



TEACHING  
CLIMATE  
CHANGE BY  
LEVERAGING  
SCIENTIFIC  
CONSENSUS  
TO DISPEL  
SOCIAL  
CONTROVERSY

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EARTH  
IS MORE  
valuable than money

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The scientific consensus on climate change is genuine, credible, and robust. It is no wonder that those who have ideological and pecuniary motives for denying the existence of anthropogenic climate change are eager to deny the existence, extent, and legitimacy of the scientific consensus, and that these denials threaten the integrity of public science education. Likewise, it is no wonder that the integrity of public science education both demands and benefits from a vigorous assertion, explanation, and defense of the scientific consensus on climate change.

## INTRODUCTION

Barbara Lee, a member of Congress representing California's 13th district, recently introduced a resolution in the House of Representatives to support science education on a single particular topic. Was it the ideal gas law, or the typology of tectonic plate boundaries, or the concept of trophic levels in ecology? Of course not. What Lee—along with eighteen of her colleagues—was concerned about was climate change. House Resolution 574, if adopted, would express the House's support for "teaching climate change in public and private schools at all grade levels."

The resolution observes, correctly, that "there is a broad consensus among climate scientists that the human activities contributing to increases in greenhouse gas emissions are the dominant cause of climate change." Indeed, multiple independent studies (e.g., Anderegg et al., 2010; Cook et al., 2013; Doran & Zimmerman, 2009; Oreskes, 2004; Powell, 2015) using different methods have consistently produced estimates of the extent of scientific consensus on anthropogenic climate change among climate scientists converging in the neighborhood of 97 percent.

With such a robust scientific consensus on anthropogenic climate change, why would Lee and her colleagues see any need to propose that Congress express support for teaching about it in the public schools? Because despite the scientific consensus, it remains socially controversial, owing largely to

a deliberate campaign to misrepresent anthropogenic climate change as scientifically controversial. In the classroom and beyond, the remedy involves not only emphasizing the scientific consensus but also explaining the process as well as the evidence by which it was attained.



## WHY IS ANTHROPOGENIC CLIMATE CHANGE SOCIALLY CONTROVERSIAL?

Although 97 percent of climate scientists agree about anthropogenic climate change, the public is not nearly as unanimous. In a national survey conducted in 2018, only 62 percent of respondents said, correctly, that global warming is caused mostly by human activities, while 23 percent said that it is caused mostly by natural changes in the environment, 6 percent volunteered that it is caused by a mix of human activities and natural causes, and 8 percent opted for “neither because global warming isn’t happening” (Leiserowitz et al., 2018, p. 26).

Ignorance of the relevant science plays a role here. Discussing a series of studies, Michael Ranney and Dav Clark (2016) report that “virtually no Americans know the basic global warming mechanism,” i.e., the greenhouse effect, understood by only 12 percent of the participants in their first study. Encouragingly, though, Ranney and Clark add that a modicum of “physical–chemical climate instruction durably increased such understandings” and moreover “also increased climate-change acceptance—across the liberal–conservative spectrum” (p. 49, emphasis in original).

Yet ignorance isn’t really the source of the social controversy. After all, the general public is not knowledgeable about the ideal gas law, tectonic plate boundaries, or trophic levels, and yet there is no controversy over these topics. Rather, the social controversy depends on the misconception that anthropogenic climate change is scientifically controversial. In the same 2018 survey, the respondents were asked to estimate “what percentage of climate scientists think that human-caused global warming is happening.” Only 31 percent selected a value in the correct quintile, 81–100 % (Leiserowitz et al., 2018, p. 28).

The misconception that anthropogenic climate change is scientifically controversial is largely the product of design. It is, in the phrase coined by Leah Ceccarelli (2008), a “manufactured controversy ... motivated by profit or extreme ideology to intentionally create public confusion about an issue that is not [or would not otherwise be] in dispute.” Extending Ceccarelli’s work, David Harker defines “created controversy” in much the same way, adding that such controversies are created mainly by “magnifying uncertainty and manufacturing doubt” (2015, p. 163).

