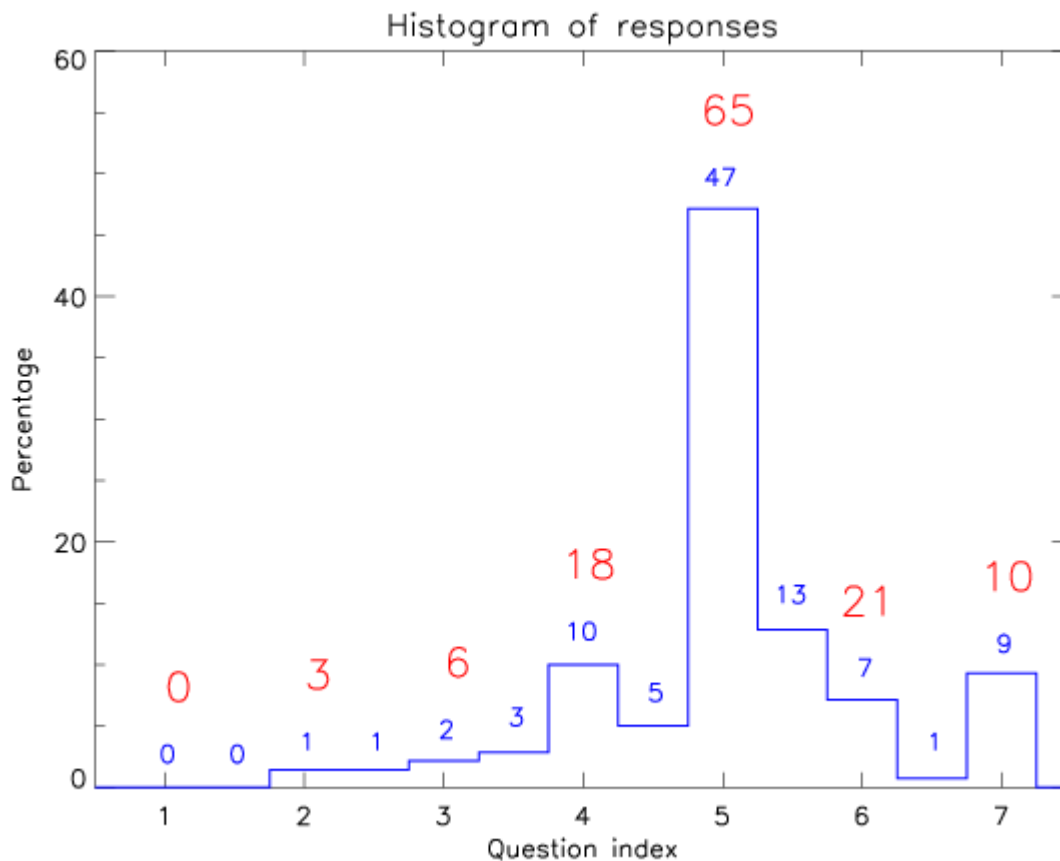


Figure 1: Response rates to opinion poll.

The questions used in the opinion poll are listed below in Table 1. The methodology is described in the online supplement.

From the initial response, we conclude that:

1. The largest group of respondents (45-50%) concur with the IPCC perspective as given in the 2007 Report.
2. A significant minority (15-20%), however, conclude that the IPCC understated the seriousness of the threat from human additions of CO<sub>2</sub>.
3. A significant minority (15-20%), in contrast, conclude that the IPCC overstated the role of human additions of CO<sub>2</sub> relative to other climate forcings.

4. Almost all respondents (at least 97%) conclude that the human addition of CO<sub>2</sub> into the atmosphere is an important component of the climate system and has contributed to some extent in recent observed global average warming.

In addition, responses were broken down by country of response. By applying a numerical value to the responses it is possible to see interesting differences between opinions within the USA and outside, in particular in EU countries. The mean score was 5.0, (where 5.0 means agreement with the IPCC WG Report). In the USA, the mean response was 4.8, compared to 5.2 in all other countries, and 5.6 in EU countries. The scientists based in the USA who replied to the survey are slightly more in disagreement with the Report than scientists outside, and scientists based in the EU (with particularly strong signals [5.9] from a small sample coming from Germany), tend to be more 'alarmed' than in other countries. Another small response, from Mexico, showed anomalously large concern, scoring 6.3).

