

# Quantifying the consensus on anthropogenic global warming in the scientific literature

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## Abstract

We analyse the scientific consensus on anthropogenic global warming (AGW) in the peer-reviewed scientific literature, examining 11,944 climate abstracts from 1991 through 2011. Two-thirds of abstracts express no position on AGW, while 32.6% endorse AGW and 0.7% reject AGW. Among abstracts expressing a position on AGW, 98.2% endorse the consensus. We also invited authors to rate their own papers. Compared to abstract ratings, a larger percentage of self-rated papers endorsed (62%) and rejected (2%) AGW, indicating that most papers that don't express a position on AGW in the abstract do so in the full paper. Among self-rated papers expressing a position on AGW, 95.2% endorse the consensus. Rejection papers are a vanishingly small proportion of the published research.

## Introduction

An accurate perception of the scientific consensus is essential to public support for climate policy <sup>1</sup>. Communicating the scientific consensus increases people's belief that climate change is happening <sup>2</sup>.

However, the public perception is that scientists still disagree about global warming. Surveys in 2012 found 57% of Americans disagreed with or were unaware that most scientists agree global warming is happening <sup>3</sup> and 57% either disagreed or were unaware that scientists agree the earth is warming due to human activity <sup>4</sup>.

Recently, the volume of climate research has increased exponentially, with annual publications doubling from 2005 to 2009 <sup>5</sup>. Given the importance of scientific consensus, our study analyses climate papers from 1991 to 2011 to determine the level of consensus in published research.

## Methodology

This paper was conceived as a "citizen science" project by contributors to the Skeptical Science website. We analysed 12,465 abstracts from the ISI Web of Science database, matching the topics "global warming" or "global climate change" over the period 1991 through 2011 <sup>6</sup>. Each abstract was classified according to the type of research (category) and degree of endorsement of AGW (e.g., explicit & implicit endorsement, explicit & implicit rejection and no expressed position). Papers were categorized based on title and abstract only. Non-peer-reviewed papers, non-climate-related papers and papers with no abstract were eliminated.

Each abstract was categorised separately by at least two independent raters. To resolve cases where raters disagreed, a third rater examined each abstract where the initial two raters disagreed and made a final determination.

To complement the abstract analysis, 8,547 authors were emailed an invitation to participate in a survey in which they categorised their own published papers.

## Results

Eliminating papers that were not peer-reviewed, not climate-related or without an abstract reduced the analysis to 11,944 papers with 3,896 abstracts (32.6%) explicitly or implicitly endorsing AGW, 78 abstracts (0.7%) rejecting AGW, and 7,970 (66.7%) expressing no position on AGW. Among abstracts expressing a position on AGW, 98.2% endorse the consensus.

