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ADDENDUM

Addendum to 'Assessing ExxonMobil's climate change communications (1977–2014)' Supran and Oreskes (2017 *Environ. Res. Lett.* **12** 084019)

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Abstract

In our 2017 study 'Assessing ExxonMobil's climate change communications (1977–2014)', we concluded that ExxonMobil has in the past misled the public about climate change. We demonstrated that ExxonMobil 'advertorials'—paid, editorial-style advertisements—in *The New York Times* spanning 1989–2004 overwhelmingly expressed doubt about climate change as real and human-caused, serious, and solvable, whereas peer-reviewed papers and internal reports authored by company employees by and large did not. Here, we present an expanded investigation of ExxonMobil's strategies of denial and delay. Firstly, analyzing additional documents of which we were unaware when our original study was published, we show that our original conclusion is reinforced and statistically significant: between 1989–2004, ExxonMobil advertorials overwhelmingly communicated doubt. We further demonstrate that (i) Mobil, like Exxon, was engaged in mainstream climate science research prior to their 1999 merger, even as Mobil ran advertorials challenging that science; (ii) Exxon, as well as Mobil, communicated direct and indirect doubt about climate change and (iii) doubt-mongering did not end after the merger. We now conclude with even greater confidence that ExxonMobil misled the public, delineating three distinct ways in which they have done so.

1. Introduction

In our recent article (Supran and Oreskes, 2017 *Environ. Res. Lett.* **12** 084019 [1]), we assessed whether ExxonMobil has in the past misled the general public about anthropogenic global warming (AGW) (we refer to Exxon Corporation as 'Exxon', Mobil Oil Corporation as 'Mobil', ExxonMobil Corporation as 'ExxonMobil Corp', and generically refer to all three as 'ExxonMobil'). Presenting an empirical document-by-document textual content analysis of the company's private and public climate change communications—including peer-reviewed and non-peer-reviewed publications, internal company documents, and paid, editorial-style advertisements ('advertorials') in *The New York Times* (*NYT*)—we concluded that it has.

After our study was published, we became aware of additional relevant ExxonMobil advertorials not included in our original analysis. Here, we present a document-by-document content analysis of 1448 advertisements, which include these additional materials. Our original finding is reinforced: between 1989–2004, Mobil and ExxonMobil Corp advertorials overwhelmingly expressed doubt about AGW as real and human-caused, serious, and solvable. By including additional advertorials in this expanded analysis, we now conclude with even greater confidence that Exxon, Mobil, and ExxonMobil Corp misled the public.

We also address a critique that ExxonMobil Corp has raised about our original study: that it 'obscur[ed] the separateness of the two corporations', Exxon and Mobil, thereby rendering our conclusions invalid [2, 3]. This was never the case: our article's citations explicitly attributed each individual advertorial to one of Exxon, Mobil, or ExxonMobil Corp; we did not obscure anything. It is the case that to avoid overcomplicating or belaboring the point, our original article focused on how the three companies—Exxon, Mobil,

and ExxonMobil Corp—have collectively misled the public. We considered this approach appropriate, because when Exxon and Mobil merged, ExxonMobil Corp inherited legal and moral responsibility for the parent companies. We reject the implied argument that ExxonMobil Corp is somehow not responsible for the actions of Exxon or Mobil, whatever they may have been. Here, we show ExxonMobil Corp's critique to be incorrect both statistically and at the level of individual documents. We delineate three distinct ways in which the data demonstrate that Exxon, Mobil, and ExxonMobil Corp have all, variously, misled the public about AGW.

2. Method

Previously we demonstrated that between 1989–2004, available advertorials—paid, editorial-style advertisements on the Op-Ed page of the *NYT*—published by Mobil and ExxonMobil Corp overwhelmingly expressed doubt about AGW as real and human-caused, serious, and solvable [1]. In this study, we analyze additional advertorials that came to light after our study was published.

We adopt the same methodology as in our prior study, characterizing each document's manifest content in terms of its (i) topic, (ii) position with respect to AGW, and (iii) position with respect to risks of stranded fossil fuel assets [1]. Results from our original analysis of the 32 Internal memos, 72 Peer-Reviewed articles, and 47 Non-Peer-Reviewed articles made available by ExxonMobil Corp are carried forward (see table 1). As before, our analysis compares these documents with Mobil and ExxonMobil Corp's public outreach in the form of advertorials in the *NYT*.

We previously analyzed 36 AGW-relevant advertorials from a collection of 97 compiled by PolluterWatch based on a search of the ProQuest archive [1, 6, 7]. Here, we add to this dataset of 36 by running two additional Boolean ProQuest searches (see section S1, supplementary information for details). In the first, we query for all advertisements in the *NYT* between 1923 and 2018 that refer to 'Mobil' *or* 'Exxon' *or* 'ExxonMobil' *and* to one or more of 13 keywords pertaining to AGW (based on a word frequency analysis of all advertorials included in [1]): 'climate' *or* 'climate change' *or* 'greenhouse' *or* 'global' *or* 'warming' *or* 'Kyoto' *or* 'carbon' *or* 'CO2' *or* 'dioxide' *or* 'temperature' *or* 'GHG' *or* 'Fahrenheit' *or* 'Celsius'. This relevance sample search yielded 1412 documents [8]. In our second search, we query for all advertisements published in the *NYT* on Thursdays between 1970 and 2018, and that refer to 'climate change' *or* 'global warming' *or* 'greenhouse gas' *or* 'greenhouse gases' *or* 'greenhouse effect' *or* 'carbon dioxide' *or* 'CO2'. (This search specifically targets Mobil and ExxonMobil Corp's 'every Thursday' (1972–2001) and 'every other Thursday' (2001+) advertorials [9, 10].) This search yielded 138 documents. Combining the above three datasets and removing redundancies yielded a total of 1448 documents spanning 1924–2013 (see table S4, supplementary information). Despite our comprehensive search, additional unidentified advertorials may, of course, exist. We would welcome ExxonMobil Corp making publicly available a complete online database of its—and Mobil's—advertorials in all newspapers (archived versions of the company's website show that in the past, some—but not all—advertorials were listed, albeit misrepresented as 'Op-Eds' [11]).

Eight research assistants conducted an initial, high-level content analysis to filter for relevance the 1412 documents generated by the first ProQuest search. The assistants downloaded and inspected each individual document within assigned publication windows spanning one to ten years. Applying a standardized procedure, they binned each document as either 'irrelevant' or 'not irrelevant' (subcategories of 'relevant', 'generic', and 'ambiguous') to AGW, erring heavily on the side of caution (even most 'not irrelevant' documents do not, in fact, express any positions on AGW). The remainder of the 1448 documents were likewise binned by one of the authors. To verify intercoder reliability, each analyst independently coded a random subset of 100 documents (approximately 7% of the total number of documents; equivalent, on average, to 61% of the number of documents analyzed by each assistant). In sum, this yielded 267 'not irrelevant' advertorials (intercoder reliability: percentage agreement = 92%; Krippendorff's $\alpha = 0.77$; these are conservative lower-bounds owing to Type I errors, the true value is close to unity—for details see section S1, supplementary information). The authors then coded these 267 advertorials according to the content analysis scheme detailed in [1]. (This included occasional reevaluations of codes assigned in our original analysis.)