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## *anthropogenic climate change*

Organized climate change denial originated with a trio of physicists who, funded by self-interested corporations and conservative foundations, sought to magnify uncertainty and manufacture doubt about the scientific consensus on acid rain, ozone depletion, and tobacco use before turning their attention to climate change around 1989. Thanks to their prestigious credentials and political connections, and abetted by a media eager to present a balanced treatment, these “merchants of doubt” succeeded in largely converting the Republican Party to climate change denial (Oreskes & Conway, 2010).

The misconception that anthropogenic climate change is scientifically controversial was—and continues to be, if to a lesser degree—promoted among the public by fossil fuel companies such as ExxonMobil and Koch Industries. Such promotion often occurs directly, for example via “advertorials” in major newspapers, but also indirectly, through founding or funding of advocacy organizations and think tanks. Remarkably, such promotion occurred even while the companies privately accepted the scientific consensus on climate change (see, regarding ExxonMobil, Supran & Oreskes, 2017).

By now, unfortunately, the misconception is firmly cemented, independently of any specific efforts to promote it, among the general public in the United States, especially those on the political right. According to a 2019 poll from CBS News, “Three in four Democrats say almost all scientists agree that human activity is a main cause of climate change, while nearly the same number of Republicans think there is still disagreement among scientists” (De Pinto et al., 2019). And the resultant social controversy is felt in the science classroom.

### **HOW IS THE SOCIAL CONTROVERSY FELT IN THE SCIENCE CLASSROOM?**

Organized campaigns to derail, delay, or degrade the teaching of climate change are not uncommon, and they typically involve the claim that anthropogenic climate change is scientifically controversial. In 2019, for example, a bill in the Connecticut legislature sought to “eliminate climate change materials” from the Next Generation Science Standards as used in the state on the grounds that climate change was “a controversial area of information.” The bill’s sponsor previously expressed “serious doubt” about whether global warming is due to human activity.

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## climate change

Sometimes these campaigns are at the district level. In Los Alamitos, California, in 2011, the district adopted a policy requiring teachers addressing any “controversial” issue to use material that offers “a balance of viewpoints and encourages students to examine each side of the issue.” As it happens, the policy was adopted at the behest of a district trustee who was concerned in particular about a new Advanced Placement class in environmental science that addressed climate change. Speaking to the Orange County Register, he emphasized that “the science is not solid” (Kopetman, 2011).



And sometimes these campaigns target the individual classroom. The Heartland Institute—a think tank with connections to the “merchants of doubt,” including past funding from ExxonMobil and the Koch brothers—repeatedly mailed unsolicited materials disputing the scientific consensus on climate change to public school teachers across the U.S., most recently in 2017. Judging from Inside Climate News’s informal survey of ninety teachers, though, these campaigns have not been particularly effective in influencing educators (Banerjee, 2017).

The misconception that anthropogenic climate change is a matter of scientific debate affects education in other ways. At present the misconception itself is included in the state science standards of five states: Mississippi, South Carolina, South Dakota, Texas, and West Virginia. And a review of sixth-grade science textbooks used in California found that “the human contribution was presented as a possibility rather than a certainty,” meaning that “the representation of uncertainty about human-caused climate change within the science textbooks is scientifically inaccurate” (Román & Busch, 2016, p. 1173).

The social controversy over climate change—and the attendant misconception that anthropogenic climate change is scientifically controversial—is further felt in the classroom. True, it is relatively unlikely that teachers will encounter overt pressure not to teach climate change. In a 2014–2015 national survey of public middle and high school science teachers conducted by the National Center for Science Education (NCSE) and researchers at Penn State University, only a few—less than one in twenty—reported encountering such pressure (Plutzer et al., 2016, p. 26).