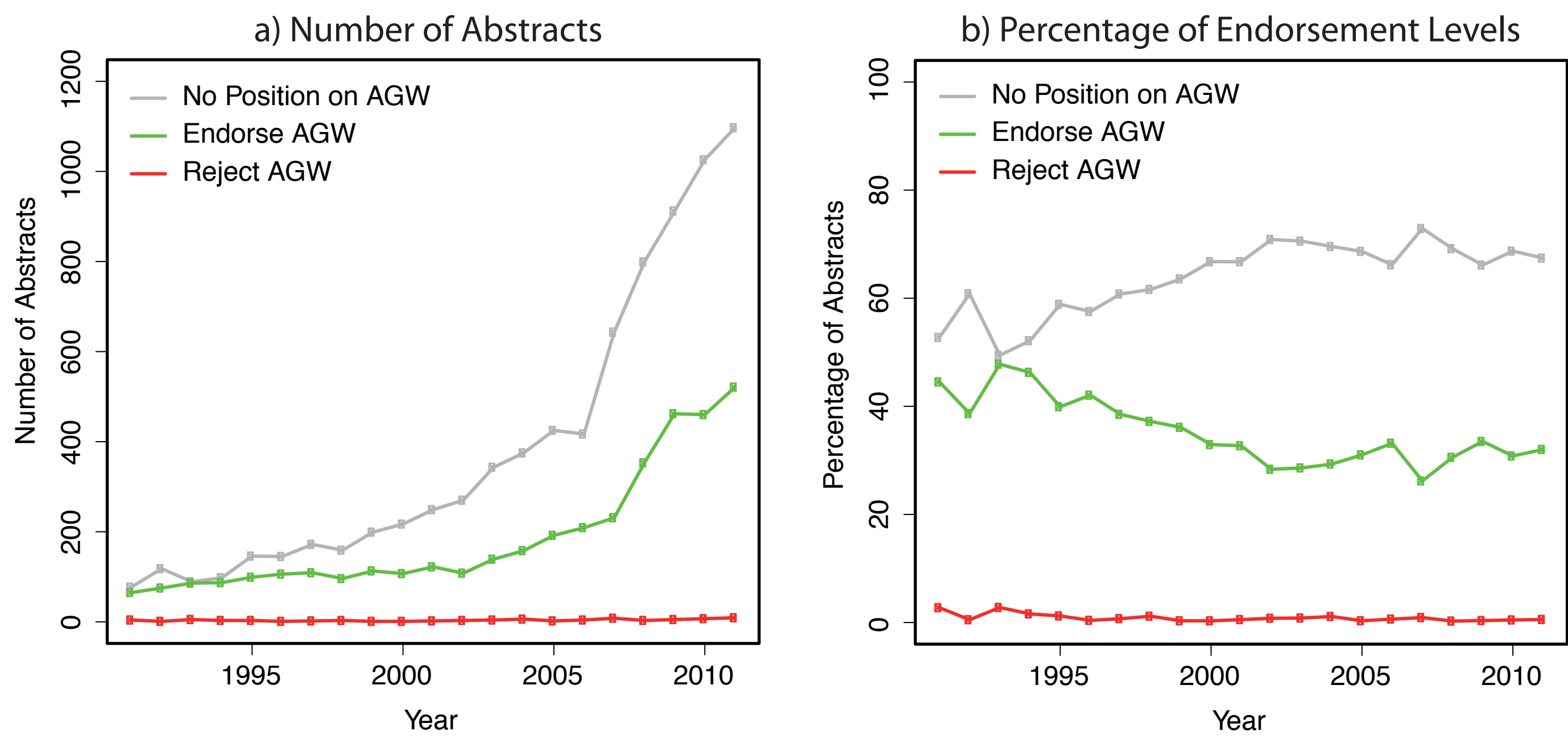
Invitations to rate their own papers were emailed to 8,547 authors, with 1,200 responses and 2,143 papers receiving self-ratings. The majority of self-rated papers endorsed AGW (62% or 1,323 papers) while 781 papers (36%) expressed no position on AGW. The number of self-rated rejections was 39 (2%). Among papers stating a position on AGW, 95.2% endorsed the consensus.

56% of abstracts expressing no position on AGW were self-rated as endorsing AGW by the paper's authors. This indicates abstracts are more likely to express no position on AGW while full papers are more likely to endorse AGW. The percentage of AGW endorsements for both self-rating and abstract-rated papers marginally increase over time ( $0.1 \pm 0.09\%$  per year for abstracts,  $0.35 \pm 0.26\%$  per year for self-ratings), with both series approaching 98% in 2011.

