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Balance as bias, resolute on the retreat? Updates & analyses of newspaper coverage in the United States, United Kingdom, New Zealand, Australia and Canada over the past 15 years

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E-mail: lucy.mcallister@tum.de**Keywords:** climate change, global warming, balance, bias, print media, content analysisSupplementary material for this article is available [online](#)

Abstract

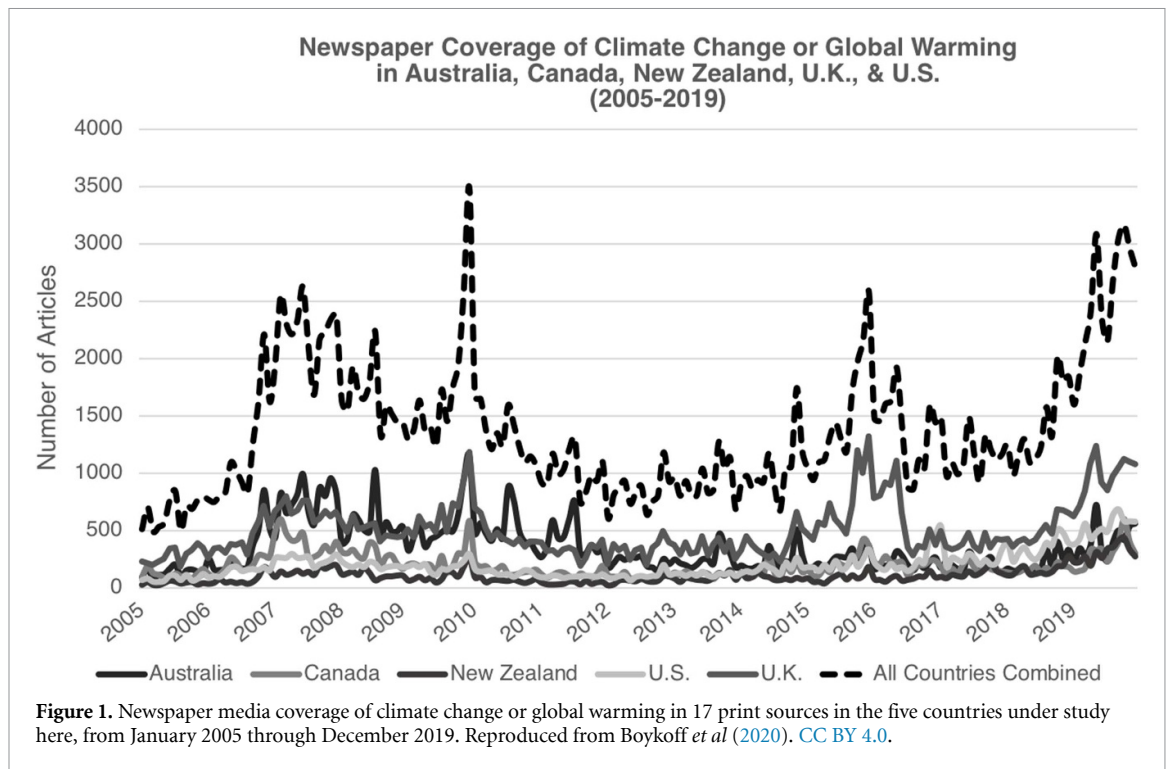
Through this research, we systematically updated and expanded understanding of how the print media represent evidence of human contributions to climate change. We built on previous research that examined how the journalistic norm of balanced reporting contributed to informationally biased print media coverage in the United States (U.S.) context. We conducted a content analysis of coverage across 4856 newspaper articles over 15 years (2005–2019) and expanded previous research beyond U.S. borders by analyzing 17 sources in five countries: the United Kingdom (U.K.), Australia, New Zealand, Canada, and the U.S. We found that across all the years of analysis, 90% of the sample accurately represented climate change. In addition, our data suggests that scientifically accurate coverage of climate change is improving over time. We also found that media coverage was significantly less accurate in 2010 and significantly more accurate in 2015, in comparison to the sample average. Additionally, Canada's *National Post*, Australia's *Daily Telegraph* and *Sunday Telegraph*, and the U.K.'s *Daily Mail* and *Mail on Sunday* (all historically conservative outlets) had significantly less accurate coverage of climate change over this time period than their counterparts.

We live in embattled times regarding media reporting on climate change. In terms of frequency of reporting, media accounting of the changing climate has fluctuated in coverage and fought for attention amid other issues (figure 1). In terms of quality and content of coverage, many challenges to provide accurate and contextualized coverage have persisted.

In this study, we systematically assessed the accuracy of media coverage of human contributions to climate change. We conducted a content analysis of coverage across 4856 articles over 15 years (January 2005 to December 2019) by analyzing 17 high-circulation national print media sources in five countries: the United Kingdom (U.K.), Australia,

New Zealand, Canada, and the United States (U.S.). We selected these five countries because the phenomenon of climate contrarianism is primarily an Anglo-Saxon phenomenon (Painter 2011). Therefore, focusing specifically on newsprint sources in Anglophone countries enables a meaningful exploration of whether the previously observed norm of 'balanced' reporting has continued to amplify outlier perspectives that bely the scientific consensus.

This research extends previous analyses conducted by Boykoff and Boykoff (2004) that examined media coverage of climate change and global warming in leading U.S. newspapers from 1990 to 2002. The study found evidence of reporting that was out of step



with the scientific consensus that humans contribute to climate change⁸. The informational bias was attributed to over-reliance on the journalistic norm of ‘balanced reporting’. Subsequent research examined U.S. and U.K. print media from 2003 to 2006 (Boykoff 2007b). This study found an ongoing and significant divergence from scientific consensus in the U.S. in 2003–2004, followed by a decline in 2005–6, along with no significant divergence in U.K. reporting over this same four-year time period⁹.

There have been several studies that have replicated parts of this previous research, often with a single western country-focus (i.e. Nisbet 2011, Bacon and Nash 2012, McGaurr *et al* 2013, Painter and Gavin 2016, Schmid-Petri *et al* 2015, Boykoff and Farrell 2019, Merkley 2020, Ruii 2021). However, there has not been systematic follow up research in the U.S. that has also expanded longitudinally to multiple country contexts. In these interim years, two critical issues have emerged:

- (a) there has been continued extrapolation based on these earlier studies to evaluate current conditions. The Boykoff and Boykoff (2004)

paper continues to be cited frequently—808 times since 2016 and 160 times since 2020 alone¹⁰. In these citations, the 2004 article is often used as evidence of ongoing problems with climate coverage due to the journalistic norm of balanced reporting.

- (b) while some follow up studies have indicated a decline in the prevalence of balanced reporting in climate coverage (Boykoff (2007b), Brüggemann and Engesser 2017) others have found a continued prevalence of this phenomenon in some contexts (Gurwitt *et al* 2017, Bolsen and Shapiro 2018, Ruii 2021), resulting in continued uncertainty about the magnitude and scope of the problem.

To address these issues, this study has methodically updated the past 15 years of coverage (2005–2009) while expanding analyses to influential national-level newspaper outlets across five countries.