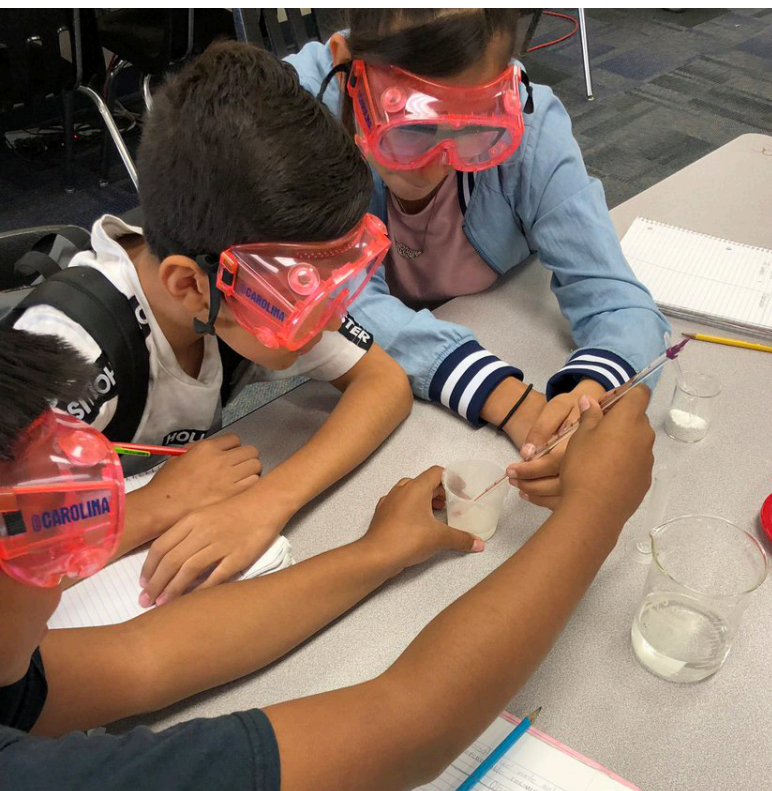
But the NCSE/Penn State survey also revealed that science teachers are conveying unwarranted doubt about the scientific consensus with dismaying frequency. Two in five reported that they emphasize that many scientists believe that recent increases in temperature are probably due to natural causes. A minority of those teachers emphasized only that claim, with the majority reporting that they also emphasize what is in fact the scientific consensus, that recent global warming is primarily caused by human release of greenhouse gases from fossil fuels (Plutzer et al., 2016, p. 16).

Pedagogical techniques that convey unwarranted doubt about the scientific consensus are also in use with dismaying frequency. Six in ten teachers said that they encouraged students “to come to their own conclusions about the causes of global warming”; almost as many said that they encouraged students “to debate the likely cause of global warming”; and almost three in ten said that they gave “equal time to perspectives that raise doubt that humans are causing climate change” (Plutzer et al., 2016, p. 18)—all techniques inappropriate for discussing topics on which there is scientific consensus.

## **WHAT CAN BE DONE FOR TEACHERS?**

Teachers misrepresent the scientific consensus on climate change apparently in part because they are not adequately informed. The NCSE/Penn State survey found that 68 percent of the teachers said, correctly, that global warming is caused mostly by human activities, while 16 percent said that it is caused mostly by natural changes, 12 percent volunteered that it is caused by a mix, and 2 percent denied that global warming is happening (Plutzer et al., 2016, p. 25). And only 39 percent of them selected the correct quintile for the degree of scientific consensus (Plutzer et al., 2016, p. 22).

It is tempting to imagine that the remedy is simply to ensure that science teachers understand climate science, including the existence and the extent of the scientific consensus on climate change. There is certainly room for improvement here. Less than half the teachers in the NCSE/Penn State survey reported having taken a course in college that devoted even a single class session to climate change (Plutzer et al., 2016, p. 23), and those with less content knowledge about climate change were less likely to emphasize the scientific consensus in their own teaching (Branch et al., 2016, p. 92).



Ensuring that pre-service and in-service science teachers have the opportunity to learn about climate change is therefore a high priority. In its recent statement on the teaching of climate science, the National Science Teaching Association (2018) appropriately calls for “curricula that incorporate climate change science” to be designed for pre-service teachers and for “ongoing professional learning opportunities to strengthen their content knowledge” to be provided for in-service teachers. These opportunities should emphasize the existence and extent of the scientific consensus on climate change.

But lack of knowledge is not the only obstacle. In the NCSE/Penn State survey, the personal political and religious values of teachers were correlated with their acceptance of the scientific consensus and their tendency to present it as such in the classroom—as

were the political and religious values prevalent in their communities. For example, teachers in counties that tend to vote Republican were less likely to be aware of the extent of scientific consensus on climate change than teachers in counties that tend to vote Democratic, regardless of their own political views (Branch et al., 2016, p. 93).