We have also obtained additional non-peer-reviewed documents not included in our original study, such as company reports, webpages, and speeches. These inform our interpretation of the results of our content analysis. The sources for these additional documents include the Climate Files archive maintained by Climate Investigations Center, ExxonMobil webpages, and digital archives (Wayback Machine) of earlier ExxonMobil webpages [12, 13]. Unlike other document categories, which are bound sets, non-peer-reviewed documents are virtually limitless in potential number and scope (see footnote on p. 2, [1]). Accordingly, while we introduce specific new non-peer-reviewed documents in this paper in order to inform our Discussion, we do not systematically assess their positions using content analysis. Table 1 and figures 1 and 2 reflect only those non-peer-reviewed documents included in our original study.

Table 1. Inventory of documents analyzed. Shown for each document category are the total number of documents, their date range, source(s), and assigned types. The internal, peer-reviewed, and non-peer-reviewed documents are those studied in [1]. Among peer-reviewed and non-peer reviewed documents, eight publications were found to be redundant, with similar or identical wording to seven other (strictly unique) publications. All 15 are included in our analysis. Among non-peer-reviewed documents, there are two citations provided by ExxonMobil Corp that are identical to two others. The identical two are not included in our analysis. Sources: 'Peer-Reviewed' and 'Additional' publications are cited in the 'Exxon Mobil Contributed Publications' list [4]; 'Supporting Materials' are internal documents offered by ExxonMobil Corp [5]; 'Other' sources refers to documents discovered independently during our research; *ICN = InsideClimate News; NYT = The New York Times. NYT* advertorials were collated from Polluter Watch and ProQuest [6, 7]: an initial relevance sample search yielded 1448 documents, from which 267 'not irrelevant' advertorials were identified for further content analysis. For details on document types, see section S2, supplementary information (available online at https://stacks.iop.org/ERL/15/119401/mmedia), [1]. Miscellaneous Opinions include, for example, commentaries, opinion editorials, and speeches.

			Sources						Document types							
			Provided by ExxonMobil Corp													
Category	No.	Dates	'Peer-reviewed'	'Additional'	'Supporting materials'	*ICN*	*NYT*	Other	Academic Journal	Conference/Workshop proceeding	Gov. report	Book	Industry White Paper	Internal doc.	Ad	Misc. opinion (e.g. comment, op-ed, speech)
Internal documents	32	1977–1995	0	0	22	28	0	1	0	0	0	0	0	32	0	0
Peer-reviewed	72	1982–2014	50	19	0	0	0	3	53	2	13	4	0	0	0	0
Non-peer-reviewed	47	1980–2014	3	29	0	3	0	12	0	24	5	2	2	0	0	13
Advertorials	1448	1924–2013	0	0	0	0	1448	0	0	0	0	0	0	0	1448	0

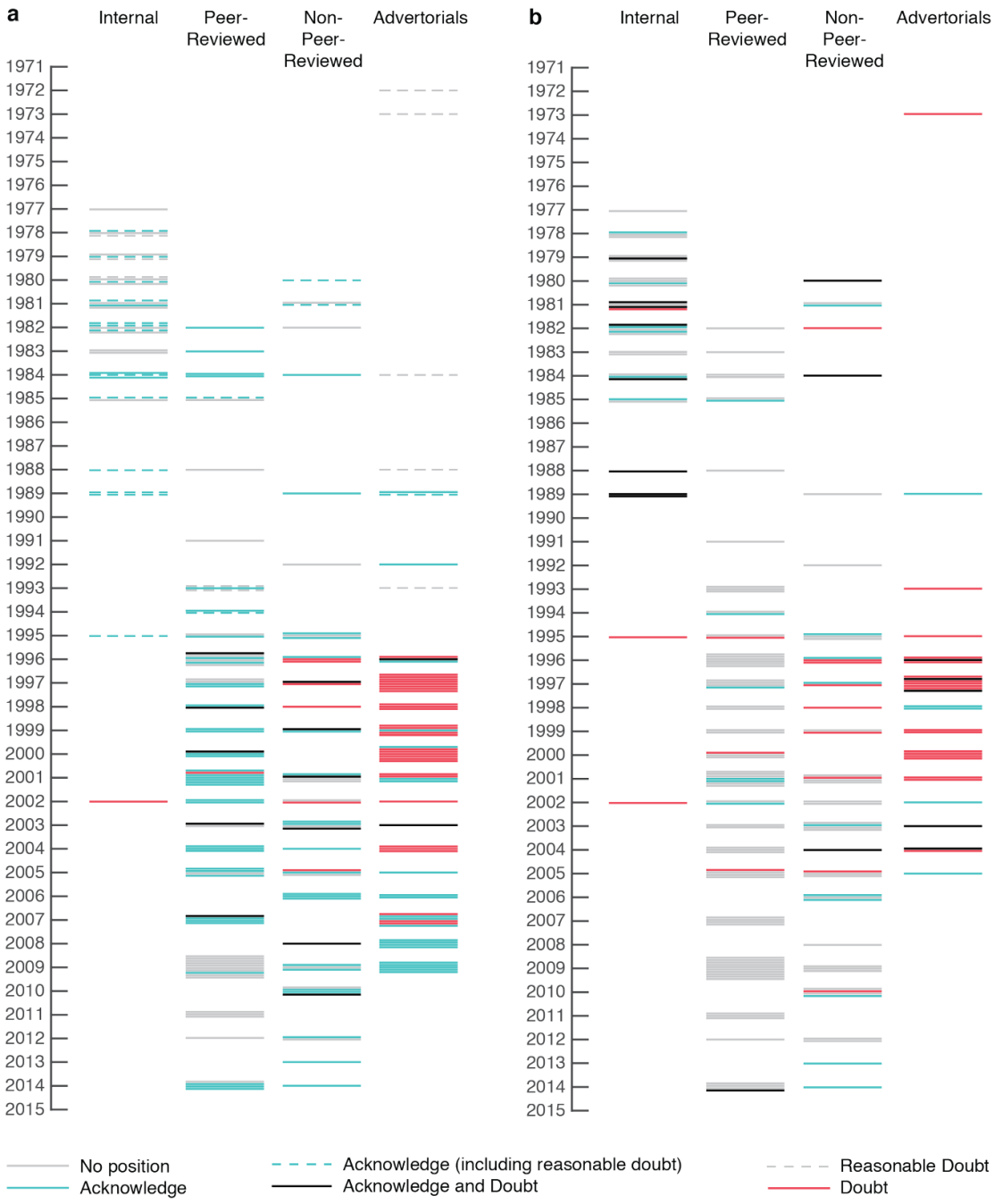

Figure 1. Timeline of the overall positions of 212 and 180 documents on AGW as (a) real and human-caused and (b) serious, respectively (overall positions are color-coded in the legend and defined in [1]). Each line represents an individual document. Documents are sorted by category and publication date. For legibility, only those Advertorials expressing positions are shown (out of a total of 1448 documents).

