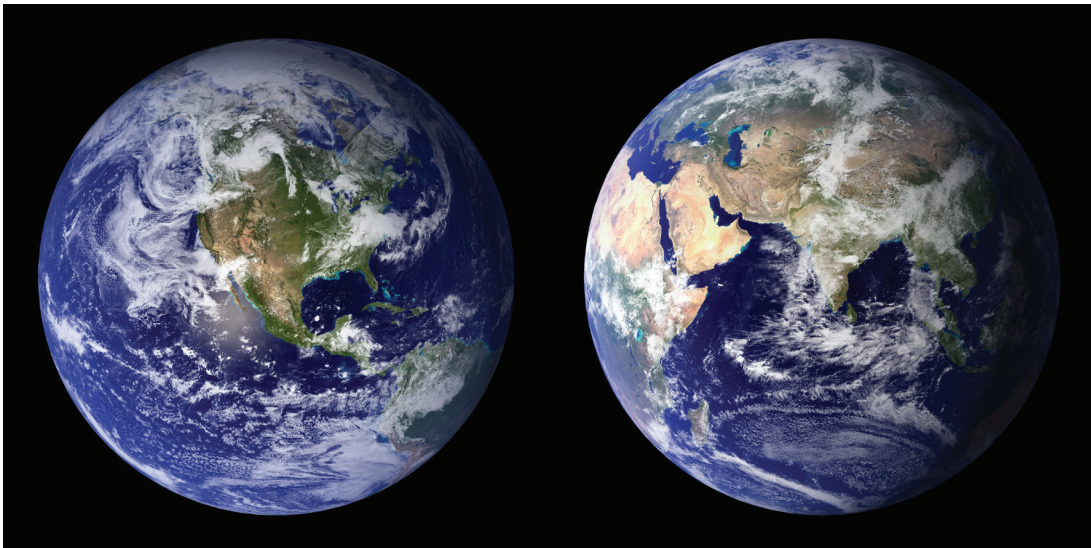


The
Teacher-Friendly
Guide™

to Climate Change



Edited by Ingrid H. H. Zabel, Don Duggan-Haas, & Robert M. Ross

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On the front cover: the "Blue Marble." Composite images produced by NASA in 2001-2002.

On the back cover: Atmospheric CO₂ concentration at Mauna Loa Observatory from 1958 to 2014 (NOAA).



Chapter 11: Perspective

1. Apocalyptic Tales of Climate Change

In polarizing issues, apocalyptic rhetoric is often found at both poles of the issue in question. The extremes related to **climate change** are destruction of the environment and civilization (or even the entire Earth) at one extreme and destruction of the economy, freedom, and the “American way of life” at the other.

We’ve been telling stories of apocalypse and of lost Edens as long as we’ve been telling stories.¹ Such tales are engaging, memorable, instructive, and motivating. Environmental educators and advocates have been telling modern versions of these tales for generations for the same reasons that other folks have told them for millennia. From the Book of Genesis to *The Lorax*,² humans are drawn to stories of paradise lost. And they learn from them too.

Rachel Carson’s *Silent Spring*³ helped to usher in an era of environmental apocalyptic writing and reporting, and those stories were fundamental to cleaning up our environment. About the same time predictions were being made by scientists and reported on by the media—predictions that, metaphorically, looked a lot like biblical visions of fire and brimstone from the Book of Revelation. The villainous actions were readily visible: flammable chemical wastes dumped directly into rivers, and black smoke billowing out of smokestacks, rivers catching fire, and cities being shrouded in smog and smoke. A recent example is the fires around Fort McMurray, Alberta (Canada), where forest fires associated with record heat surrounded the strip-mined landscape containing the Athabasca **Tar Sands** and its piles of waste sulfur (see Box: *Real-life Fire and Brimstone*).

Al Gore and Bill Nye are examples of many who point out the urgency and apocalyptic outcomes of rapid climate change. While they’ve both done great work and deepened the understandings of millions of Americans, they’ve simultaneously unintentionally deepened the convictions of millions who reject the scientific consensus on climate change. The reasons for these mixed outcomes are complex, but at least one may be the apocalyptic storylines associated with their messages. Al Gore is also seen as a political partisan and is instantly polarizing for many, regardless of what he says (what he says is

climate change • the current increase in the average surface temperature worldwide, caused by the buildup of greenhouse gases in the atmosphere, and the related changes to other aspects of climate such as precipitation patterns and storm strength. See also GLOBAL WARMING.

tar sand • a mixture of clay, sand, water, and bitumen, a thick oil that can be extracted and refined into liquid oil.

