Journal of
Earth Science & Climatic Change

Thompson, J Earth Sci Clim Change 2017, 8:9
DOI: 10.4172/2157-7617.1000410

Research Article Open Access

Climate Science Needs Effective Imagens

Jonathan E. Thompson*

Department of Chemistry and Biochemistry, Texas Tech University, Lubbock, TX, USA

Abstract

Despite being broadly accepted by physical scientists, the prospect of anthropogenic climate change is often politically contentious among the broader public. In this short communication, I make the case for the development of more potent imagens that depict the physical science mechanism for anthropogenic influence on climate change. Imagens are graphics that allow viewers to construct mental visualizations and models of STEM related topics. To support the central thesis, I summarize recent survey data that suggests visualization of climate forcing mechanisms is crucial for acceptance among the public. In addition, I briefly discuss several case studies from history in which physical models used to visualize complex topics have been highly effective at communicating and gaining broad public acceptance of scientific hypothesis. I conclude that development and dissemination of imagens may catalyze the broader public acceptance of climate science and policy change.

Keywords: Climate change; DNA; Ozone; Public policy; Visualization

Introduction

The politics of climate change has recently resurfaced within the United States given the recent decision to withdraw from the Paris agreement of 2015, and the very public letter penned to Energy Secretary Rick Perry by the Executive Director of the American Meteorological Society (AMS) that chastised Perry for comments he made questioning the role of greenhouse gases (GHGs) in climate change [1]. Scientists have also recently faced broad criticism of their communication skills, and have been encouraged to improve efforts to succinctly describe results and impacts of scientific research [2-4]. Given the circumstances, it is crucial to scrutinize public opinions regarding climate change and consider caveats of current approaches used to communicate GHG induced climate change.

Discussion

Recently published survey results indicate that 92.7% of respondents believe GHG such as methane, water vapor, or carbon dioxide can warm Earth's atmosphere [5]. Nearly 76% of respondents believe the 'global warming' phenomenon has a human signature. However, digging deeper into the results indicates significant confusion exists in understanding the physical mechanism of warming and Earth's natural greenhouse effect. Less than 1-in-3 respondents correctly predicted the Earth's temperature would be >10°C degrees cooler if no greenhouse gases were present in the atmosphere. A similar fraction predicted the Earth would be warmer without GHGs. In addition, less than 40% of survey responses cited absorption of infrared radiation being crucial to the warming mechanism of GHGs while over 52% of responses reflected an incorrect belief that GHGs (such as carbon dioxide or methane) destroy stratospheric ozone and this is primarily responsible for warming climate! Over 52% of respondents also reported GHGs either directly absorb sunlight or contribute to urban smog formation, and these effects lead to climate change. To a certain extent, the survey results reflect the public simply reciting a list of bullet points bludgeoned into their heads through social media, formal education, and debates in the news media rather than demonstrating an understanding of the physical science behind the topic of GHG-induced climate change. The lack of understanding of the physical science mechanism through which temperature may raise represents a significant obstacle to acceptance of GHG induced warming influence.

Conversely, those individuals surveyed rarely encountered discussions of direct and indirect aerosol climate forcing in the media (reported frequency of 3.5/10 scale compared to 6/10 for GHG), and 70% of respondents were not aware of the well-documented temporary decrease in Earth's average temperature following the eruption of Mt. Pinatubo in 1991 [6]. Despite the chemical and optical complexity of atmospheric particulates [7-9], many survey respondents correctly believed that aerosols and black carbon could affect Earth's climate. Interestingly, only 7.9% to 8.9% of respondents felt aerosols and black carbon could not alter climate, despite their unfamiliarity with aerosol forcing from previous experience. When prompted, approximately 81% of survey respondents were able to successfully project that aerosols could affect Earth's climate system through absorbing or scattering sunlight, or altering the lifetime or properties of clouds. This projection represents a higher-order cognitive process that requires formation of mental models through visualization in the respondent.

STEM education is deeply rooted in constructivist learning theory, in which previous experiences of individuals act as a filter and foundation upon which new theories and mental models can be built. Given the publics' familiarity with fogs, mists, and light scattering by dispersed particles, the participants quickly constructed rational mental models that explain how aerosols influence climate. Given the respondents practical experience with the idea that 'darkly colored objects strongly absorb sunlight and are warmed' they were more apt to accept black carbon aerosol as a climate-warming agent.

The creation of such rich, non-verbal, visio-imaginative models termed imagens within learners is absolutely crucial for forming associative structures or referential connections between scientific jargon and deep understanding of concepts [10]. The formation of imagens allows science to be inclusive rather than exclusive and confusing. I posit that the scientific community has not produced effective imagens that convey the physical science basis/mechanism for

***Corresponding author:** Thompson JE, Department of Chemistry and Biochemistry, Texas Tech University, Lubbock, TX, USA, Tel: 794091061; E-mail: jon.thompson@ttu.edu

Received July 29, 2017; **Accepted** September 16, 2017; **Published** September 20, 2017

Citation: Thompson JE (2017) Climate Science Needs Effective Imagens. J Earth Sci Clim Change 8: 410. doi: 10.4172/2157-7617.1000410

the warming of Earth's climate as induced by GHGs. The lack of these imagens is what is primarily responsible for the difficulty incurred in communicating climate science to the public, and partially contributes to frustrating attempts at policy change.