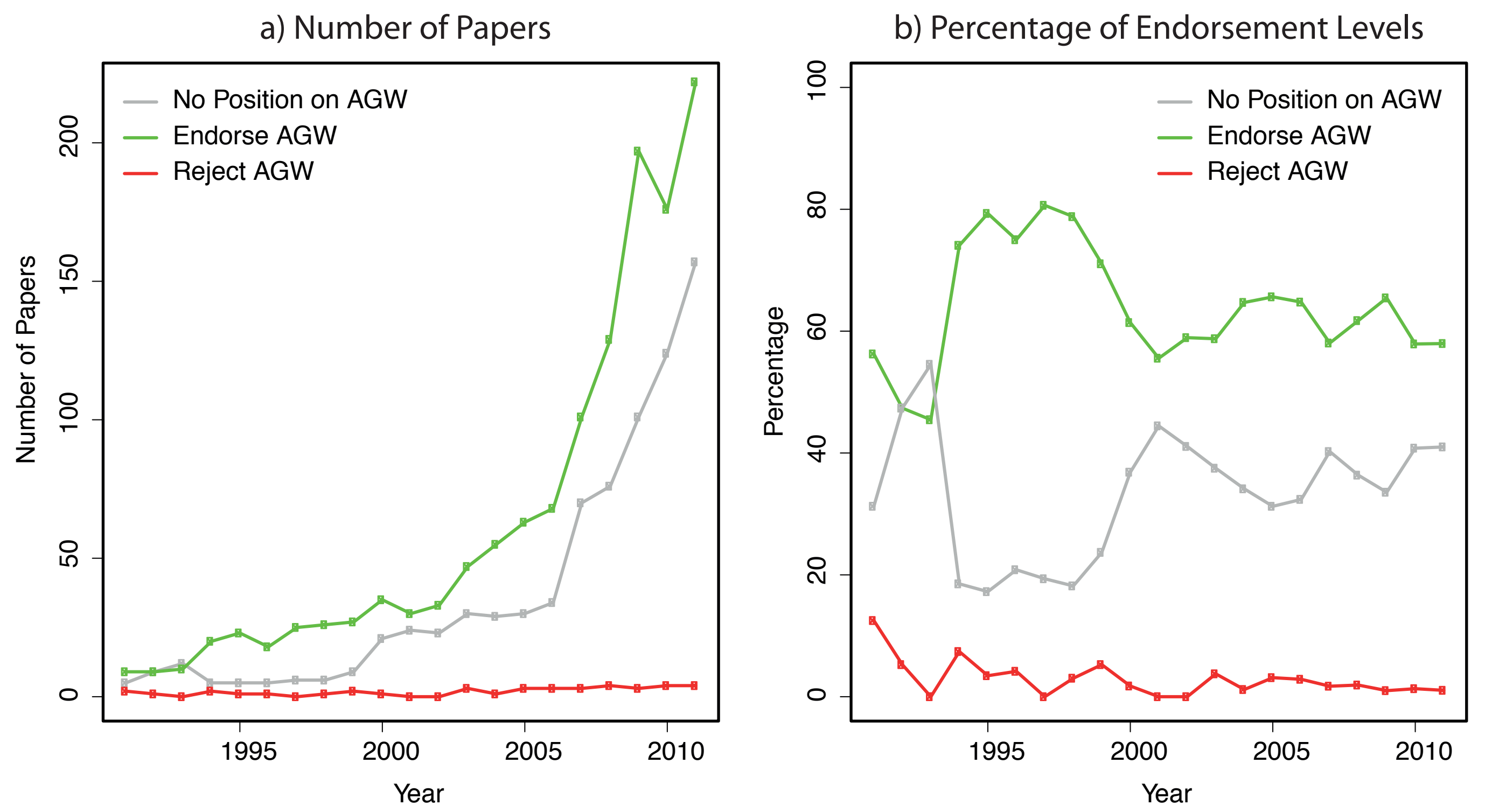
## Conclusion

This study demonstrates that analysis of abstracts offers a useful surface glimpse of peer-reviewed climate literature. We confirm Oreskes' result that the rejection of AGW comprises a negligible percentage of the peer-reviewed literature <sup>6</sup>. Self-ratings by the papers' authors offers interesting contrasts with the abstract ratings, providing a deeper insight into the nature of the scientific consensus amongst climate experts.