In conclusion, there is strong agreement on the important role of radiative forcing due to human additions of CO<sub>2</sub> on AGW. However, the relative role of this forcing, in comparison to other human climate forcings, is still an open scientific question. Thus, those who claim that the radiative effect of human added CO<sub>2</sub> is unimportant are not supported in our poll of climate scientists. However, a significant minority of 15-20% take the view that the IPCC does exaggerate the relative role of this forcing.

An important inference from these conclusions is that there continues to be an important debate about the correct attribution of forcings which should be clearly expressed as an area of uncertainty to policy makers in the relevant scientific summaries, and that there remains a strong case for continued investment and investigation into this area of climate research.

As a follow on to this preliminary polling, scientists engaged in disciplines related to climate in all its variety are invited to respond to the first author, in confidence, to aid in verification of the findings and development of the analysis as presented here, as well as to provide further insight into the degree of acceptance of the IPCC WG1 Report. The respondent should e-mail their numerical category in Table 1, the country that they are from, their scientific discipline and their highest academic degree and discipline, as well as their role, if any, in the preparation of the 2007 IPCC Report to [fwmb@btinternet.com](mailto:fwmb@btinternet.com). It is hoped that a future article will be able to discern between differing attitudes by scientific discipline as well as by country, as well as have a larger sample of the professional community.

### **Table 1**

These were the options and the questions as presented in the opinion poll:

Which one statement most nearly matches your personal opinion about the physical science basis of global warming, as exemplified by the IPCC WG1 report?

\* [If your personal opinion falls between two adjacent statements, please mark **both**]

1. There is no warming; it is a fabrication based on inaccurate/inappropriate measurement. Human activity is not having any significant effect on Climate. The data on which such assumptions are made is so compromised as to be worthless. The physical science basis of AGW theory is founded on a false hypothesis.
2. Any recent warming is most likely natural. Human input of CO<sub>2</sub> has very little to do with it. Solar, naturally varying water vapour and similar variables can explain most or all of the climate changes. Projections based on Global Climate Models are unreliable because these are based on too

many assumptions and unreliable datasets.

3. There are changes in the atmosphere, including added CO<sub>2</sub> from human activities, but significant climate effects are likely to be all within natural limits. The 'scares' are exaggerations with a political motive. The undue emphasis on CO<sub>2</sub> diverts attention away from other, important research on climate variability and change.

4. There is warming and the human addition of CO<sub>2</sub> causes some of it, but the science is too uncertain to be confident about current attributions of the precise role of CO<sub>2</sub> with respect to other climate forcings. The IPCC WG1 overestimates the role of CO<sub>2</sub> relative to other forcings, including a diverse variety of human climate forcings.

5. The scientific basis for human impacts on climate is well represented by the IPCC WG1 report. The lead scientists know what they are doing. We are warming the planet, with CO<sub>2</sub> as the main culprit. At least some of the forecast consequences of this change are based on robust evidence.

6. The IPCC WG1 is compromised by political intervention; I agree with those scientists who say that the IPCC WG1 is underestimating the problem. Action to reduce human emissions of CO<sub>2</sub> in order to mitigate against serious consequences is more urgent than the report suggests. This should be done irrespective of other climate and environmental considerations.

7. The IPCC WG1 seriously understates the human influence on climate. I agree with those scientists who say that major mitigation responses are needed immediately to prevent catastrophic serious warming and other impacts projected to result from human emissions of CO<sub>2</sub>. We are seriously damaging the Earth's climate, and will continue to face devastating consequences for many years.

## Methods

A simple, single question opinion poll was carefully constructed to test scientific opinion. From the outset, this was designed to be conducted via email, so the format and wording were designed with this in mind. Under the supervision of Roger Pielke Sr., and with the assistance of James Annan and David Jepson, the wording and construction of the poll was constructed so as to address the specialist nature of the sample community and minimise the possibility of wording or construction bias.