3. Results

3.1. Endorsement Levels (ELs)—AGW as real and human-caused

Figure 1(a) is a timeline of the overall positions of 212 documents on AGW as real and human-caused, sorted by publication date and into four categories: *Internal Documents, Peer-Reviewed, Non-Peer-Reviewed*, and *Advertorials*. Each line represents an individual document and is color-coded (see [1] for definitions): No position (grey); Acknowledge (blue); Acknowledge and Doubt (black); and Doubt (red). Dashed lines indicate documents that have been filtered for reasonable doubt. ELs for Internal, Peer-Reviewed, and Non-Peer-Reviewed documents are reproduced from our original analysis. ELs are shown for 61 advertorials, spanning 1972–2009, found to express a position (for legibility, the remainder of the 1448 documents with no position are not shown). For each category and for all documents that express a position, figure 2(a) shows the fractions of documents that take that position. For each category (except

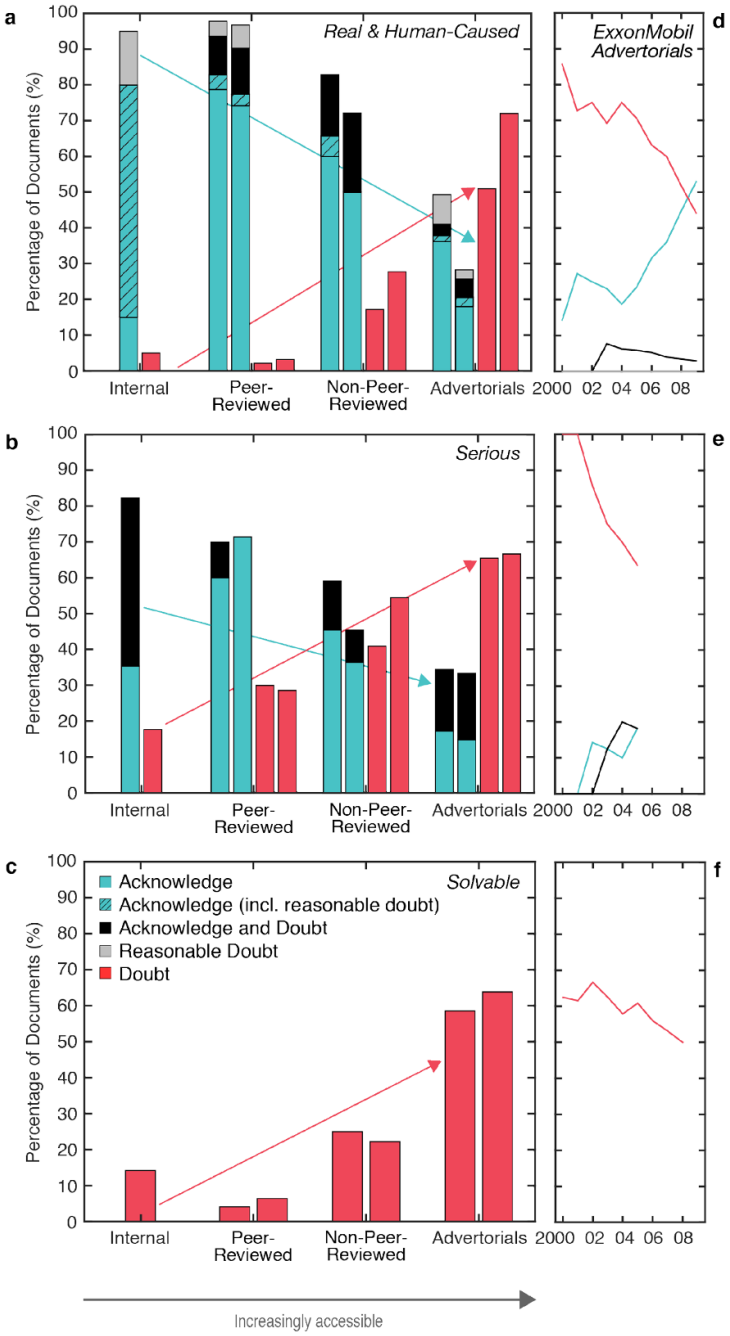

Figure 2. Percentage of documents taking each overall position on AGW as (a), (d) real and human-caused, (b), (e) serious, and (c), (f) solvable (overall positions are color-coded in the legend and defined in [1]). In (a)–(c), for each document category and for all documents that express a position, the fractions of documents taking that position are shown integrated over full time periods. For each category (except internal documents[1]), two bars are shown, based on: (left bar) all documents in figure 1; (right bar) documents published over the date range spanned by the advertorials in our original analysis (1989–2004). Blue and red arrows are guides to the eye, computed as linear least-squares regressions of the average (mean of left and right bars) percentage of documents in each category taking positions of 'Acknowledge' (including reasonable doubt) and 'Doubt', respectively. In (d)–(f), for all ExxonMobil Corp (post-merger) advertorials that express a position, the cumulative fractions of documents taking that position are shown over time.

internal documents[1]), two bars are shown: the left bar of each pair is based on all documents in figure 1; the right bar is based on documents published over the date range spanned by the advertorials in our original analysis (1989–2004), allowing direct comparison to [1]. In both cases (1972–2014 and 1989–2004), positions on AGW as real and human-caused vary significantly across document categories (Fisher's exact test, FET: $p = 8.8 \times 10^{-10}$ and $p = 7.0 \times 10^{-9}$, respectively; see section S2, supplementary information, for details and all probability values).

[1]As in [1], only one bar is shown for internal documents, based on all internal documents (1977–2002), because only 4 of the 20 internal documents expressing a position fall between 1989–2004.

3.1.1. Peer-reviewed, non-peer-reviewed, and internal documents

For detailed descriptions of the positions of Exxon and ExxonMobil Corp's peer-reviewed, non-peer-reviewed, and internal documents, see [1]. Figures 1(a) and 2(a) show that Exxon and ExxonMobil Corp's peer-reviewed publications overwhelmingly acknowledge AGW as real and human-caused ('Acknowledge'). Over the timespan of all documents (left bars in figure 2(a)[1]; see right bars for 1989–2004), of the 65% (47/72) of peer-reviewed documents that express a position, more than four-fifths hold an 'Acknowledge' position (39/47 = 83%). The predominant stance in non-peer-reviewed communications is also 'Acknowledge', although compared to peer-reviewed work, it loses ground to the 'Acknowledge and Doubt' and 'Doubt' stances in roughly equal measure ($p = 0.044$, FET). Of the 74% (35/47) that take a position, 66% (23/35) 'Acknowledge', 17% (6/35) 'Acknowledge and Doubt', and 17% (6/35) 'Doubt' that AGW is real and human-caused. Finally, the bulk of Exxon's internal documents also take the 'Acknowledge' stance. Of the 63% (20/32) that take a position, 80% (16/20) adopt 'Acknowledge', with most of the rest expressing 'Reasonable Doubt' (3/20 = 15%).

3.1.2. Advertorials

In contrast, the predominant stance in Mobil and ExxonMobil Corp advertorials between 1989 and 2004 is 'Doubt', consistent with our original results (e.g. peer-reviewed publications versus advertorials: $p = 2.9 \times 10^{-9}$, FET). Figures 1(a) and 2(a) (right bars) show that of the 8.5% (39/457) of advertorial search results over this period that take a position (including 13 new advertorials uncovered by our ProQuest searches), 72% (28/39) take the position of 'Doubt', with the remainder mostly split between 'Acknowledge' (8/39 = 21%) and 'Acknowledge and Doubt' (2/39 = 5%). Table 2 (top row) provides sample quotations (see section S4, supplementary information, for substantiating quotations for all advertorials). A characteristic example not included in our original dataset is a 2000 ExxonMobil Corp (not Mobil or Exxon) advertorial in the *NYT* and *The Washington Post*, in which the company criticized a US National Assessment report on climate change as putting the 'political cart before a scientific horse' and being based 'on unreliable models' that were 'not yet capable of predicting Earth's global climate' [14, 15]. The advertorial was condemned by the former director of the National Assessment Coordination Office: 'To call ExxonMobil's position out of the mainstream is…a gross understatement' [16]. Another 2000 ExxonMobil Corp advertorial says that 'climate change may appear as confusing as a maze' [17].