We focus on anthropogenic climate change as an issue where there is clear convergent agreement among relevant expert researchers. This provides testable hypotheses regarding how this consensus is subsequently represented in prominent news media outlets (see section 1).

Expert consensus on anthropogenic climate change has emerged and strengthened over the past three decades. Relevant expert communities and institutions, peer-reviewed scientific research, and government reports have consistently found that human activity has driven the observed increase in

⁸ This consensus is clearly articulated in United Nations (UN) Intergovernmental Panel on Climate Change (IPCC) reports since its 1988 founding by the World Meteorological Organization and the UN Environment Programme.

⁹ Boykoff and Boykoff (2004) examined U.S. newspapers *The Los Angeles Times*, *The New York Times*, *USA Today*, *The Wall Street Journal*, and *The Washington Post* from 1988–2002. Boykoff (2007b) studied these same sources in the U.S. and also the *Independent* (and *Sunday Independent*), the *Times* (and *Sunday Times*), and the *Guardian* (and *Observer*) in the U.K. from 2003 to 2006.

¹⁰ Based on citation metrics available through Google Scholar.

globally averaged temperatures since the Industrial Revolution (Allan *et al* 2000, Houghton *et al* 2001, Solomon *et al* 2007, Pachauri *et al* 2014, Gaffney and Steffen 2017, Commonwealth Academies of Science 2018). Furthermore, social science research that empirically measures the strength of this consensus has found that 97% of relevant expert scientists agree that humans contribute to climate change (Oreskes 2004, Anderegg *et al* 2010, Cook *et al* 2013, Verheggen *et al* 2014).

Moving from this consensus to media portrayals of anthropogenic climate change, the journalistic values and norms of balanced reporting and objectivity shape representational practices and habits. Balanced reporting is a value that often appears to fulfill pursuits of objectivity (Cunningham 2003). Objectivity and balance developed through the professionalization of journalism amid a rapid expansion of modern media communications (Starr 2004). Professional media institutions—punctuated by standards of accuracy, accountability, and objectivity through social and ethical responsibility—were seen to contrast with partisan press (McQuail 2005). Balance also provided a ‘validity check’ for reporters on deadline or lacking the capacity to assess the veracity of nuanced or complex claims themselves (Dunwoody and Peters 1992). Over the past few decades, many scholars and practitioners have called for reassessments of objectivity and balance in the context of accurate and reliable reporting (i.e. Gerken 2020).

Media deployment of objectivity and balance when covering various dimensions of climate change have been widely acknowledged as problematic (Boykoff and Boykoff 2004, Boykoff 2007a). Research examining objectivity and balance in the context of climate change reporting has, in part, motivated related studies.

Analyzing coverage of press releases in the *New York Times*, *USA Today*, and *Wall Street Journal*, Wetts (2020) found that press releases that opposed climate action earned about twice the amount of coverage as those that called for action on climate change. These findings indicate the propensity for a continued ‘false balance’ in the U.S. print media, thereby raising questions about whether the norms of balance and objectivity are truly a ‘thing of the past’ when it comes to climate change coverage (Wetts 2020, 19059). In another study, Bohr (2020) ran a computational analysis of sources of bias in coverage of climate change across 52 newsprint sources in the U.S. The study found that the ideological orientation and circulation size of the newspaper outlet significantly influenced the attention given to topics and framings. In a similar vein, Brüggemann and Engesser (2017) found that right-leaning media outlets, in addition to the national-political context, and contrarian-leaning journalists contribute to niches of climate denialism (66). Brüggemann and Engesser (2017) also found a shift from ‘objective/balanced’ journalism in climate

change reporting, toward interpretative journalism, where contrarian voices are quoted *and* placed in the context of a dismissal of their stance (65).

These recent studies illustrate the persistence of inaccurate, contested or biased coverage of climate change. However, there remains a pressing need to re-evaluate the occurrence of this problem more recently and in a broader context. Additionally, cross-national comparisons often rely on purely quantitative or automated content analysis (i.e. Engesser and Brüggemann 2016). Notable exceptions include Painter and Ashe (2012) and Brüggemann and Engesser (2017). However, both studies covered a shorter time frame, where the former study focused on several months’ worth of coverage in 2007 and between 2009 and 2010, and the latter study covered the years 2011 and 2012. In this study, we provide an updated and expanded assessment of the prevalence of overly ‘balanced’ coverage of climate change across major national print media sources in Australia, New Zealand, Canada, the U.K., and the U.S. from 2005 to 2019. Further, the study combines a relatively large sample ($N = 4856$) with a qualitative discourse analytic approach, thereby balancing both scope and sensitivity of analysis, to make significant contributions to the broader field.

1. Methods

We analyzed coverage across 17 sources in newspapers from five countries, January 2005–December 2019, selecting for sources that met the criteria of: (a) high circulation and (b) accessibility of the entire article text through the Nexis Uni database in 2019. Based on these criteria, we included the following sources:

- U.K.: *Guardian* and *Observer*, *Daily Mail* and *Mail on Sunday*, *Telegraph* and *Sunday Telegraph*, *Times* and *Sunday Times*
- Australia: *Sydney Morning Herald*, *Courier Mail* and *Sunday Mail*, *Daily Telegraph* and *Sunday Telegraph*, *The Age*
- New Zealand: *New Zealand Herald*, *Dominion Post*, *The Press*
- Canada: *Globe and Mail*, *Toronto Star*, *National Post*
- U.S.: *New York Times*, *USA Today*, *Washington Post*

The unit of analysis was the individual article. We searched articles with keywords ‘global warming’ or ‘climate change’ and deployed content analysis to code the full sample set. Searches were conducted in Nexis Uni and duplicates were not grouped to ensure replicability¹¹. The population was $N = 246\,320$ articles. A random number generator was used on each month of data to take an initial sample set of

¹¹ Nexis Uni continuously re-groups what they consider to be duplicates and therefore searches conducted that group duplicates cannot be replicated from one search to the next.

Table 1. Sample size by country and by source (2005–2019).

Country & Source	Number of articles
Australia	
<i>Sydney Morning Herald</i>	208
<i>Courier Mail/Sunday Mail</i>	102
<i>Daily Telegraph/Sunday Telegraph</i>	52
<i>The Age</i>	241
Canada	
<i>Globe and Mail</i>	135
<i>Toronto Star</i>	152
<i>National Post</i>	120
New Zealand	
<i>New Zealand Herald</i>	101
<i>Dominion Post</i>	54
<i>The Press</i>	60
United Kingdom	
<i>Daily Mail/Mail on Sunday</i>	80
<i>Guardian/Observer</i>	520
<i>Telegraph/Sunday Telegraph</i>	129
<i>Times/Sunday Times</i>	271
United States	
<i>New York Times</i>	274
<i>USA Today</i>	36
<i>Washington Post</i>	127

20%, which yielded $N = 48\,603$ articles. To further randomize article selection, we chronologically analyzed 10% of the sample set using a random number generator again on each month of data. Our sample set was 4856 articles (i.e. 1.97% of the total sample; see tables 1 and 2).