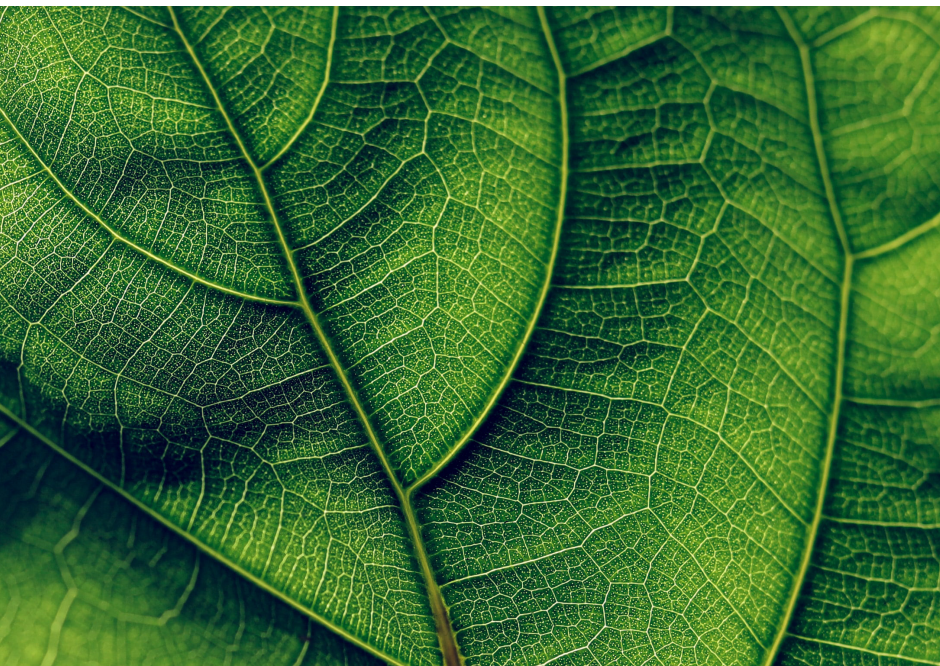
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## *misconception-based learning*

To improve climate science education, it is therefore not sufficient (though it is necessary) to ensure that pre-service and in-service science teachers have the opportunity simply to learn the relevant science and with it to understand the existence and the extent of the scientific consensus on climate change. It is important to ensure also that these teachers have the opportunity to learn pedagogical techniques for teaching climate change effectively in the context engendered by the social controversy—and that these techniques are employed by their own instructors.



For example, in light of the fact that teachers and students often hold political and religious beliefs associated with rejection of anthropogenic climate change, Berbeco, Heffernan, and Branch (2017, p. 240) suggest, “citing prominent climate scientists who share such beliefs yet accept the science—such as the evangelical Katharine Hayhoe or the Republican Kerry Emanuel—and using resources from organizations that endorse such beliefs and yet accept the science—such as the Evangelical Climate Institute and RepublicEn ... —is likely to be helpful in reconciling them to the scientific consensus.”



The National Science Teaching Association’s statement on the teaching of climate science (2018) explicitly recognizes the importance of equipping teachers to teach climate change effectively in the context engendered by the social controversy, urging science teachers to “explore effective strategies for teaching climate science accurately while acknowledging social or political controversy” and educational administrators to help teachers “develop confidence to address socially controversial topics in the classroom.” Here, too, emphasis on the scientific consensus on climate change is important.

## HOW CAN TEACHERS PRESENT THE SCIENTIFIC CONSENSUS?

“The message from popular culture can seem to urge that teachers just get with the program and tell students what to think,” observes NCSE’s Ann Reid (2019). “This is the attitude displayed by celebrity-fronted and profanity-laden videos like George Clooney’s ‘Dumbf\*\*\*ery’ public service announcement and Bill Nye’s ‘the planet is on f\*\*\*ing fire’ segment.” She suggests that rather than merely affirming the consensus on climate change, science teachers treat the misconception that anthropogenic climate change is scientifically controversial as they would any misconception: as a teachable moment.