Expanding beyond our original analysis to include 4 and 18 new advertorials published pre-1989 and post-2004, respectively, figures 1(a) and 2(a) (left bars) show that 'Doubt' continues to account for half of all positions (31/61 = 51%), though it loses some ground to the 'Acknowledge' stance (23/61 = 38%). The remaining positions are shared between 'Reasonable Doubt' and 'Acknowledge and Doubt' (5/61 = 8% and 2/61 = 3%, respectively). Examples of 'Doubt' include three ExxonMobil Corp advertorials in 2007, which, despite acknowledging 'the risks of climate change', variously say that 'climate science remains extraordinarily complex', that it is 'evolving', and that 'areas of uncertainty do exist' [18–20]. Of those advertorials expressing 'Acknowledge' from 2005 onwards, 93% (14/15) do so only implicitly (EP3a), almost exclusively by discussing mitigation (such as energy efficiency and technology innovation) rather than climate science. None explicitly say that climate change is real and human-caused.

Accompanying the emergence of implicit acknowledgments is a rhetorical framework focused on 'risk'. 'Risk(s)' of AGW (or of greenhouse gases) becomes ExxonMobil Corp's watchword, appearing at least once in 87% (13/15) of these advertorials (table S4, supplementary information). A characteristic example is a 2007 advertorial entitled 'Saving Energy and Reducing Greenhouse Gas Emissions', which refers to 'steps ExxonMobil is taking to address the risk of climate change' and says that 'industry, consumers and policymakers all have a role to play in addressing the risks of climate change' [21]. A 2008 advertorial discusses lower-carbon fuels and other approaches to 'addressing the risks posed by rising greenhouse gas emissions', but without mentioning AGW [22].

These observations—of implicit acknowledgments and 'risk' rhetoric—are part of a wider trend. Regarding the former: across all advertorials in all years, only two express any form of explicit acknowledgment (EP2). One, a borderline case in 2005, does so only indirectly, by quoting a statement from the Group of Eight (G8) that does not address causation [23]. The other, in 1989, is not in fact an advertorial, but an advertisement in *The New York Times Magazine* that may or may not have actually included Exxon among its industry sponsors [24]. All other acknowledgments are implicit: they avoid directly addressing climate science and the issue of human causation, instead discussing emissions reductions strategies. Figure S1, supplementary information, shows that from the late 1990s onwards, advertorials focused on mitigation rapidly outnumbered those focused on methods and climate science—cumulatively, by more than three-to-one.

We shall address the wider trend concerning 'risk' rhetoric in a forthcoming study. See table 3, however, for examples of the pervasiveness of 'risk' language in ExxonMobil Corp's public communications about AGW.

Table 2. Example quotations (coding units) from Mobil/ExxonMobil Corp advertorials expressing (left) acknowledgment and (right) doubt that AGW is (top row) real and human-caused, (middle row) serious, and (bottom row) solvable. Quotations are sourced only from advertorials not included in [1]. For each position, two examples are given: the first typifies a relatively 'strong' quotation, the second a relatively 'mild' one (except AGW as serious, for which only one new advertorial expresses acknowledgment; and except for AGW as solvable, for which only 'Doubt' is coded). Substantiating quotations for all advertorials are provided in section S4, supplementary information.

	Acknowledge		Doubt	
AGW as real & human-caused (EP1,2,3)	**2007**	Title: 'Saving Energy and Reducing Greenhouse Gas Emissions'. 'Two weeks ago, we described some of the steps ExxonMobil is taking to address the risk of climate change. These included working to improve energy efficiency and fuel economy, and groundbreaking research into low-emissions technologies. This week, we focus on consumers…industry, consumers and policy-makers all have a role to play in addressing the risks of climate change' [21].	**2000**	Title: 'Political cart before a scientific horse'. 'The Clinton administration has released a draft overview of the purported potential effects of climate change on specific U.S. geographic regions and economic sectors…But as climate scientists will tell you, we currently have neither the knowledge nor the tools to [produce an accurate assessment]…Climate models are evolving research tools but are not yet capable of predicting Earth's global climate and are currently unsuitable for making national or regional assessments'. Advertorial cites 'key scientific uncertainties' and quotes Freeman J. Dyson, calling climate models 'unreliable'. 'Most of the underlying reports and analyses are not yet available for scientific peer review…' [this was untrue—see [16]] [14].
	2008	'To meet this [higher future global energy] demand, while addressing the risks posed by rising greenhouse gas emissions, we will need to call upon a broad mix of energy sources' [22].	**2007**	'Climate remains an extraordinarily complex area of scientific study. But the risks to society and ecosystems from climate change could prove to be significant—so despite the areas of uncertainty that do exist, it is prudent to develop and implement strategies that address the risks' [20].

(continued)

Table 2. (Continued).

	Acknowledge		Doubt	
AGW as serious (IP1,3)	**2005**	"'Climate change is a serious and long-term challenge that has the potential to affect every part of the globe." These quotes—with which we agree entirely—were among those endorsed by government leaders at the recent G8 meeting in Gleneagles, Scotland' [23].	**1993**	Title: 'Apocalypse no'. 'For the first half of 1992, America was inundated by the media with dire predictions of global warming catastrophes…Unfortunately, the media hype proclaiming that the sky was falling did not properly portray the consensus of the scientific community. After the Earth Summit, there was a noticeable lack of evidence of the sky actually falling and subsequent colder than normal temperatures across the country cooled the warming hysteria as well'. 'If nothing else, [The Heidelberg Appeal's] message is illustrative of what's wrong with so much of the global warming rhetoric. The lack of scientific data'. Quoting Robert C. Balling: "there is a large amount of empirical evidence suggesting that the apocalyptic vision is in error and that the highly touted greenhouse disaster is most improbable." Quoting S. Fred Singer: "the net impact [of a modest warming] may well be beneficial." 'All of which would seem to suggest that the jury's still out on whether drastic steps to curb CO_2 emissions are needed' [25].
			1996	'Such speed [of international climate action] may not be needed or even desirable given what we know and do not know about the economic and environmental impact of what climate change might produce' [26].
AGW as solvable (SP1)			**1996**	UN-sponsored climate action 'is likely to cause severe economic dislocations…If developed nations act *alone* to reduce emissions, the staggering cost imposed on energy-intensive industries will drive nations to export much of their industrial base to countries with less stringent controls. World economic health will suffer as nations are forced to switch from fossil fuels, saddled with large carbon taxes and driven to prematurely scrap many factories and machinery. The dislocations will be even more severe if the solutions are not implemented globally…Jobs and livelihoods are at stake [in deciding on climate policy]' [26].
			2007	'Businesses, governments and NGOs are faced with a daunting task: selecting policies that balance economic growth and human development with the risks of climate change' [18, 19].

3.2. Impact Levels (ILs)—AGW as serious

Figure 1(b) is a timeline of the overall positions of 180 documents on AGW as serious. ILs for Internal, Peer-Reviewed, and Non-Peer-Reviewed documents are reproduced from [1]. ILs are shown for 29 Advertorials, spanning 1973–2005, found to express a position. For each category and for all documents that take a position, figure 2(b) shows the fractions of documents that take that position. For both spans of documents shown in figure 2(b) (left bar: 1973–2014; right bar: 1989–2004), positions on AGW as serious vary significantly across document categories at $p < 0.1$ (FET: (1973–2014) $p = 0.066$; (1989–2004) $p = 0.061$).