We manually coded a representative sample of the population of articles ($N = 4856$). This is an abbreviated version of that codebook (see supplemental materials (available online at stacks.iop.org/ERL/16/094008/mmedia)):

- **Category 1:** anthropogenic global warming only contributes to climate change (distinct from natural variations)
- **Category 2:** anthropogenic global warming significantly contributes to climate change (in combination with natural variation)
- **Category 3:** anthropogenic global warming and natural variability equally contribute to climate change
- **Category 4:** anthropogenic global warming negligently contributes to climate change
- **Category 5:** not applicable: includes articles that are not about anthropogenic climate change¹².

¹² For some articles coded as a 5, the topic of climate change, or global warming was peripheral to the article. For other articles coded as a 5, climate change or global warming was the main topic of the article. For example, articles on climate change adaptation that did not mention the science of anthropogenic climate change, were coded as 5 for the purposes of this research, as there was no discernible viewpoint regarding the causes of climate change. However, from an analysis perspective, this draws attention to additional spaces in the media where the science of climate change could potentially be explained or included.

Category 5 articles were removed from the final sample.

Category 2 refers to articles that portrayed the scientific consensus view that humans are the main driver of currently observed climate change, while Category 3 refers to articles that provide false balance between scientific consensus and contrarian views regarding the existence or causes of climate change. Category 4 refers to articles that either refute the existence of climate change or else make claims that observed climate change is not driven primarily by humans.

This coding scheme was consistent with previous investigations of media coverage of anthropogenic climate change (Boykoff and Boykoff 2004, Boykoff 2007b, Boykoff and Mansfield 2008, Boykoff 2008).

Coding was conducted using a critical discourse analytic approach, rather than tallying frequencies of words or phrases. Critical discourse analysis has been widely used in the field of media studies for decades to analyze discrete media texts to examine which voices and discourses are privileged over others (Phelan 2017). Following Boykoff and Boykoff (2004, p 126), we define discourse as a ‘recognizable network of questions, assumptions, reference points, and language games employed by a given group of people that enables them to organize and understand the world.’ Coding therefore focused on applying topics (see codebook) to textual units by identifying combinations of terminology, framing techniques, salience of elements in the text, tone, and relationships between clusters of messages to discern larger inter-textual patterns. The validity of discourse analysis is established when linguistic details converge to support agreement (Gee 2014).

To ensure validity, each article was independently coded by two coders in the larger group of six coders on the team. Pairing of coders was rotated once during analysis to ensure consistency across the entire coding team. Coding within a joint research project requires iteratively refining the codebook to ensure shared interpretation and application within individual coding efforts (Saldaña 2016). Following this period of independent coding, the coding team convened at regular intervals to assess interpretive convergence and coding agreement and to update the codebook.

Following the coding process, intercoder agreement was calculated using Krippendorff alpha and Scott’s Pi tests of intercoder reliability. The intercoder reliability correspondence was 89.6% and Krippendorff alpha rate was 0.81, while Scott’s Pi test was 0.809, meeting acceptability standards (Lombard *et al* 2002). This reliability and validity testing accounted for spuriousness while also integrating past knowledge and familiarity with various facets of climate change science, policy, and news coverage (Metag 2016).

Table 2. Overall coverage in a country by year (2005–2019).

Country	Australia	Canada	NZ	U.K.	U.S.
2005	20	12	9	33	11
2006	36	31	7	45	21
2007	110	52	23	100	31
2008	61	32	16	60	24
2009	64	38	12	134	37
2010	61	24	8	77	17
2011	49	13	8	47	20
2012	28	11	5	33	13
2013	22	26	10	52	12
2014	15	24	13	44	26
2015	21	26	18	87	36
2016	23	21	14	74	36
2017	24	25	12	39	46
2018	19	28	12	46	41
2019	50	44	48	129	66
Total	603	407	215	1000	437

Coders also assembled notes as they proceeded through the coding process, capturing illustrative passages in articles, and drawing representative examples from each of the sources. Consistent with previous research, ‘balance’ was determined to be coverage that provided roughly equal attention and emphasis to competing viewpoints on anthropogenic climate change, however not necessarily equal time and space (Entman 1989, Dunwoody and Peters 1992, Boykoff 2011). Table 3 includes article quotes illustrative of Categories 1 through 4.

In addition to news articles, the analysis included letters, editorials, and other publications that contained the keywords ‘global warming’ or ‘climate change.’ These latter units of analysis may be outside the bounds of journalistic norms—for example, the author of a letter or editorial may not follow guidelines on balance or ‘truth’ in reporting—but these still reflect the overall content of the sources in which they are published and, thereby, impact readers.

Throughout the coding process, coders discussed and addressed coding differences, revising the codebook and coding process as necessary. How to code for tone proved a common point for discussion. For example, an article may not directly deny anthropogenic climate change, but may read in a mocking or sarcastic tone with respect to human-caused climate change. With some exceptions, coders generally coded based on the content of the article itself, as opposed to tone, as tone can be difficult to interpret. On the other hand, if tone came through strongly in an article, then this was reflected in the final category assignment. Given the large sample size for this project, the researchers determined that it is not necessary to achieve a ‘perfect formula’ for article category assignments with respect to tone; among the general pool of readers of a published piece, one reader may pick up on sarcasm in an article, whereas another reader may not.

Following coding, we first analyzed the percentage of articles in each category and the percent difference between Category 2 articles (i.e. accurate reporting) and Category 1, 3, and 4 articles combined (i.e. biased or otherwise inaccurate reporting). Per our codebook, 2194 articles were coded as Category 5 (not applicable) and were removed from the sample, yielding a total of $N = 2662$ articles (i.e. 1.08% of the total sample) that were directly relevant to the causes of climate change (i.e. Categories 1, 2, 3 and 4 combined). Across the 15 years, there were two articles in Category 1, 2397 articles in Category 2, 150 articles in Category 3, and 113 articles in Category 4. Only those articles directly relevant to climate change (i.e. $N = 2662$) were used in the calculation of percentages per category and percent difference scores in tables 4 and 5.

The null hypothesis was that newspaper coverage reflected the convergent agreement in the scientific community regarding anthropogenic climate change in each year ($H_0: \pi_1 = \pi_2$). The alternative hypothesis was that media portrayals significantly diverged from this scientific consensus ($H_a: \pi_1 \neq \pi_2$).

The study utilized z -score significance testing (comparing ratios) similar to a t -test ($z \geq 1.96$, $p = 0.05$; $z \geq 2.575$, $p = 0.01$; $z \geq 3.29$, $p = 0.001$):

$$z = \frac{(\Pi_1 - \Pi_2)}{\tilde{O}'_{\Pi_1 - \Pi_2}} \text{ and } \tilde{O}'_{\Pi_1 - \Pi_2} = \sqrt{\Pi^\wedge (1 - \Pi^\wedge) \left(\frac{1}{n_1} + \frac{1}{n_2} \right)}$$

where π^\wedge = pooled estimate based on the whole sample.