Evidence of the power of imagens to direct policy can be found in the historical record. In June of 1986 several prominent scientists testified before a Senate subcommittee on the topics of ozone depletion, the greenhouse effect, and climate change [11]. Robert Watson's testimony included a film constructed from satellite data to illustrate a 30% to 40% reduction in ozone within the polar vortex over the south-pole between 1979-1985 [12]. The feature quickly became popularly known as the 'ozone hole' and the film served as a powerful imagen allowing associative structure to be built between laboratory studies demonstrating catalytic ozone destruction by chlorofluorocarbons (CFCs) and Earth's atmosphere [13-15]. The transcript of the proceedings reflects several of the Senators being enamored with the film, viewing it in advance of the hearing, asking clarifying questions about ozone, and whether alternative refrigerant options exist [16]. Within 16 short months of the Senate hearing, the framework for the Montreal protocol phasing out CFCs was in place.

Additional evidence of the power of visualization is presented in the work of Evagorou et al. who presented several case-studies in which the construction of visual or physical models were crucial to advancement of a field of study [17]. Perhaps the most famous example of which was Watson, Crick, and Franklin's helical model of DNA – which was originally constructed and perfected using a 3-dimensional ball-and-stick molecular model kit. The helical structure of DNA was quickly adopted following the development of the visual model that described a structure consistent with crystallographic data. Evagorou et al. also point out that the published works of Michael Faraday often featured drawings, sketches, and visual representations of data that powerfully communicated complex ideas such as magnetic lines of force/fields. More recently, an entire journal – The Journal of Visual Experiments (JOVE) has been devoted to the visual representation of experimental methods. So powerful is the visual medium that in this peer-reviewed and indexed journal, experimenters often publish videos of their methods and results to more effectively communicate to peers.

Conclusion

Progress towards mitigating climate change requires us to create and broadly disseminate high-quality visual media (imagens) that allow the public to form mental models of the physical science mechanism of GHG induced warming. I challenge the community to develop imagens that illustrate the physical science basis for GHG-based warming rather than continuing with text-based decrees and standoffish position statements. Given the leading role Journal of Earth Science and Climatic Change plays in support of environmental sciences, the front matter of this journal may serve as effective clearinghouse for disseminating imagens to the community. Challenge your colleagues, your research group, and students to reflect upon the science and generate imagens that clearly and conclusively demonstrate the physical science basis behind GHG induced climate change!

References

1. https://www.ametsoc.org/ams/index.cfm/about-ams/ams-position-letters/letter-to-doe-secretary-perry-on-climate-change/ Accessed June 30 2017.
2. "Effective Communication, Better Science." https://blogs.scientificamerican.com/guest-blog/effective-communication-better-science/ Accessed on July 1 2017.
3. McNutt M (2013) Improving scientific communication. Science 342: 13-16.
4. http://www.cmu.edu/news/stories/archives/2014/september/september15_sciencecommunication.html Accessed July 1 2017.
5. Thompson JE (2017) Survey data reflecting popular opinions of the causes and mitigation of climate change. Data Brief 14: 412-439.
6. McCormick MP, Thomason LW, Trepte CR (1995) Atmospheric effects of the Mt. Pinatubo eruption. Nature 373: 399-404.
7. Wei Y, Ma L, Cao T, Zhang Q, Wu J, et al. (2013) Light scattering and extinction measurements combined with laser-induced incandescence for the real-time determination of soot mass absorption cross section. Anal Chem 85: 9181-9188.
8. Zhang Q, Thompson JE (2014) Effect of particle mixing morphology on aerosol scattering and absorption: A discrete dipole modelling study. Geo Res J 3: 9-18.
9. Wei Y, Cao T, Thompson JE (2012) The chemical evolution and physical properties of atmospheric organic aerosol: A molecular structure based approach. Atmos Environ 62: 199-207.
10. Gilbert JK (2010) The role of visual representations in the learning and teaching of science: An introduction. Asia-Pacific Forum on Science Learning and Teaching. Foreward J.
11. https://www.washingtonpost.com/news/energy-environment/wp/2016/06/11/30-years-ago-scientists-warned-congress-on-global-warming-what-they-said-sounds-eerily-familiar/?utm_term=.e2bb83b03ed3 accessed September 19, 2017.
12. Stolarski RS, Krueger AJ, Schoeberl MR, Mcpeters RD, Newman PA, et al. (1986) Nimbus 7 satellite measurements of the springtime Antarctic ozone decrease. Nature 322: 808-811.
13. Farman JC, Gardiner BG, Shanklin JD (1985) Large losses of total ozone in Antarctica reveal seasonal ClOx/NOx interaction. Nature 315: 207-210.
14. McElroy MB, Salawitch RJ, Wofsy SC, Logan JA (1986) Reductions of Antarctic ozone due to synergistic interactions of chlorine and bromine. Nature 321: 759-762.
15. Solomon S, Garcia R, Rowland FS, Wuebbles DJ (1986) On the depletion of Antarctic ozone. Nature 321: 755–758.
16. Climate Change (1986) Ozone depletion, the Greenhouse effect and climate change: Hearing before the Subcommittee on Environmental Pollution of the Committee on Environment and Public Works. United States Senate, Ninety-Ninth Congress, June 10 and 11, 1986, U.S. Government Printing Office, Washington, D.C., USA.
17. Evagorou M, Erduran S, Mantyla T (2015) The role of visual representations in scientific practices from conceptual understanding and knowledge generation to 'seeing' how science works. International Journal of STEM Education.