3.2.1. Peer-reviewed, non-peer-reviewed, and internal documents

For detailed descriptions of the positions of Exxon and ExxonMobil Corp's peer-reviewed, non-peer-reviewed, and internal documents, see [1]. In summary, figures 1(b) and 2(b) show that over the timespan of all documents (left bars in figure 2(b)[1]; see right bars for 1989–2004), of the 10 peer-reviewed publications that discuss the potential impacts of AGW, 60% (6/10) take a position of 'Acknowledge', 30% (3/10) of 'Doubt', and 10% (1/10) of 'Acknowledge and Doubt'. Non-peer-reviewed documents offer a mix of positions. Among the 47% (22/47) that take a position, 45% (10/22) 'Acknowledge', 41% (9/22) 'Doubt', and 14% (3/22) 'Acknowledge and Doubt'. Finally, internal documents also typically acknowledge the potential for serious impacts, but also highlight uncertainties. Of the 53% (17/32) of documents with a position, 35% (6/17) 'Acknowledge' and 47% (8/17) 'Acknowledge and Doubt'.

3.2.2. Advertorials

Mobil and ExxonMobil Corp's advertorials overwhelmingly take the position of 'Doubt', consistent with our original findings (e.g. peer-reviewed publications versus advertorials, FET: (1973–2014) $p = 0.043$; (1989–2004) $P = 0.014$). Figures 1(b) and 2(b) (right bars) show that over the period 1989–2004 covered in our original analysis, of the 5.9% (27/457) of advertorial search results that take a position (including six new advertorials from our ProQuest searches), 66.5% (18/27) express 'Doubt', with the remainder split between 'Acknowledge' and 'Acknowledge and Doubt' (4/27 = 15% and 5/27 = 18.5%, respectively). A characteristic example (table 2, middle row) not included in our original dataset is a 1996 Mobil advertorial saying that 'such speed [of international climate action] may not be needed or even desirable given what we know and do not know about the economic and environmental impact of what climate change might produce' [26]. The 2000 ExxonMobil Corp advertorial discussed earlier claims that the US National Assessment 'report's language and logic appear designed to emphasize selective results to convince people that climate change will adversely impact their lives'—implying that it will not [14, 15]. A third example is a 1993 Mobil advertorial entitled 'Apocalypse No' [25], which claims that 'dire predictions of global warming catastrophes' in 1992 were 'media hype' that 'did not properly portray the consensus of the scientific community'. It goes on to argue that 'what's wrong with so much of the global warming rhetoric' is 'the lack of solid scientific data', and alleges 'a noticeable lack of evidence of the sky actually falling' and 'colder than normal temperatures' in the US The advertorial quotes prominent climate contrarian Robert C. Balling, who argues 'that the apocalyptic vision is in error and that the highly touted greenhouse disaster is most improbable'. The advertorial also quotes physicist S Fred Singer, well known at the time for challenging the scientific evidence of stratospheric ozone depletion, claiming that: 'the net impact [of a modest warming] may well be beneficial' [27].

Expanding beyond our original analysis to include all years has little effect on the overall result: 'Doubt' continues to dominate (19/29 = 66%), while 'Acknowledge' and 'Acknowledge and Doubt' make up the difference (5/29 = 17% apiece). Post-2004, advertorials are virtually silent about the seriousness of AGW (beyond generic 'risk' statements—see [1]). In other public communications, however, this doubt has continued (a few examples are given in table 3—see ExxonMobil Corp statements from ∼2008 onwards).

3.3. Solvable Levels (SLs)—AGW as solvable

Positions on AGW as solvable vary significantly across document categories (FET: (all years with positions, 1981–2008) $p = 9.0 \times 10^{-11}$; (1989–2004) $p = 6.9 \times 10^{-10}$). Expressed as a fraction of the total number of documents per category communicating any positions on AGW (real and human-caused, serious, or solvable), figure 2(c) (left bars[1]) shows that over the timespan of all documents, only 4% (2/48) of peer-reviewed papers express 'Doubt' that AGW is solvable. Internal and non-peer-reviewed materials also express relatively low levels of doubt: 14% (3/21) and 25% (9/36), respectively. In contrast, 58% (45/77) of advertorials do so (e.g. peer-reviewed publications versus advertorials: $p = 9.1 \times 10^{-11}$, FET). Similarly, figure 2(c) (right bars) shows that over the period 1989–2004 covered in our original analysis, levels of 'Doubt' are: 6% (2/31) of peer-reviewed papers, 22% (4/18) of non-peer-reviewed documents, and 64% (37/51) of advertorials (e.g. peer-reviewed publications versus advertorials: $p = 2.2 \times 10^{-9}$, FET).

A characteristic example of doubt that AGW can be effectively addressed (table 2, bottom row) is a 2000 ExxonMobil Corp advertorial (not included in our original dataset) that says the Kyoto Protocol to the United Nations Framework Convention on

Table 3. Examples of public doubt about AGW either directly communicated or indirectly funded by ExxonMobil Corp following the merger of Exxon and Mobil. Quotations are sourced from documents not included in our content analysis, such as company reports, speeches, newspaper accounts, and archived websites. Although we do not formally code the positions of these statements on AGW, and the relative 'strengths' of doubt vary from statement to statement, ExxonMobil Corp's direct representations through 2007/8 appear to express doubt about AGW as real and human-caused. Through to the present day, the company continues to itself question the 'competency' of climate models and the role of humans as the 'principal drivers of climate change', yet emphasis also shifts to promoting doubt about AGW as serious and solvable (as indicated, most statements also include 'risk' rhetoric). Examples are also given of third-party individuals and organizations funded by ExxonMobil Corp that have communicated doubt about AGW as real and human-caused, serious, or solvable in the recent past and/or present.

Year	Publication	Quotation
2000	Company report (preface by CEO Lee Raymond) [106]	Raymond: '[W]e do not now have a sufficient scientific understanding of climate change to make reasonable predictions and/or justify drastic measures…the science of climate change is uncertain…'. '[N]atural period of warming' (ice ages), 'solar activity', '[v]olcanic eruptions, El Nino': 'With all this natural climate 'noise' and the complexities of measurement, science is not now able to confirm that fossil fuel use has led to any significant global warming…Currently, there does not appear to be a consensus among scientists about the effect of fossil fuel use on climate'. Risk rhetoric: 'it may pose a legitimate long-term risk…'.
2001	'Climate talking points' in press release [44]	'Misinformation exists over the role and membership of IPCC: it is not a research organization and its members are not scientists… scientists work together only in the small teams that draft individual chapters…[IPCC's climate science models] have…fundamental gaps in basic understanding…'. Regarding the 'Hockey Stick' graph showing global warming: 'The error bars are huge, yet some prefer to ignore them'. Risk rhetoric: 'long-term risk(s)'.
2001	Lee Raymond, speech [105]	'We need good, and better, climate science…if we cannot forecast the weather a week from now, I would be suspect of our ability to forecast the climate 100 years from today'. Risk rhetoric: 'risks'.
2001	Press release [106]	'[T]here is no consensus about long-term climate trends and what causes them…during the 1970's [*sic*], people were concerned about global cooling'. Risk rhetoric: 'long-term risks'.
2002	Lee Raymond, speech [107]	'We in ExxonMobil do not believe that the science required to establish this linkage between fossil fuels and warming has been demonstrated—and many scientists agree…[T]his is because of incomplete data and methodology and the overarching role of natural variability'. Risk rhetoric: 'risk'.
2004	Company report [108]	'ExxonMobil recognizes that although scientific evidence remains inconclusive, the potential impacts of greenhouse gas emissions…may prove to be significant…Climate: Infinitely more complex than weather…[T]he cause of this [global warming] trend and whether it is abnormal remain in dispute…[T]he geological record…shows considerable variation'. Cites numerous non-human factors influencing climate. Risk rhetoric: 'risks'.
2005	Academic article funded by ExxonMobil (also Charles G Koch Charitable Foundation and American Petroleum Institute) [109]	'[T]he hypothesis of a CO_2-dominated warming of the Arctic is not likely consistent with the large decadal-and-multidecadal warming and cooling signals contained in the Arctic-wide SAT record'.
2005	Lee Raymond, television interview [96]	'There is a natural variability that has nothing to do with man…It has to do with sun spots…with the wobble of the Earth…[T]he science is not there to make that determination [as to whether global warming is human-caused]…[T]here are a lot of other scientists that do not agree with [the National Academy and IPCC]…[T]he data is not compelling'.
2006–2007	ExxonMobil website & *2005 Corporate Citizenship Report* [110]	'Climate science is complex…the extent to which recent temperature changes can be attributed to greenhouse gas increases remains uncertain…[G]aps in the scientific basis for theoretical climate models and the interplay of significant natural variability make it very difficult to determine objectively the extent to which recent climate changes might be the result of human actions'. Risk rhetoric: 'risk(s)'.
2007	Academic (non-peer-reviewed) article funded by ExxonMobil (also Charles G Koch Charitable Foundation and American Petroleum Institute) [111]	'[I]t is highly premature to argue for the extinction of polar bear [*sic*] across the circumpolar Arctic within this century…It is certainly premature, if not impossible, to tie recent regional climatic variability in this part of central Canada to anthropogenic greenhouse gases and, further, to extrapolate species-level conditions on this basis…[T]here is no ground for raising public alarm about any imminent extinction of Arctic polar bears'.