2. Results

We asked the essential question across 17 national print media sources in five countries over 15 years

Table 3. Article Quotes illustrative of Categories 1, 2, 3, or 4.

Category	Quote 1	Quote 2
Category 1 <i>anthropogenic global warming only contributes to climate change (distinct from natural variations)</i>	‘We are fishing out the sea and cutting down our rain forests. We are polluting the air and causing climate change. And all the time, the cause of the problem, human population, continues to increase.’ (<i>The Press</i> , Christchurch, New Zealand, 2014, ‘No Political Home’)	
Category 2 <i>anthropogenic global warming significantly contributes to climate change (in combination with natural variation)</i>	‘The National Climate Assessment, written by the nation’s top scientists and four years in the making, found that global warming is already having widespread effects across the U.S. ... The solution to climate change is starkly simple and will be massively expensive, the report said. “Harm to the nation will increase substantially in the future unless global emissions of heat-trapping gases are greatly reduced,” it said.’ (<i>The Globe & Mail</i> , Canada, 2014, ‘Environment; Obama calls for “urgent action” ...’)	“Senator Barbara Boxer, the California Democrat, promised today to draft cap-and-trade legislation for the reduction of greenhouse gas emissions in as little as the next few weeks ... Ms. Boxer laid out the following six broad principles ... A commitment to reducing emissions to levels guided by science to avoid global warming ... Ms. Boxer said she expects to draw both Democratic and Republican support. ‘We know that we have to act,’ Boxer said, ‘and we intend to act.’” (<i>The New York Times</i> , U.S., 2009, ‘Barbara Boxer Promises Cap-and-Trade Bill; Green’)
Category 3 <i>anthropogenic global warming and natural variability equally contribute to climate change</i>	‘The students were demanding the resignation of one of the board’s members: Gregory H. Boyce, the chairman of Peabody Energy Corporation, the nation’s largest coal company and one of the most ardent corporate opponents of efforts to address global warming ... And John Christy, a scientist and climate-change skeptic at the University of Alabama in Huntsville who was a lead author for a 2001 report of the authoritative Intergovernmental Panel on Climate Change, called the big green groups ideologues. “it is a strategy that does not require any scientific defensibility,” he said, but “the real data will eventually win.”’ (<i>The New York Times</i> , 2014, ‘Environmental Groups Focus on Change by Strengthening Their Political Operations’)	‘A leading climate skeptic scientist told MPs yesterday that “doing nothing for 50 years” about climate change would be better than present policies which seek to cut emissions. Richard Lindzen, a former professor of meteorology at Massachusetts Institute of Technology, believes that climate change poses no risk to mankind and insists that there is no consensus that sea levels are rising ... Tim Yeo, chairman of the Energy and Climate change Committee, took issue with Mr. Lindzen’s views. “The evidence that we have just had the hottest ever decade does not seem to be conclusive proof that global warming has come to an end,” he said.’ (<i>The Times</i> (London), 2014, ‘Heat is on Met Office over global warming forecast’)
Category 4 <i>anthropogenic global warming negligently contributes to climate change</i>	‘When this global warming madness passes, future generations will remove this derelict solar and wind infrastructure and return to the only reliable and economical electricity options—coal, gas, hydro and nuclear.’ (<i>The Sunday Telegraph</i> , London, 2010, ‘Officials & climate’)	‘The past six months has seen a series of unprecedented setbacks for the cause of catastrophic man-made climate change: the collapse of the Kyoto process; the release of incriminating Climategate emails; the discovery of the shoddy standards of the Intergovernmental Panel on Climate Change (IPCC); the mounting evidence that a job-creating green industrial revolution is a fantasy ... The British Royal Society recently released a statement that “Any public perception that the science is somehow fully settled is wholly incorrect,” thus contradicting its own former president, and true believer, Lord May. And if the science is not settled, there can hardly ever have been “consensus” on the issue.’ (<i>National Post</i> , Canada, 2010, ‘Climate junk hard to dump’)

Table 4. Newspaper discourse and scientific discourse regarding anthropogenic climate change: By year, 2005–2019; $N = 2662$.

Year	Number of articles	Category 1 (%)	Category 2 (%)	Category 3 (%)	Category 4 (%)	Difference between Category 2 & Categories 1, 3, 4 (%)	Z-score
2005	85	0.00	91.76	7.06	1.18	83.53	0.50
2006	140	0.71	86.43	8.57	4.29	72.86	−0.86
2007	316	0.00	89.56	7.28	3.16	79.11	−0.06
2008	193	0.00	89.12	5.18	5.70	78.24	−0.18
2009	285	0.00	90.88	3.51	5.61	81.75	0.27
2010	187	0.00	81.82	9.63	8.56	63.64	−2.05**
2011	137	0.00	84.67	10.22	5.11	69.34	−1.31
2012	90	0.00	92.22	4.44	3.33	84.44	0.62
2013	122	0.00	86.07	9.02	4.92	72.13	−0.96
2014	122	0.82	88.52	6.56	4.10	77.05	−0.33
2015	188	0.00	96.28	1.06	2.66	92.55	1.66*
2016	168	0.00	89.29	6.55	4.17	78.57	−0.13
2017	146	0.00	92.47	3.42	4.11	84.93	0.68
2018	146	0.00	94.52	3.42	2.05	89.04	1.21
2019	337	0.00	93.47	3.26	3.26	86.94	0.94

Note: The percentages refer to the proportion of articles that were categories 1, 2, 3, & 4 relative to the total number of articles ($N = 2662$). The difference score in each row of the table was converted to a z-score by subtracting the average difference in the sample (79.61%) and dividing by the standard deviation of the difference score in the sample (7.81%). Category 1 = anthropogenic global warming only contributes to climate change (distinct from natural variations); Category 2 = anthropogenic global warming significantly contributes to climate change (in combination with natural variation); Category 3 = anthropogenic global warming and natural variability equally contribute to climate change; and Category 4 = anthropogenic global warming negligently contributes to climate change. The newspapers analyzed here were *Sydney Morning Herald*, *Courier Mail/Sunday Mail*, *Daily Telegraph/Sunday Telegraph*, *The Age*, *Globe and Mail*, *Toronto Star*, *National Post*, *New Zealand Herald*, *Dominion Post*, *The Press*, *Guardian/Observer*, *Daily Mail/Mail on Sunday*, *Telegraph/Sunday Telegraph*, *Times/Sunday Times*, *New York Times*, *USA Today*, *Washington Post*. * $p < .05$, ** $p < .01$, *** $p < .001$.

(2005–2019): has coverage of climate change or global warming been ‘balanced,’ and therefore actually perpetrating an informational bias?