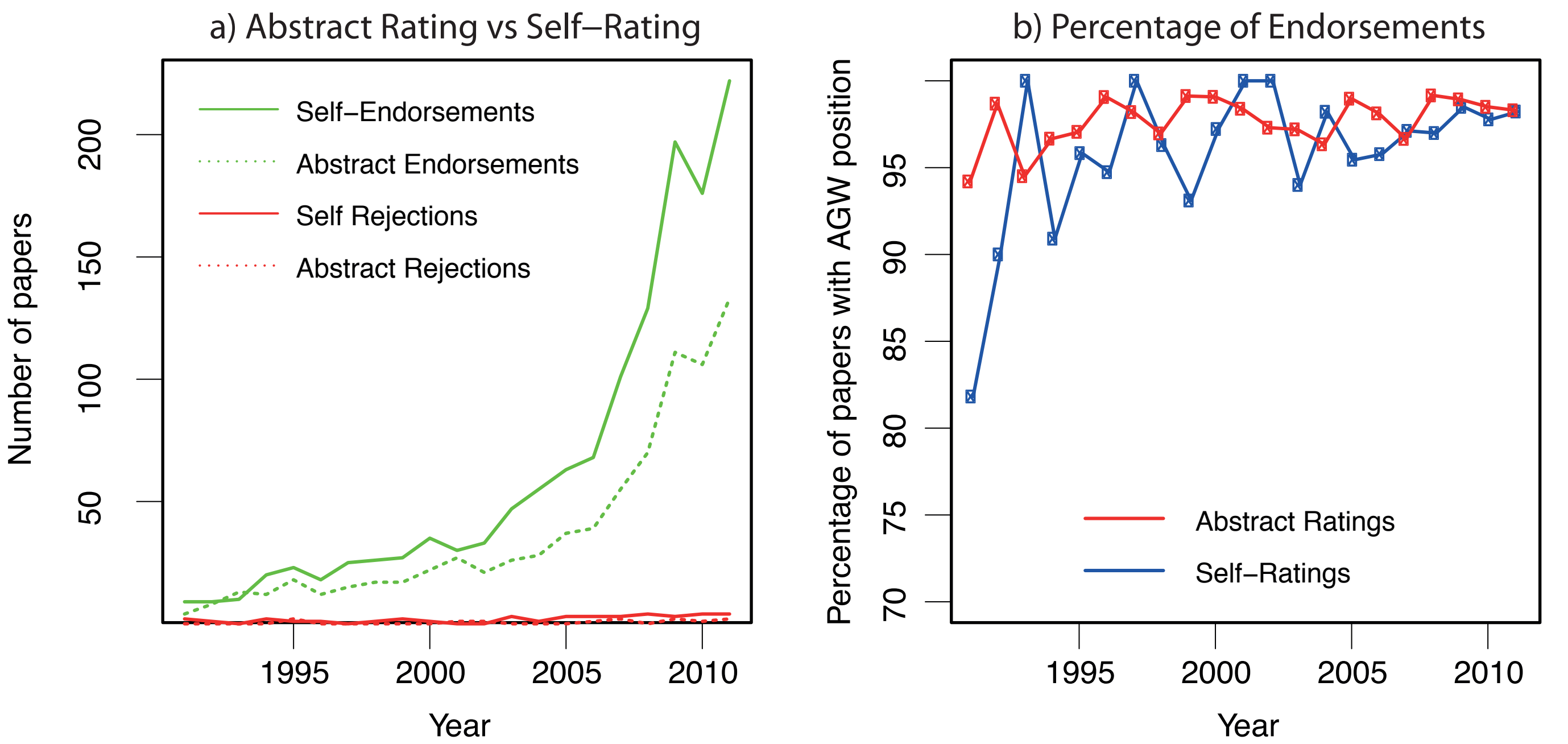
One narrative presented by contrarians is that the scientific consensus is "...on the point of collapse" <sup>9</sup>. Our analysis provides quantitative evidence countering this assertion. The number of papers rejecting AGW is a very small proportion of the published research, with the percentage decreasing over time. Among papers expressing a position on AGW, the percentage endorsing the consensus is increasing with an overall value from 95% (self-rated papers) to 98% (abstract ratings). The amount of cumulative research endorsing AGW is increasing with a growing gap between the amount of endorsement and rejection papers.



a) Total number of abstracts categorised into Endorsement, Rejection and No Position. b) Percentage of Endorsement, Rejection & No Position abstracts.



a) Total number of papers self-rated by authors into Endorsement, Rejection and No Position. b) Percentage of self-rated Endorsement, Rejection & No Position papers.