(continued)

Table 3. (Continue).

Year	Publication	Quotation
2008	CEO Rex Tillerson, interview [112]	'…to not have a debate on [AGW] is irresponsible…To suggest that we know everything we need to know about these issues is irresponsible…Anybody that tells you that they got this figured out is not being truthful. There are too many complexities around climate science for anybody to fully understand all of the causes and effects and consequences of what you may chose to do to attempt to affect that. We have to let scientists to [*sic*] continue their investigative work, unencumbered by political influences'.
2010	Rex Tillerson, Congressional testimony [113]	'[T]here is no question climate is changing, that one of the contributors to climate change are greenhouse gases that are a result of industrial activities—and there are many greenhouse gases besides CO_2…[T]he real challenge I think for all of us is understanding to what extent and therefore what can you do about it…[L]et us continue to support the scientific investigation…It is extremely complicated…So, yes, we acknowledge that it is a contributing factor. Where I think we have differences [is that] we understand the difficulties of modeling the science…[T]here is not a model available today that is competent…So we say keep studying it'. Risk rhetoric: 'risk management'.
2012	Rex Tillerson, speech [114]	'[T]he competencies of the [climate] models are not particularly good…We cannot model aerosols; we cannot model clouds, which are big, big factors in how the CO_2 concentrations in the atmosphere affect temperatures…[O]ur ability to predict, with any accuracy, what the future's going to be is really pretty limited…I am not disputing that increasing CO_2 emissions in the atmosphere is going to have an impact. It will have a warming impact. The—how large it is is [*sic*] what is very hard for anyone to predict. And depending on how large it is, then projects how dire the consequences are'.
2013	Rex Tillerson, television interview [115]	'[T]he facts remain there are uncertainties around the climate, climate change, why it is changing, what the principal drivers of climate change are. And I think the issue that I think is unfortunate in the public discourse is that the loudest voices are what I call the absolutist, the people who are absolutely certain that it is entirely man-made and you can attribute all of the climate change to nothing but man-made burning of fossil fuels…[T]here are other elements of the climate system that may obviate this one single variable that we are concentrating on because we are concentrating on a single variable in a climate system that has more than 30 variables. We are only working on one. And so that's that uncertainty issue…'. Risk rhetoric: 'risk(s)', 'serious risks', 'managing risks'.
2013	Rex Tillerson, speech [116]	'If you examine the temperature record of the last decade, it really had not changed…Our ability to project with any degree of certainty the future is continuing to be very limited…[O]ur examination about the models are [*sic*] that they are not competent'. Risk rhetoric: 'risk'.
2014	ExxonMobil affiliate, Syncrude [117]	Syncrude submits that the production and consumption of petroleum fuels is not dangerous and does not pose a risk to human health or safety'.
2015	Senator Jim Inhofe (R-OK), funded by ExxonMobil [118]	'[W]e keep hearing that 2014 has been the warmest year on record. I ask the Chair, 'You know what this is?' It's a snowball, and that's from just outside here, so it's very, very cold out'.
2015	Rex Tillerson, speech [119]	'We do not really know what the climate effects of 600 ppm versus 450 ppm will be because the models simply are not that good'. Risk rhetoric: 'risk management'.
2017	Rex Tillerson, Congressional testimony [120, 121]	'I understand these [greenhouse] gases [due to 'combustion of fossil fuels'] to be a factor in rising temperature, but I do not believe the scientific consensus supports their characterization as the 'key' factor'. Risk rhetoric: 'risk'.
1992-2018	American Legislative Exchange Council, funded by ExxonMobil [122–124]	'Global Climate Change is Inevitable. Climate change is a historical phenomenon and the debate will continue on the significance of natural and anthropogenic contributions'. (2020)
2002-present	National Black Chamber of Commerce, funded by ExxonMobil [125–127]	'There is no sound science to support the claims of Global Warming'. (2020)

Climate Change involved 'highly unrealistic carbon reduction goals' that were 'not possible' for the US to meet [28]. 'Ambitious public policies and international treaties that assume very rapid change in total energy use are simply unrealistic' and 'attempts to mandate such change are fraught with risk'. Another ExxonMobil Corp advertorial, which appeared twice in 2007, says that 'businesses, governments and NGOs are faced with a daunting task: selecting policies that balance economic growth and human development with the risks of climate change' [18, 19]. These advertorials echo two of the prominent themes of 'Doubt' identified in our original analysis: (i) an alleged dichotomy between climate mitigation and poverty reduction, and (ii) the allegedly severe adverse economic impacts of mitigation [1]. A third example is a 1996 Mobil advertorial that states: '[UN-sponsored climate action] is likely to cause severe economic dislocations at a time when many nations are striving for growth and jobs...World economic health will suffer as nations are forced to switch from fossil fuels, saddled with large carbon taxes and driven to prematurely scrap many factories and machinery…Jobs and livelihoods are at stake' [26].

As might be expected, the content and tone of advertorials change with time. As the scientific evidence of AGW strengthened in the early 2000s, advertorials began to include discussion of options for greenhouse gas emissions reductions, such as investment in energy efficiency and technology research and development. This is the context in which the third 'Doubt' argument we identified in our original study appears: insisting on the limitations of renewable energy [1]. A 2001 ExxonMobil Corp advertorial expresses a characteristic sentiment: 'Though promising, renewable energy's potential should be tempered with realism' [29]. The advertorial points out that wind power 'generally enjoys tax subsidies', yet says nothing about the much larger subsidies that fossil fuels receive [30–32]. In various forms, the advertorials reinforce the presumed inevitability of continued fossil fuel dominance [33–36].