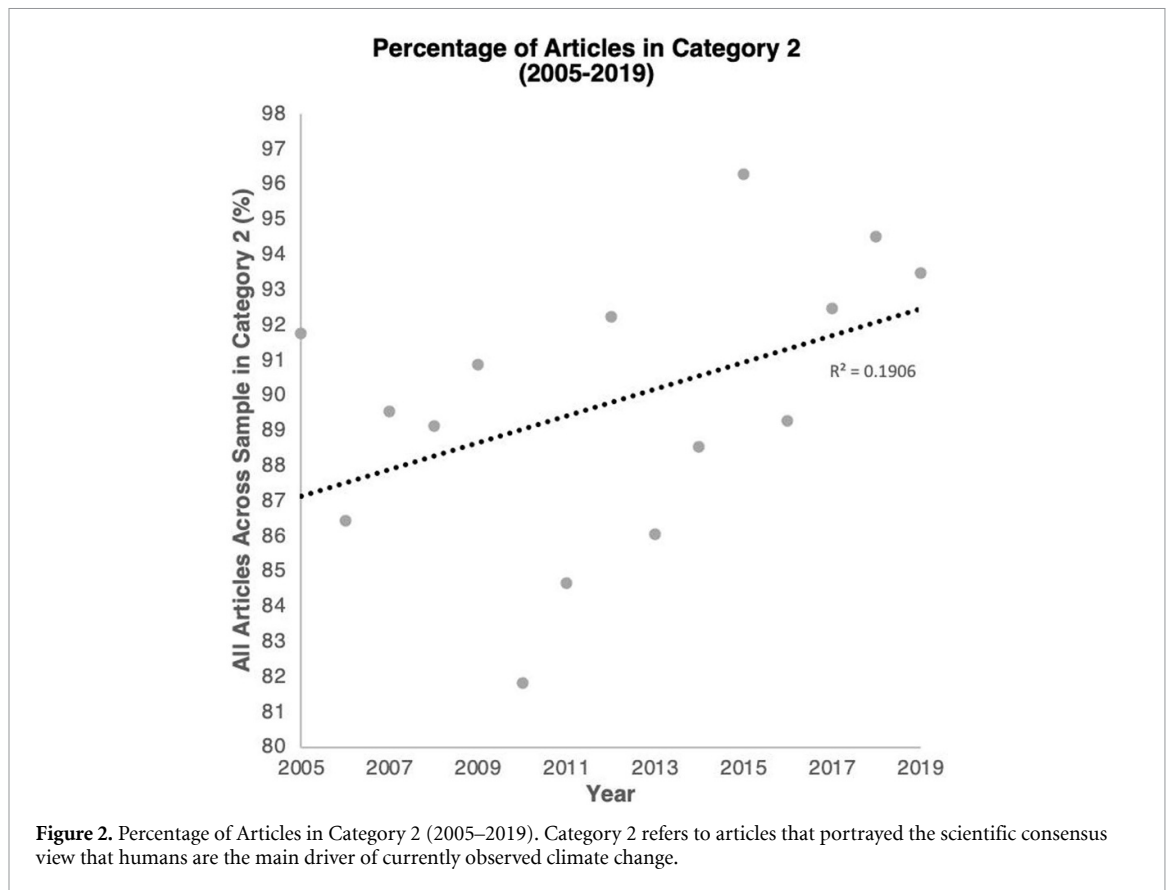
We analyzed the significance of differences in discourse between the consensus in the relevant expert scientific community and media representations of anthropogenic climate change by coding for scientifically accurate reporting (Category 2) and biased or otherwise inaccurate reporting (Categories 1, 3, and 4). We examined these categories across (a) time and (b) source by country.

To start, we analyzed differences in newspaper coverage of climate change or global warming, as related to the scientific consensus, by year across all sources (see table 4). As a percentage of total coverage, the average difference between accurate representations of the scientific consensus (Category 2) and less accurate or biased coverage (Categories 1, 3, and 4 combined) was $79.61\% \pm 7.81$. The lowest difference between accurate and less-accurate reporting was 63.64% in 2010. This was statistically significant at the 95% confidence level (z -score = -2.05 , $p < 0.05$)¹³. We found that the highest difference

between accurate and less accurate reporting, 92.55%, occurred in 2015. This was statistically significant at the 90% confidence level (z -score = 1.66 , $p < 0.1$). Additionally, the upward trend of the fit line in figure 2 shows an approximately five percentage point increase (from 87% to 92%) in Category 2 articles (anthropogenic global warming significantly contributes to climate change in combination with natural variation) over the 15 year period, suggesting that scientifically accurate climate coverage is improving over time.

Next, we analyzed differences in the accuracy of reporting across the 17 sources by country of publication (see table 5). As a percentage of the total coverage, the average difference between accurate coverage and less accurate coverage was $75.53\% \pm 18.13$. We also found that the *Daily Mail* and *Mail on Sunday*, *Telegraph* and *Sunday Telegraph*, and the *National Post* all had significantly less accurate coverage of climate change than the other sources. The *National Post* of Canada had the least accurate coverage with 70.83% of articles representing scientific consensus on climate change (Category 2), compared to 9.17% in Category 3 (i.e. anthropogenic global warming and natural variability equally contribute to climate change) and 20.00% in Category 4 (i.e. anthropogenic global warming negligently contributes to climate

¹³ Note that the percentage of articles in Category 1 were negligible for the entire sample, making up only .71% of reporting in 2006, .82% in 2014, and 0.00% in all other years.



change). This was statistically significant at the 90% confidence level ($z\text{-score} = -1.87$, $p < 0.1$). In Australia's *Telegraph* and *Sunday Telegraph*, 71.15% of articles were in Category 2 (i.e. accurate reporting), 15.38% in Category 3, and 13.46% in Category 4 (i.e. less accurate or biased reporting). This was statistically significant at the 90% confidence level ($z\text{-score} = -1.83$, $p < 0.1$). Finally, for the U.K.'s *Daily Mail* and *Mail on Sunday* 72.50% of coverage was Category 2 (i.e. accurate reporting), 8.75% was Category 3, and 18.75% was Category 4 (i.e. less accurate or biased reporting). This was statistically significant at the 90% confidence level ($z\text{-score} = -1.68$, $p < 0.1$). It is also interesting to note that across all sources, Canada's *Toronto Star* and the U.K.'s *Guardian* and *Observer*, which had the greatest number of articles in the sample ($N = 520$), had the best or most scientifically accurate coverage of climate change, with 97.37% of the *Toronto Star*'s coverage in Category 2 and 95.00% of the *Guardian* and *Observer*'s coverage in Category 2. Thus, both Canada and the U.K. had sources with the best and worst coverage of climate change within the sample.

Figure 3 shows the percentage difference between Category 2 (i.e. accurate reporting) and Categories 1, 3, and 4 (i.e. less accurate or biased reporting) for all the sources, from most accurate coverage of climate

change to least accurate. The middle bar represents the average difference score (75.53%), while the top bar is the average difference score plus one standard deviation (93.67%) and the bottom bar is the average difference score minus one standard deviation (57.40%).