Misconception-based learning is employed in a set of lesson plans developed by NCSE (freely available on-line at <https://ncse.ngo/supporting-teachers/classroom-resources>). As John Cook, who helped to develop the plans, explains, “In misconception-based lessons, misconceptions are first activated then immediately countered with accurate information or inoculating refutations” (Cook, 2019, p. 289). He adds, “Misconception-based learning has been found to be one of the most powerful ways of teaching,” producing better engaging students and producing stronger enduring gains in learning.

The lesson plans—developed by teams of master teachers aided by scientific experts—are intended to help students overcome five central misconceptions that they may bring to the classroom. In the first lesson plan, students emulate the scientific community in analyzing independent lines of evidence separately, communicating their conclusions—and the arguments supporting them—to the community as a whole, and then reaching a consensus based on the total evidence. They are then in a position to appreciate the significance of the scientific consensus on climate change.

It is important for students to understand not only the scientific consensus but also the ways in which it is misrepresented. Thus the misconception that anthropogenic climate change is scientifically controversial is then examined as part of a “spot the fallacy” exercise. After a variety of techniques of science denial—fake experts; logical fallacies; impossible expectations; cherry picking; conspiracy theories—are defined and illustrated, students are asked to evaluate the significance of a climate change denial petition that (as they will discover) teems with fake experts.

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## *scientific consensus*

Because students will have examined the evidence for themselves, Reid (2019) comments, “they will not have been told how to think; they will have learned to think for themselves.” They will be equipped “not only with knowledge they will need to flourish in a warming world but also with know-how that they will be able to use throughout their lives: how to ask testable questions about the world, seek relevant and credible evidence, and discuss differences (without shouting!) to reach agreement with peers through cooperative problem-solving and inquiry.”

Emphasizing the scientific consensus on climate change is also likely to be helpful when parents, administrators, and members of the community express fear about, suspicion of, or hostility toward climate change education. They may demand that teachers discontinue or curtail their teaching of climate change, or stage a classroom debate about the reality of climate change, or agree to use supplementary materials (such as the Heartland Institute's) that deny the scientific consensus on climate change. Or they may merely wish to register a vague discomfort with climate change education.

Teachers already understand the need to listen respectfully and respond calmly to such complaints. But they also ought to be prepared to assert their status as professional science educators. As such, they have a duty to their employer, to their profession, and above all to their students to teach the central results and methods of contemporary science as they are understood by the scientific community, as specified in the lesson plans, curricula, and state science standards relevant for their classes. And that unquestionably includes the scientific consensus on anthropogenic climate change.

## CONCLUSION

When contemplating the obstacles that stand in the way of effective climate change education, it is important to realize that there is, in fact, widespread support among the public for teaching about climate change. According to the Yale Project on Climate Change Communication's estimate, as of 2019, 77 percent of Americans—and 80 percent of Californians—strongly or somewhat agree with the statement that schools should teach our children about the causes, consequences, and potential solutions to global warming (Marlon et al., 2019).

To be sure, the public is not particularly knowledgeable about the causes, consequences, and potential solutions to global warming, as polls from the Yale Project on Climate Change Communication (e.g., Leiserowitz et al., 2018) and elsewhere have repeatedly demonstrated. But the public generally seems to understand that, as with the ideal gas law, or the typology of tectonic plate boundaries, or the concept of trophic levels in ecology, it is sensible to delegate the question of what is scientifically credible when it comes to climate change to the relevant scientific community.



The scientific consensus on climate change is genuine, credible, and robust. It is no wonder that those who have pecuniary and ideological motives for denying the existence of anthropogenic climate change are eager to deny the existence, extent, and legitimacy of the scientific consensus, and that these denials threaten the integrity of public science education. Likewise, it is no wonder that the integrity of public science education both demands and benefits from a vigorous assertion, explanation, and defense of the scientific consensus on climate change.