3.4. Stranded fossil fuel assets

As discussed in [1], 24 of the analyzed documents allude to the concept of stranded fossil fuel assets. Our updated analysis finds that, as before, no advertorials address the issue. Therefore, the contrast across document categories remains clear and statistically significant: the threat of stranded assets is recognized in internal and academic documents, but never mentioned in advertorials (FET: (all years) $p = 3.3 \times 10^{-7}$; (1989–2004) $p = 3.2 \times 10^{-6}$).

3.5. Summary of results

Our ProQuest searches described herein add 18 advertorials expressing positions on AGW (real and human-caused, serious, or solvable) to those included in our original analysis spanning 1989–2004, and 26 outside of these years (these new documents are indicated by yellow highlights in table S4, supplementary information).

An updated analysis of the period 1989–2004 continues to yield statistically significant results, and our conclusions therefore remain unchanged: between 1989–2004, Mobil and ExxonMobil Corp advertorials overwhelmingly expressed doubt about AGW as real and human-caused, serious, and solvable. Indeed, having augmented our archive of advertorials, and with our prior document codings undisputed by ExxonMobil Corp's critiques, our original conclusions are now strengthened [2, 3].

Expanding beyond the timeframe of our original analysis negligibly affects the overall positions of advertorials on AGW as serious and solvable: Over all years with advertorial positions (1973–2005 and 1988–2008, respectively), 'Doubt' remains the overwhelming position in both respects (sections 3.2.2 and 3.3). The predominant stance over all years on AGW as real and human-caused also remains 'Doubt' (section 3.1.2). From 2005–09 this is reduced, with the positions of advertorials transitioning from mostly 'Doubt' (1989–2004) to mostly 'Acknowledge', punctuated by doubt in 2007 (figure 1(a)).

Most of these recent 'Acknowledgments' are ambiguous. As described in section 3.1.2, the vast majority (93%) are implicit: in no case does ExxonMobil Corp state that climate change is real and human-caused. Nor do they acknowledge a change in their position. In this sense, the acknowledgments are asymmetric compared to the doubt promoted in earlier advertorials. Earlier advertorials *explicitly* challenged climate science; later ones merely sidestepped it, citing undefined 'risk(s)' of climate change (87% of post-2004 advertorials) and discussing options for emissions reductions without stating why they are necessary.

4. Discussion

Our results imply at least three ways in which Exxon, Mobil, and ExxonMobil Corp have, variously, misled the public about AGW. Sections 4.1–4.3 address each of these in turn.

4.1. Exxon and ExxonMobil Corp misled with discrepant communications

The first way the public was misled derives from the results of our content analysis and relies on a line of reasoning presented in our original paper: comparison across company document categories.

Figure 2(d) shows that from 2000 through 2004 (after the Exxon-Mobil merger), the overwhelming position of ExxonMobil Corp advertorials on AGW as real and human-caused continued to be 'Doubt' (12/16 = 75%). The discrepancy between this doubt and the predominant acknowledgment in Exxon

and ExxonMobil Corp peer-reviewed, non-peer-reviewed, and internal documents shown in figure 1(a) is statistically significant (FET: $p = 8.5 \times 10^{-8}$, $p = 0.0079$, and $p = 1.6 \times 10^{-5}$, respectively, for all peer-reviewed, non-peer-reviewed, and internal documents through 2004). From a statistical standpoint it is essentially certain that whereas Exxon and ExxonMobil Corp's private and academic documents predominantly acknowledge that climate change is real and human-caused, ExxonMobil Corp's advertorials disproportionally—and overwhelmingly—promote doubt on the same matter. This unambiguously reaffirms our original conclusion.

The contrast across document categories—that is, evidence of misleading communications—is also clear when analyzed at a year-to-year scale (figure 1(a)). During the early 2000s, ExxonMobil Corp's peer-reviewed publications and advertorials in the same years contradict one another. For instance, in 2004, one peer-reviewed ExxonMobil Corp publication refers to 'the fraction of anthropogenic CO_2 emissions that remains in the atmosphere, and contributes to the radiative forcing of climate'; another presents 'cumulative CO_2 emissions' for a '550 ppm stabilization trajectory'; and a third discusses 'CO_2 disposal as an option to mitigate climate change from an enhanced greenhouse effect' [37–39]. Yet, that same year, one ExxonMobil Corp advertorial stressed the alleged 'debate over climate change' and fostered uncertainty that AGW had been observed, saying 'last year's record summer heat in Europe does not confirm a warming world' (climate attribution assessments have since disproved this claim [40]). They insisted that 'in the face of natural variability and complexity, the consequences of change in any single factor, for example greenhouse gases, cannot readily be isolated and prediction becomes difficult… scientific uncertainties continue to limit our ability to make objective, quantitative determinations regarding the human role in recent climate change or the degree and consequences of future change' [41]. Another advertorial the same year emphasized the 'gaps and uncertainties that limit our current ability to know the extent to which humans are affecting climate and to predict future changes caused by both human and natural forces' [42].

Given these discrepancies it is clear that ExxonMobil Corp misled the public over this period. The historical record categorically refutes ExxonMobil Corp's recent claims that only Mobil was responsible for misleading advertorials (and for other misleading communications, as we discuss below). Misleading advertorials did not cease when Exxon and Mobil merged.

Figures 2(e) and (f) show that across all ExxonMobil Corp advertorials with positions on AGW as serious and solvable, respectively, levels of 'Doubt' outweigh those in peer-reviewed, non-peer-reviewed, and internal documents (Serious, FET: $p = 0.10$, $p = 0.87$, and $p = 0.093$, respectively; Solvable, FET: $p = 6.0 \times 10^{-6}$, $p = 0.063$, and $p = 0.0027$, respectively). These discrepancies again demonstrate that ExxonMobil Corp misled the public.

Additionally, peer-reviewed, non-peer-reviewed, and internal documents from Exxon and ExxonMobil Corp acknowledge the risks of stranded assets (24 times), whereas ExxonMobil Corp's advertorials do not ($p = 3.3 \times 10^{-7}$, FET). This imbalance has not been disputed by ExxonMobil Corp in its critiques of our original study [2, 3].

The significance of these discrepancies is compounded by the imbalance in the physical and intellectual accessibility of advertorials versus other document categories. As evidenced in our original study, ExxonMobil contributed to scientific articles with likely average readerships of tens to hundreds, yet raised doubts about that science in newspapers potentially read by millions of people [1].

Non-peer-reviewed Exxon and ExxonMobil Corp documents also communicate greater doubt about AGW as real and human-caused and solvable than peer-reviewed Exxon and ExxonMobil Corp publications (and, with respect to real and human-caused positions, than Exxon and ExxonMobil Corp internal documents) (figures 1(a) and (c)). Although this discrepancy is smaller, it is statistically significant at or below $p < 0.1$ (FET: (real and human-caused) $p = 0.044$ for peer-reviewed publications and $p = 0.077$ for internal memos; (solvable) $p = 0.0076$), suggesting that Exxon and ExxonMobil Corp's non-peer-reviewed communications, which tended to be more orientated towards non-scientific audiences (such as industry groups and journalists) than peer-reviewed papers, were sometimes misleading.

The non-peer-reviewed documents demonstrate that the doubt ExxonMobil Corp expressed in advertorials post-merger was not an unintentional or isolated incident: it was part of the company's broader public communications effort. As noted in our original paper, there are countless non-peer-reviewed materials beyond those included in our corpus [1]. Table 3 lists just a few examples, among them 'climate talking points' that ExxonMobil Corp distributed to reporters in 2001 as part of a press release specifically promoting their publication of two advertorials ('major ads') in the *Los Angeles Times, NYT, The Wall Street Journal*, and *The Washington Post* [43]. In step with the advertorials, the talking points question the scientific authority of the Intergovernmental Panel on Climate Change (IPCC) and the validity of the 'Hockey Stick' graph showing global warming, which was a centerpiece of the 2001 IPCC report [44].