Nonetheless, there remain fluctuations in how accurately the scientific consensus is represented from year to year. For example, 2010 had the lowest percentage of scientifically accurate articles (Category 2), at 81.82%, while 2015 had the highest, at 96.28% (figure 4). Figure 5 shows the % difference between accurate (Category 2) and less accurate reporting (Categories 1, 3, and 4). We observe significant variation across the five countries. The accuracy of coverage has increased steadily in the U.S. and Canada since 2012, and to a lesser extent in Australia. We also observe significant interannual variation in the U.K. and New Zealand with no clear growth trend¹⁴. Moreover, while U.S. and New Zealand newspapers reveal similar trends across all sources, it is notable

¹⁴ The exact causes of increased articles and increased accuracy in these years and the variation between countries is beyond the scope of this research, but it is worth noting that the Yale Program on Climate Change Communication's data on climate views over time in the U.S. show similar trends in their data to the U.S. trends shown in figure 3 (Ballew et al 2019).

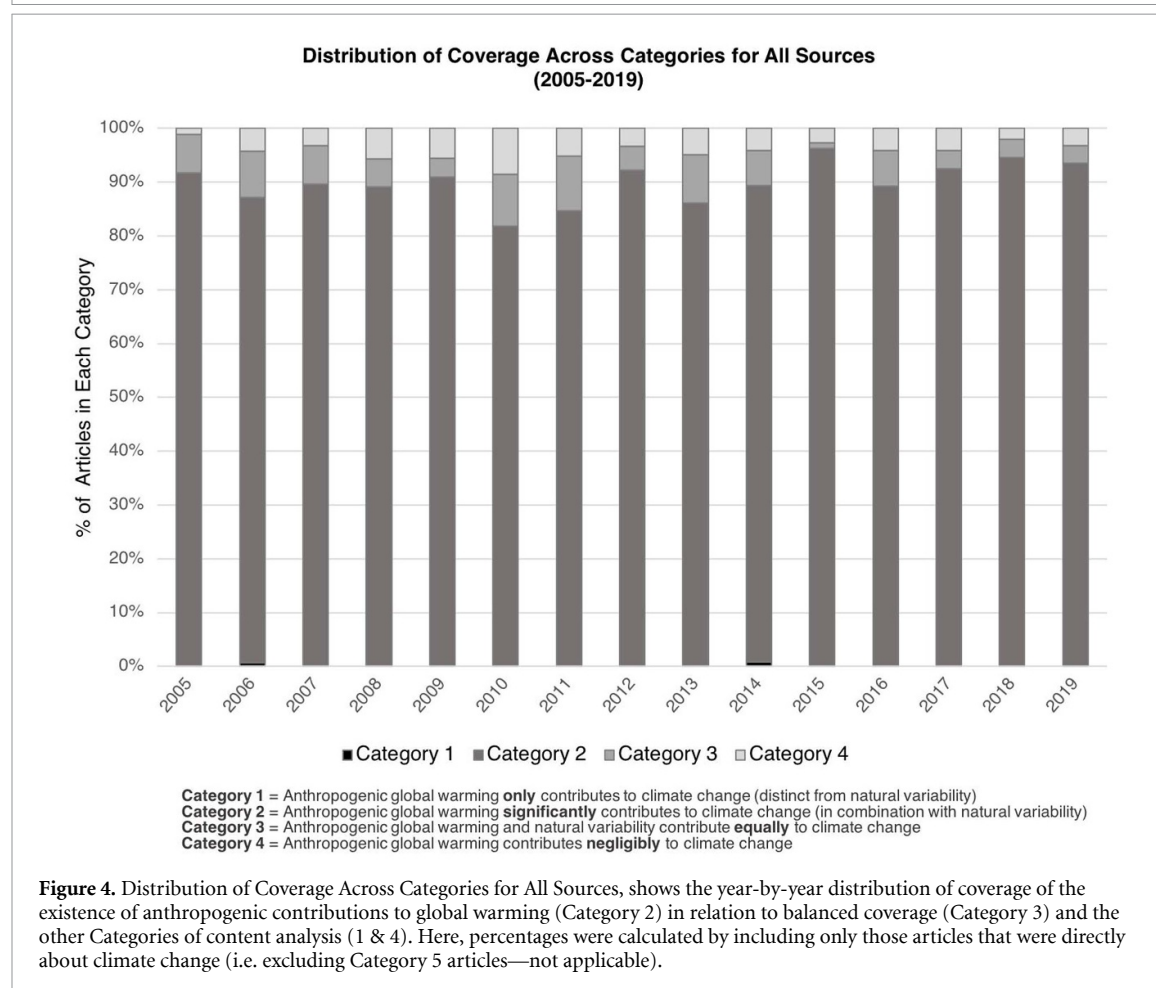
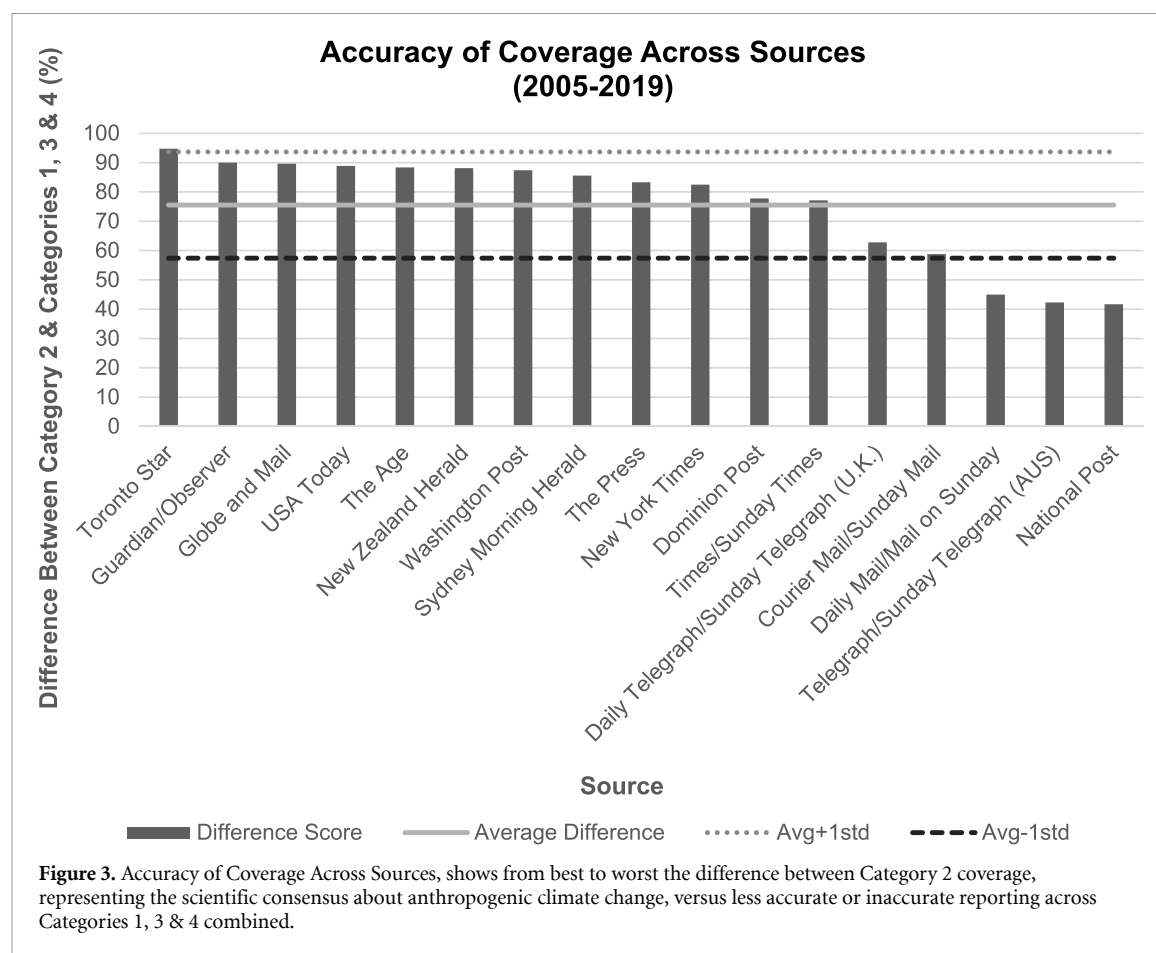
Table 5. Newspaper discourse and scientific discourse regarding anthropogenic climate change: By Country and Source, 2005–2019; $N = 2662$.