#### BIOGRAPHY

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#### PHOTO CREDITS - UNSPLASH

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## REFERENCES

- Anderegg, W. R. L., Pall, J. W., Harold, J., & Schneider, S. H. (2010). Expert credibility in climate change. *Proceedings of the National Academy of Sciences (USA)*, 10(27), 12107–12109.
- Banerjee, N. (2017, December 22). Science teachers respond to climate materials sent by Heartland Institute. *Inside Climate News*. Retrieved from <https://insideclimatenews.org>
- Berbeco, M., Heffernan, K., & Branch, G. (2017). Doubt and denial as challenges to, and in, teaching climate change. In D. P. Shepardson, A. Roychoudhury, & A. S. Hirsch (Eds.), *Teaching and learning about climate change* (pp. 235–245). New York: Routledge.
- Branch, G., Rosenau, J., & Berbeco, M. (2016). Climate education in the classroom: Cloudy with a chance of confusion. *Bulletin of the Atomic Scientists*, 72(2), 89–96.
- Ceccarelli, L. (2008). Manufactroversy. *Science Progress*. Retrieved from <https://scienceprogress.org/2008/04/manufactroversy/>
- Cook, J. (2019). Understanding and countering misinformation about climate change. In I. Chilwa & S. Samoilenko (Eds.), *Handbook of research on deception, fake news, and misinformation online* (pp. 281–306). Hershey, PA: IGI-Global.
- Cook, J., Nuccitelli, D., Green, S. A., Richardson, M., Winkler, B., Painting, R., Way, R., Jacobs, P., & Skuce, P. A. (2013). Quantifying the consensus on anthropogenic global warming in the scientific literature. *Environmental Research Letters*, 8, 024024.
- De Pinto, J., Backus, F., & Salvanto, A. (2019, September 15). Most Americans say climate change should be addressed now—CBS News poll. *CBS News*. Retrieved from <https://www.cbsnews.com>
- Doran, P. T., & Zimmerman, M. K. (2009). Examining the scientific consensus on climate change. *Eos*, 90(3), 22–23.
- Harker, D. (2015). *Creating scientific controversies: Uncertainty and bias in science and society*. Cambridge: Cambridge University Press.
- Kopetman, R. (2011, May 16). Los Alamitos class must present both views of global warming. *The Orange County Register*. Retrieved from <https://www.ocregister.com>
- Leiserowitz, A., Maibach, E., Rosenthal, S., Kotcher, J., Ballew, M., Goldberg, M., & Gustafson, A. (2018). *Climate change in the American mind: December 2018*. Retrieved from <http://climatecommunication.yale.edu/wp-content/uploads/2019/01/Climate-Change-American-Mind-December-2018.pdf>
- Marlon, J., Howe, P., Mildenerger, M., Leiserowitz, A., & Wang, X. (2019). Yale climate opinion maps 2019. Retrieved from <https://climatecommunication.yale.edu/visualizations-data/ycom-us/>
- Oreskes, N. (2004). The scientific consensus on climate change. *Science*, 306 (5702), 1686.
- Oreskes, N., & Conway, E. M. (2010). *Merchants of doubt: How a handful of scientists obscured the truth on issues from tobacco smoke to global warming*. New York: Bloomsbury Press.
- National Science Teaching Association. (2018). The teaching of climate science. Retrieved from [http://static.nsta.org/pdfs/PositionStatement\\_ClimateScience.pdf](http://static.nsta.org/pdfs/PositionStatement_ClimateScience.pdf)
- Plutzer, E., Hannah, A. L., Rosenau, J., McCaffrey, M. S., Berbeco, M., & Reid, A. H. (2016). *Mixed messages: How climate change is taught in America's public schools*. Retrieved from <https://ncse.ngo/files/MixedMessages.pdf>

- Powell, J. L. (2015). Climate scientists virtually unanimous: Anthropogenic global warming is true. *Bulletin of Science, Technology & Society*, 35(5–6), 121–124.
- Ranny, M. A., & Clark, D. (2016). Climate change conceptual change: Scientific information can transform attitudes. *Topics in Cognitive Science*, 8(1), 49–75.
- Reid, A. (2019). Dry facts, debate, despair: How not to teach climate change. *Education Week*, 39(6), 20.
- Román, D., & Busch, K. C. (2016). Textbooks of doubt: using systemic functional analysis to explore the framing of climate change in middle-school science textbooks. *Environmental Education Research*, 22(8), 1158–1180.
- Supran, G., & Oreskes, N. (2017). Assessing ExxonMobil's climate change communications (1977–2014). *Environmental Research Letters*, 12(8), 084019.