¹ The loss of a past ideal state and the destruction of the current state are different but sometimes related ways of expressing regret or fear of significant negative change. For the sake of readability, these are lumped together in this chapter as “apocalyptic tales.”

² *The Lorax* is a children’s book by Dr. Seuss (Theo Geisel) about the destruction of the environment through corporate greed. It was published in 1971 during a rise in public environmental awareness.

³ Rachel Carson published *Silent Spring* in 1962, about the effects of the widespread use of insecticides (Houghton Mifflin Company: Boston, MA, 368 pp.). The book had an enormous effect on the growth and awareness of environmental sciences.

CHAPTER AUTHOR

Don Duggan-Haas



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Box: Real life fire and brimstone

Among many stories of environmental degradation going on today, one of the more symbolic of apocalyptic “fire and brimstone” is the stunning late spring 2016 fires around Fort McMurray, Alberta. The site is the largest area for oil (“tar”) sands development in the world. To mine the tar sands several hundred square miles of surface boreal bogs are removed for open-pit mining.

Fort McMurray is the town adjacent to the oil sands production facility (and production waste). Producing oil from tar sands is more energy intensive than other forms of oil production. That means it produces more greenhouse gases per barrel of oil than other means. And in an Earth system irony, it may be that the likelihood of drought-induced fires in the Canadian Rockies was increased by climate change associated with carbon emissions—less snowpack than typical and record setting temperatures of about 90 degrees F (32 C), low humidity, and high winds.

Production of oil from oil sands also produces another byproduct in huge quantities - sulfur. The largest pyramids in the world are not in Egypt or made of cut stone. They are near Fort McMurray and made of sulfur from tar sands development. Brimstone is a stone—sulfur—that forms at the brim of a volcano. Though some sulfur is sold for commercial use, in Fort McMurray, it accumulates much faster than it’s used.

The two months of Fort McMurray fires was the costliest disaster in Canadian history, and forced the evacuation of 90,000 people, also the largest in Canadian history. The fires were associated with over 2400 burned structures, extensive burned forest, and weeks of halted oil sands production. The fire and brimstone together had the ingredients of a biblical apocalypse.



Fire near the Fort McMurray oil sands production facility.



generally well aligned with the consensus of scientists). Bill Nye is increasingly seen in the same light.

2. Use of Language and Perspective in Teaching Climate Change

Research shows that the impact of apocalyptic messages and dire warnings may not lead to the responses we might expect or that the messages are intended to create. Fear, for example, may influence people to stop doing something (stop smoking, for example), but it may be less effective than hoped at persuading people to take action.⁴ Consistently bad news over time may lead people to lose hope, which can have the effect of causing people to give up, deciding their actions are likely to be ineffectual. Thus, while not sugar-coating the reality, it's important to celebrate successes where they occur. For example, alternative energy use has been growing exponentially, and the rate of growth of CO₂ emissions has been declining, so people should recognize that positive actions are making a difference.

Moreover, while apocalyptic approaches may motivate some to act to reduce **global warming's** impacts,⁵ they may reduce acceptance of global warming in audiences already skeptical.⁶ These latter audiences may see doom and gloom scenarios, with associated pictures of smoke stacks and industrial pollution, as propaganda rather than scientific information. Such audiences may respond better to consideration of personally relevant impacts on the economy and local communities, to attention to saving money through conserving energy. These approaches seek common ground and work toward goals at least in part outside a narrative of environmental alarm.

There is also a difference in how new information is integrated into pre-existing beliefs between those who accept or deny climate change. Those who are skeptical of global warming are more likely to change their beliefs in response to unexpected good news (for example, if temperature rise is less than predicted) and less likely to change their beliefs given unexpected bad news (if temperature rise is larger than expected). The converse is true for people who think that human-induced climate change is occurring.⁷

In sum, the lesson you teach or the materials you create will have different effects on different people. It's common for education about climate change to be effective for one audience and not merely ineffective for another, but anti-

Use of Language

global warming • the current increase in the average temperature worldwide, caused by the buildup of greenhouse gases in the atmosphere. With the coming of the Industrial Age and exponential increases in human population, large amounts of gases have been released into the atmosphere (especially carbon dioxide) that give rise to global warming. The term **CLIMATE CHANGE** is preferred because warming contributes to other climatic changes such as precipitation and storm strength.