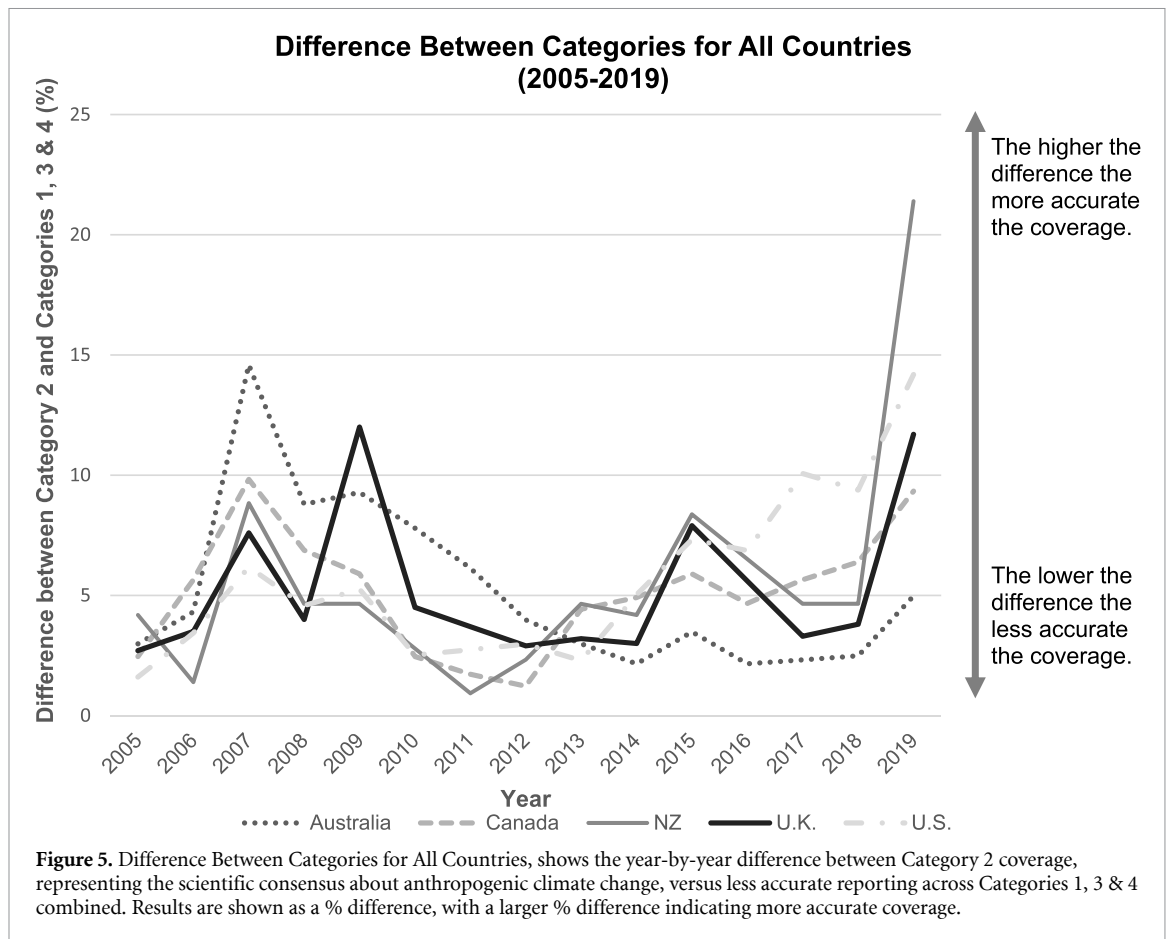
Country & Source	Number of articles	Category 1 (%)	Category 2 (%)	Category 3 (%)	Category 4 (%)	Difference between Category 2 and Categories 1, 3 & 4 (%)	Z-score
Australia							
<i>Sydney Morning Herald</i>	208	0.5	92.8	4.3	2.4	85.6	0.55
<i>Courier Mail & Sunday Mail</i>	102	0.0	79.4	11.8	8.8	58.8	−0.92
<i>Telegraph & Sunday Telegraph</i>	52	0.0	71.2	15.4	13.5	42.3	−1.83*
<i>The Age</i>	241	0.0	94.2	5.0	0.8	88.4	0.71
Canada							
<i>Globe & Mail</i>	135	0.0	94.8	5.2	0.0	89.6	0.78
<i>Toronto Star</i>	152	0.0	97.4	2.0	0.7	94.7	1.06
<i>National Post</i>	120	0.0	70.8	9.2	20.0	41.7	−1.87*
New Zealand							
<i>New Zealand Herald</i>	101	0.0	94.1	4.0	2.0	88.1	0.69
<i>Dominion Post</i>	54	0.0	88.9	5.6	5.6	77.8	0.12
<i>The Press</i>	60	1.7	91.7	3.3	3.3	83.3	0.43
United Kingdom							
<i>Daily Mail & Mail on Sunday</i>	80	0.0	72.5	8.8	18.8	45.0	−1.68*
<i>Guardian & Observer</i>	520	0.0	95.0	3.8	1.2	90.0	0.80
<i>Daily Telegraph & Sunday Telegraph</i>	129	0.0	81.4	7.8	10.9	62.8	−0.70
<i>Times & Sunday Times</i>	271	0.0	88.6	6.3	5.2	77.1	0.09
United States							
<i>New York Times</i>	274	0.0	91.2	6.9	1.8	82.5	0.38
<i>USA Today</i>	36	0.0	94.4	2.8	2.8	88.9	0.74
<i>Washington Post</i>	127	0.0	93.7	3.9	2.4	87.4	0.65

Note: The percentages refer to the proportion of articles that were either ‘Category 2’, or ‘Categories 1, 3, & 4’ relative to the total number of articles ($N = 2662$). The difference score in each row was converted to a z-score by subtracting the sample average (75.53%) and dividing by the sample standard deviation (18.13%). Category 1 = anthropogenic global warming only contributes to climate change (distinct from natural variations); Category 2 = anthropogenic global warming significantly contributes to climate change (in combination with natural variation); Category 3 = anthropogenic global warming and natural variability equally contribute to climate change; and Category 4 = anthropogenic global warming negligently contributes to climate change. * $p < .05$, ** $p < .01$, *** $p < .001$.

that the outlets in Australia (*Telegraph* and *Sunday Telegraph*), Canada (*National Post*) and the U.K. (*Daily Mail* and *Mail on Sunday*) were found to publish significantly less accurate coverage of climate change over time (table 5). These outlets also ran fewer articles about human contributions to climate change over this time period in comparison with their counterparts within these respective countries (table 1).