1807 emails were sent to scientists, in 53 countries, with specialisations in fields of science directly related to a study of climate, selected from sources which were judged to be representative of the climate science community, in the context of the wider scientific community. To this end, and to provide the greatest opportunity for international coverage of the sample community, the following journals were selected: *Geophysical Research Letters*, *Atmospheric Chemistry and Physics*, *Climate of the Past*, the *Journal of Atmospheric Science* and the *Journal of Climate*. Author lists and article lists from 2007 only were initially used, as representing those scientists most likely to be currently active in their respective fields. Additional emails were sent to members of the editorial boards of the *Atmospheric Sciences* section of the *Journal of Geosciences of China*, but an apparent server malfunction prevented any replies from this source. In an effort to make the international cross-section more representative, in particular the Asia-Pacific region, and to improve the proportion of statisticians involved in the field, emails were also sent to participants in the forthcoming 10<sup>th</sup> *International Meeting on Statistical Climatology* (Beijing, August 2007).

In the case of the journals, in each case the abstract and reference terms were checked individually to confirm that the authors were involved in work relating to climate science. In cases where the published article was not related to climate science, (for example, in the case of *GRL*, articles on planetary physics or geology), no email was sent. Each email was sent individually, to prevent duplication and reduce the possibility of sample error.

Email addresses were also collated from the session information of the 2007 AGU Joint Assembly and the 4<sup>th</sup> EGU General Assembly, 2007, from four sections: *Atmospheric Sciences*, *Global Climate Change*, *Ocean Sciences* (selectively) and *Palaeoceanography and palaeoclimatology* (for the EGU, this was *Climates past, present and future* ). Once again, entries were cross-checked for relevance before a

request was sent. Selecting potential respondents from the second and third authors of papers and posters in these assemblies allowed for a larger range of participation from less senior scientists and those active in roles such as research assistant and research fellow, thereby broadening the range of job roles and seniority in the sample.

140 replies were received from respondents in 23 countries. As agreed in the terms of response, these responses were classified only in terms of the country of origin, as defined by the institution cited by the scientist and the email address suffix. A process of cross-validation of suitability of respondent involved an anonymous online reference check for each respondent, where this was possible.

### **Sampling Issue**

It is important to recognize that we are not presenting the results as representing anything other than the views of those who responded as we have no way to assess the relationship of the responders with the total relevant population. We view this article as the preliminary analysis of the active climate research community, a motivation for a more rigorous statistical polling, and a focused set of questions for the climate community to discuss.

On the coverage and responses, there are large discrepancies between the numbers of responses from various countries. The lack of response from China, along with the number of 'message failure' automated response, suggest that few, if any, of the scientists in that country received the email. This is interpreted as a function of a server error or malfunction. The relatively large responses from the United States and the United Kingdom are, at least in part, a function of the language in which the poll was constructed (although almost all climate change research is in English); no translations were made; all enquiries were in English. It should also be noted, though, that the Global community of scientists involved in climate related disciplines is heavily skewed, with a large proportion of the work taking place in US and EU academic and state institutions. Therefore, though the language bias is likely to have suppressed the level of response from countries where English is not the common language, the international range and proportion of responses is interpretable as broadly representative of the community as a whole. One consequence of the diverse and relatively low response rate from countries other than the USA and, to a lesser extent, the UK, however, is that no statistically meaningful international comparisons can be made at this time, though a comparison of scientific opinion from those who

responded within the USA and in 'other countries' collectively is possible.

### **The 'scientific' opinion poll**

The poll conducted amongst scientists was designed to replicate the range of 'attitudes' to what is commonly referred to as the 'AGW hypothesis'. This took three parts: an opinion on the degree of recent and/or future climate impacts; an opinion on the reliability of the IPCC AR4 WG1 science; and an opinion on the relative role of CO<sub>2</sub> as a climate forcing. Each of the seven options for the poll offered 'matched' statements which, collectively, can be interpreted as a generic 'opinion' on the scientific basis for the 'AGW hypothesis'. In addition to the seven principle statements, respondents were also given the option to select an 'interim' stance, which represented a compromise between any two adjacent statements or 'attitudes'. The poll was designed such that the lower numbered options represented varying degrees of disagreement, or uncertainty, below the thresholds outlined in the IPCC AR4 WG1. Statement 5 was the 'pure agreement' position, which represented a strong agreement with the scientific basis of the AR4 WG1 and little or no uncertainty. The higher numbered options represented opinions that conclude that the AR4 WG1 is too conservative in reporting on the changes humans are causing to the climate system through the radiative forcing of CO<sub>2</sub>.