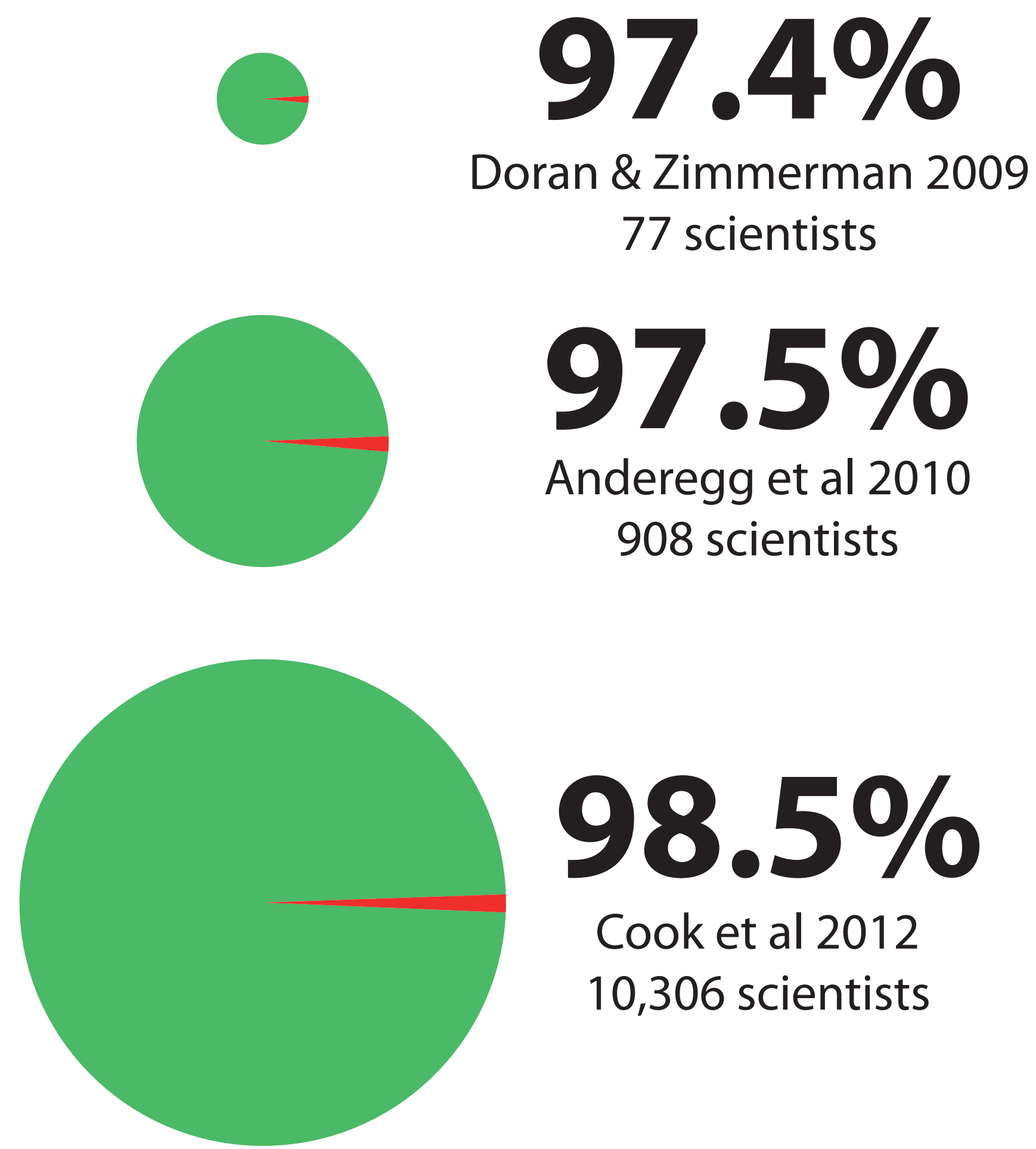
a) Comparison of endorsement levels in abstract ratings versus self-ratings, considering only papers that received a self-rating. Solid lines represent self-ratings (green endorsing AGW, red rejecting AGW) while dashed line represents ratings based on the abstract (green endorsing AGW, red rejecting AGW). b) Percentage of papers endorsing AGW among only papers that express a position on AGW. Red represents abstract ratings, blue represents self-ratings.

## Estimates of scientific consensus

A survey of over 10,000 Earth scientists revealed that among actively publishing climate scientists, there was 97% agreement that human activity was significantly changing global temperature <sup>7</sup>.

A compilation of scientists who signed public declarations on climate change, both supporting and rejecting the tenets of AGW, found that among climate scientists with at least 20 publications, there was 97% agreement with the consensus position <sup>8</sup>.

Our analysis finds that among the 10,306 scientists who authored an abstract expressing a position on AGW, 98.5% endorse the consensus.



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