Overall, there are significant differences in the percentage of articles that accurately represented the scientific consensus about anthropogenic climate change (Category 2) over time and sources across our entire sample. However, this is underscored by the fact that the vast majority of reporting—an average of 90% across all years and sources—accurately reflected the consensus view (figure 4).





3. Conclusion

This research has sought to move from limited, dated, or speculative characterizations of media coverage of anthropogenic climate change over the past 15 years to a methodical and empirically driven analysis of newspaper media portrayals in Australia, New Zealand, Canada, the U.K., and the U.S.

We conclude that in the 17 major print news outlets analyzed here, the journalistic norm of balanced reporting has not informationally biased coverage of anthropogenic climate change from 2005 to 2019. In fact, we found that on average scientifically accurate climate coverage improved (see figure 2). Thus, we argue that it is time to retire blanket statements regarding the continued dominance of ‘balanced’ coverage of the scientific consensus on climate change that gives equal credence to ‘both sides.’ However, our correlational data show that it is still important to proceed with caution, as there have been significant fluctuations in the accuracy of reporting across time, within countries, and by newspaper outlets.

For example, after the University of East Anglia email hacking scandal (known also as ‘climategate’) and the Copenhagen Accord in November/December 2009, among other climate-related events receiving substantial press coverage, 2010 was the least accurate year of climate coverage in our

sample, 81.82% of coverage represented the scientific consensus view, 9.63% of coverage represented a false balance view, and 8.56% portrayed denialist or contrarian views. The most accurate coverage of climate change in our sample was in 2015 with 96.28% of coverage portraying the scientific consensus view, 1.06% of coverage representing a false balance view, and 2.66% representing denialist or contrarian views. Interestingly, this period preceded the successful negotiation of the Paris Agreement in December 2015. Furthermore, 2019 saw a significant rise in coverage across both the world and the U.S. due to a confluence of high profile climate-related disasters and political events. Sub-Saharan African drought, Central American migration pressures, South American deforestation, Asian public health concerns, European decarbonization, UN climate talks, Australian bushfires, Canadian federal elections, U.S. withdrawal from the Paris Climate Agreement, and global youth-led climate social movements punctuated the 2019 media and climate change landscape and lofted coverage into unseen territories, especially as the year came to an end (see also Boykoff *et al* 2020). 2019 was also the third most accurate year of reporting (after 2015 and 2018) in terms of coverage of climate change in our sample: 93.47% of coverage portrayed the scientific consensus view while 3.26% of coverage represented a false balance

view and 3.26% represented denialist or contrarian views.

As a second example—and similar to the findings of other research (i.e. Boykoff and Mansfield 2008, Painter and Gavin 2016, Stoddart *et al* 2016, Ruijter 2021)—the sources with significantly less accurate climate change coverage, Canada's *National Post*, Australia's *Telegraph* and *Sunday Telegraph* (owned by Rupert Murdoch) and the U.K.'s *Daily Mail* and *Mail on Sunday*, all have a right leaning political orientation, while the left-leaning sources within the U.K., the *Guardian* and *Observer*, and Canada, the *Toronto Star*, had the most accurate climate coverage. As studied elsewhere (i.e. Carvalho 2007, Dunlap 2008, Boykoff 2011), ideological cultures and stances are among several factors that shape media coverage of climate change. Combined with our finding that these outlets have run fewer stories on anthropogenic climate change than their in-country counterparts over this time-period, the coverage in these conservative outlets has comparatively remained more 'silent' on these critical issues while these sources have continued to contribute to informational biases in the public arena.

These findings also raise additional questions for future studies. This research did not examine other aspects of journalistic coverage, such as placement and prominence of articles or differences between article types. Additionally, this study only included newspaper reporting on climate change, though it is well recognized that the print media industry has undergone significant decline and transformation in the last several decades¹⁵. While outside the scope of this study, it will be important to expand longitudinal and cross-national studies to include other types of media (i.e. cable news, digital native media, radio, etc) and to further interrogate the underlying features that shape uneven accuracy of reporting we observed over time and across sources in subsequent research.

Furthermore, while our data show that accurate reporting vastly outweighed less accurate reporting by a factor of 9–1 across all years included in our analysis, this may not be a cause for complacency. As Lamb *et al* (2020) have pointed out, the terrain of climate debates has shifted in recent years away from strict denial of the scientific consensus on human causes of climate change toward 'discourses of delay' that focus on undermining support for specific policies meant to address climate change (see also Schmid-Petri *et al* 2015). Additionally, other studies have shown that there is not always a direct relationship

between the accuracy of individuals' climate knowledge and their beliefs about climate change (Fischer and Said 2021). This is compounded by the fact that individuals receive and take up knowledge about climate change via multiple information sources, with complex and varying effects on behavioral change (Arlt *et al* 2011). Thus, accurate reporting of the scientific consensus in print media alone is not sufficient to ensure that the public is both well-informed and willing to take individual or collective action to address climate change.

This research provides a valuable and timely update to previous studies examining the issue of balanced climate change reporting, which can help focus research efforts on pressing, current issues—a few of which we have outlined above. This research also contributes to comparative investigations of media coverage of climate change across national, political, and cultural contexts (i.e. Petersen *et al* 2019, Vu *et al* 2019) and consideration of its effects on perceived consensus that humans contribute to climate change (i.e. Koehler 2016, Bertoldo *et al* 2019). More widely, this research adds to ongoing research regarding issue salience and agenda-setting, as well as prioritization at the science-policy interface (i.e. Bromley-Trujillo and Karch 2019).

Going forward, this type of systematic research can inform ongoing discussions and debates about media coverage of climate change, helping those discussions focus elsewhere to other ongoing challenges inside as well as outside the newsroom. There is no doubt that there will remain many challenges associated with news reporting about climate change in the 21st century.

Data availability statement

The data that support the findings of this study are available upon reasonable request from the authors.

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Conflict of interest

The authors declare no competing interests.

¹⁵ The Pew Center for Research regularly produces 'State of the News Media' fact sheets. In their analysis of U.S. newspapers, they have found significant declines in circulation, revenues, and staffing (see also Twenge *et al* 2019). Similar trends have been observed in other countries (i.e. Papathanassopoulos 2001, Casero-Ripollés and Izquierdo-Castillo 2013).

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