The design of the poll thus allows for a graphic representation of responses which indicates the full range of opinions in a distribution curve. The poll design was skewed slightly to compensate for likely bias, by allowing more responses for doubt on the 'conservative' side than the opposite; therefore, it is to be expected that a normal distribution which reflected a broad consensus on the WG1 science would be centred around option 5, rather than the central option, thereby shifting the curve to the right of the graph.

A strength of the poll was that the three-part statements allowed for more respondents to find a statement which matched their personal understanding or opinion. A weakness is that the responses do not distinguish between the three elements of the statements, so no inference can be made about agreement with any one part of the statements. This is further discussed in the conclusions.

The seven 'attitudes' can be characterised broadly as:

1. No warming, no scientific basis for AGW hypothesis;
2. Some warming, probably natural, role of CO<sub>2</sub> small, climate model projections unreliable;
3. Some warming, probably within natural variability, impacts exaggerated;
4. Warming; CO<sub>2</sub> contributes; WG1 overestimates role of CO<sub>2</sub>, underestimates other forcings;
5. WG1 an accurate assessment of human impacts, at least some robust consequences;
6. WG1 too 'conservative', problems more urgent, need for mitigation urgent;
7. WG1 assessment seriously underestimates problem, immediate mitigation action needed.

Several responses by participants provided interesting additional information about the interpretation of the questions. One respondent suggested that he/she could have truthfully answered with any of four statement choices. Two respondents could find no statement which matched their personal opinion. Six respondents qualified their selection of option 5 with an additional statement that they also were inclined to agree with elements of option 7; these were recorded as selecting only option 5, as the additional information was discounted by the structure of the poll's options. This latter response might imply, though, that the number of scientists who selected the 'consensus' option may have reduced the possible number of those who were unwilling to admit to an 'alarmed' position.

The authors would like to express their gratitude to all those busy individuals who took the effort to participate in this poll and were willing to place their trust in the first author, and to the useful suggestions and replies received in addition by respondents.

**Text of cover letter sent by email to scientists by the first author between April-June 2007, with the poll questionnaire.**

Dear Professor/Dr.,

**Why am I contacting you?**

I am contacting you to ask if you will participate in a simple opinion poll on the subject of Global Warming. The information provided is to be used for publication purposes in the form of anonymous data. I have extracted names from author and editor lists of six journals. These have been reduced to those active in the field of climate science or a closely related field. If you believe I have contacted you in error, please excuse my mistake and ignore this request.

**Who am I?**

I am an unaffiliated student of climate science and climate change issues. I contribute as a 'poster' to several climate science and related websites and weblogs, including *RealClimate*, *Climate Science*, *Prometheus*, and *Climate Audit*, for example. I also contribute to the individual weblogs of William Connolley, James Annan, Coby Beck, Michael Tobis, and Eli Rabett. I now also work my own weblog. Several of the above-named individuals have already agreed to participate in this research, which is being overseen by a professor active in the field.



**What am I asking of you?**

Your participation in an opinion poll, which involves only replying to this request with one answer from seven options. A prompt and intuitive response would be most valuable; this is most likely to reflect your 'gut feeling' on the subject. I am asking you to cooperate so I can produce a robust result from a sufficiently sizeable sample. If you choose to respond, your reply will be recorded on a password protected offline file and your email deleted from my files. In a separate offline file I will note the names of respondents without reference to the responses.

**What is the purpose of this research?**

The principal aim is to test the hypothesis that there is a divergence between public opinion and scientific opinion on the subject of Global Warming. Secondary aims include; establishing by proper method whether there is a scientific consensus on the subject, whether there is a public consensus, and whether any inferences can be made about the influence of the mass media on public opinion and, thereby, policy decisions. It is intended to publish the findings of this research.

**What information will I share?**

The only information to be published will consist of breakdowns of responses and products of these. No other data will be used except to identify the sources of the database/sample. No names other than those of myself and any co-authors will be revealed in any published form.

When the survey is complete, the names of all respondents will be deleted from files, to protect privacy; though this means the results cannot be precisely replicated, it should protect all participants from the need to justify their privately-held opinions.

With my sincere thanks for your time and in anticipation of your help in supporting this research, I am,

Yours sincerely,

Fergus Brown.