4.2. Exxon, Mobil, and ExxonMobil Corp misled with misinforming advertorials and non-peer-reviewed publications

The second way the public was misled also derives from the results of our content analysis and relies

on a line of reasoning presented in our original paper: comparison of public company communications against available scientific information.

ExxonMobil Corp has not disputed any of our original document codings, including those identifying numerous expressions of doubt—some, factual misrepresentations—about AGW (notably in Mobil and ExxonMobil Corp advertorials and Exxon and ExxonMobil Corp non-peer-reviewed publications) [2, 3]. Using as proxies for mainstream climate science both the conclusions of the IPCC (our analysis filters for 'reasonable' doubt—see [1]) and the science of Exxon and ExxonMobil Corp itself (ExxonMobil Corp says its 'researchers recognized the developing nature of climate science at the time…[and] mirrored global understanding'), it is evident that Exxon, Mobil, and ExxonMobil Corp's public communications were inconsistent with available scientific information and therefore misled the public [45, 46].

4.2.1. What did Mobil know?

ExxonMobil Corp's critiques of our original study imply that Mobil was oblivious to the insights and warnings of mainstream climate science, even as it ran advertorials attacking that science [2]. Yet a 1997 Mobil advertorial suggests otherwise: 'We continue to sponsor research at universities…At Columbia's Lamont-Doherty Geophysical Observatory, we supported work on the role that oceans play in the climate system' [47].

Additional documents not included in our original analysis confirm that Mobil, like Exxon, had direct access to the insights of mainstream climate science [48–51]. For example, as a 1997 report by Mobil's Anthony R. Corso summarized, 'Over the past five years we have funded scientific and economic studies at The Massachusetts Institute of Technology, the Lamont-Dougherty [*sic*[2]] Geophysical Observatory of Columbia University, the Harvard-Smithsonian Astrological [*sic*] Observatory, and the Australian Bureau of Agricultural and Resource Economics'. [48] Mobil was '[f]unding [this] research to increase the understanding of the science and economics of global climate change'.

According to a newly discovered internal budget proposal, '1994 Mobil Foundation Grant Recommendations', Mobil's funding at Columbia University included $25 000 per year in 1991 and 1992 and would continue at the same rate in 1993 and 1994 [49]. Mobil described the university's Lamont-Doherty laboratory as 'a world-wide leader in earth and atmospheric studies' and said the purpose of the grant was to 'develop an improved computer model [that] will become part of the larger models predicting the impact of increased greenhouse gas emissions on global climate'. 'Ultimately', they noted, 'these models will be the basis for regulatory action'. 'Benefits to Mobil Foundation' included '[t]echnical information and understanding…key to Mobil's ability to participate in the debate on [potentially imminent greenhouse gas] regulations...Mobil scientists involved in the global warming issue can gain first hand understanding of the role of the oceans in global warming and develop personal relationships with some of the key experts…[P]articipating at this level is far more valuable to Mobil than merely reading papers…'.

In other words, Mobil had scientists studying AGW and learning from some of the same groups of independent climate experts as Exxon scientists. (For example, from the late 1970s through the mid-1980s, Exxon spent tens of thousands of dollars funding a 'cooperative program with Lamont-Doherty' in which scientists at Exxon and Columbia University collaboratively co-authored AGW project proposals and conducted AGW research [52–59]. ExxonMobil Corp has continued to fund the Lamont-Doherty Earth Observatory throughout most of the 2000s to present [60–71].) In turn, those Exxon scientists overwhelmingly acknowledged AGW as real and human-caused. Mobil's access to these same mainstream scientific resources preceded and paralleled its publication of advertorials attacking climate science and its implications, further demonstrating that Mobil knowingly misled the public.

Mobil was also an active member of the American Petroleum Institute (API), and numerous documents record API's early awareness of the potential AGW dangers of its products. These include API-commissioned research on carbon dioxide at the California Institute of Technology in 1955; an in-person warning to API by physicist Edward Teller in 1959; API monitoring of warnings about AGW by President Johnson's Science Advisory Committee in 1965; and API-commissioned research on AGW at Stanford Research Institute in 1968 and 1969 [72–75].

4.3. Exxon and ExxonMobil Corp misled with additional direct and indirect climate denial

The third way the public was misled relies on an additional line of reasoning that was not explicitly discussed in our original paper: comparison of the results of our content analysis against an extensive literature of scholarly research and investigative journalism that has chronicled the company's history of directly and indirectly perpetuating climate science misinformation.

ExxonMobil Corp has not disputed our document codings, which reveal overwhelming acknowledgement by both Exxon and ExxonMobil Corp scientists that AGW is real and human-caused [2, 3]. At the same time, it is well-documented (based on documents beyond those included in our analysis, as well as on some non-peer-reviewed documents

[2]Correct spelling is Lamont-Doherty.

included herein) that (i) from at least the 1990s until at least 2015 (and arguably to this day), Exxon and ExxonMobil Corp have sometimes publicly promoted doubt about climate science through direct company communications; and that (ii) from at least the late 1980s through to the present, Exxon and ExxonMobil Corp have funded groups and individuals and participated in organizations that cast doubt in public on climate science [27, 76–103] (table 3 provides a few examples). To our knowledge, ExxonMobil has never disputed its history of direct and indirect climate denial. Likewise, Exxon and ExxonMobil Corp have a track record of directly and indirectly promoting public doubts about AGW as serious and solvable that are inconsistent with the views of company scientists chronicled by our analysis (again, see table 3 for examples).

This comparison—between what ExxonMobil knew and its broader history of climate denial and delay—is an inherent, central line of reasoning in many journalistic and legal investigations of the company. It highlights an important point: Our work does not stand in isolation. At the onset of our study, substantial evidence already existed to suggest that ExxonMobil had misled the public on a variety of aspects of AGW and in a variety of ways [27, 77–82]. The purpose of our study was to bring to bear an additional, complementary empirical methodology to test the hypothesis that ExxonMobil misled the public. Our results show this to be the case.

5. Conclusion

We have updated our original analysis to include additional Mobil and ExxonMobil Corp advertorials in the *NYT*, and have also introduced new documents never previously analyzed in the peer-reviewed literature. Among other things, we have shown that misleading communications, direct and indirect, emanated from both Exxon and Mobil before their 1999 merger, and continued thereafter. We have also introduced new evidence that Mobil was aware of developments in mainstream climate science, even as they took out advertorials that challenged it. We now conclude with even greater confidence that Exxon, Mobil, and ExxonMobil Corp misled the public about climate change.

The history of ExxonMobil's communications about AGW is consistent with what scholars have labeled merchandising doubt, manufacturing doubt, or doubt-mongering [27, 128–135]. A party whose interests are threatened by scientific findings may seek to protect those interests by casting doubt on the science: 'emphasiz[ing] the uncertainty', as a 1988 Exxon strategy memo put it, focusing on 'debate', and suggesting that remedies are unavailable, unrealistic, too expensive, or otherwise undesirable [136]. Often these claims are not made outright, but are insinuations, which are harder to refute. They may also attack scientists, suggesting they are unreliable or biased. Many of these strategies are evident in ExxonMobil's communications, as well as in their public and private critiques of our work that we have here addressed.

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Data availability statement

The data that support the findings of this study are openly available.

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