⁴ Tali Sharot's 2011 book *The Optimism Bias: A Tour of the Irrationally Positive Brain* explores the influence of positive versus negative emotions in outlook and decision-making. Pantheon Books: NY, 272 pp.

⁵ Some environmental activism occurs not despite apocalyptic framing but because of it. See Veldman, Robin Globus. "Narrating the Environmental Apocalypse: How Imagining the End Facilitates Moral Reasoning Among Environmental Activists." *Ethics & the Environment* 17, no. 1 (2012): 1–23.

⁶ A proposed explanation for why apocalyptic predictions diminish willingness to act on climate change is that such stories are perceived to be at odds with a world that is "...just, orderly and stable." See Feinberg M, and Willer R. "Apocalypse Soon? Dire Messages Reduce Belief in Global Warming by Contradicting Just-World Beliefs." *Psychological Science* 22, no. 1 (2011): 34–38.

⁷ Sunstein, Cass R. and Bobadilla-Suarez, Sebastian and Lazzaro, Stephanie C. and Sharot, Tali, *How People Update Beliefs about Climate Change: Good News and Bad News* (September 2, 2016) <https://ssrn.com/abstract=2821919>.



Hope and Optimism

greenhouse gas • a gas that absorbs and re-radiates energy in the form of heat; carbon dioxide, water vapor, and methane are examples.

chlorofluorocarbons • compounds of carbon, hydrogen, chlorine, and fluorine, usually ANTHROPOGENIC gases used as refrigerants or in aerosol cans. Released into the ATMOSPHERE, these compounds are GREENHOUSE GASES and are responsible for the OZONE HOLE.

stratospheric ozone • a region of OZONE gas in the STRATOSPHERE.

ultraviolet light • electromagnetic radiation in the part of the spectrum with wavelengths from 10 to 400 nanometers.

ozone hole • a region of ozone depletion in the STRATOSPHERE above Antarctica, caused by destruction of ozone from ANTHROPOGENIC chemicals released into the ATMOSPHERE.

glacier • a very large piece of ice that sits at least partially on land and moves under the force of gravity.

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effective other audiences. One class or program may include multiple audiences in the same crowd. How do we craft our instruction so that it maximizes the desired understandings, while *both* being true to the science and minimizing the pushback brought by what some might consider to be like false prophecies?

3. Hope and Optimism

At first blush, some of society's previous environmental parables may seem to have been false prophecies in the sense that these tales of apocalypse did not become fully fulfilled. One reason, of course, is that some of these issues were resolved because people did something about them.

As one relatively localized but well publicized example, certain rivers in the US caught fire a number of times in the 19th and 20th centuries, and they don't anymore. The most famous example is Cleveland's Cuyahoga, but it's far from the only example. Generally, the water in US rivers, lakes and streams, and the air we breathe, are much cleaner than was the case a few decades ago. The environment in many heavily industrialized areas is less polluted than it was half a century ago. Littering has declined substantially, and in many areas municipal solid waste disposal rates are substantially down because recycling rates are up.

A global atmospheric example, the most comparable we have to controlling **greenhouse gas** emissions, is reducing chemicals—especially coolants such as **chlorofluorocarbons** (CFCs)—that deplete **stratospheric ozone**.⁸ The ozone layer absorbs **ultraviolet light** and thereby protects tissues of living organisms. In the 1980s it became established that the ozone concentration declined by over half its natural state during summers over Antarctica—this became known as the “**ozone hole**” (ozone also diminished in the Arctic and in temperate latitudes, but not to the same degree). By the 1980s an international agreement was made to freeze and then phase out CFCs. Once regulations of CFCs were put into place, ozone concentrations began to stabilize, and at the time of this writing, the ozone hole over Antarctica is showing signs of healing. Environmental issues can and do improve.

How did we clean up our act in these cases? In these examples, we responded to the scientific projections that were coming true before our eyes. We created laws and agreements to regulate what we were putting into our waters and into our atmosphere, and we changed cultural norms regarding acceptable ways to treat the environment.

4. Apocalyptic Prophecies Versus Predictions of Climate Change

Are the apocalyptic prophecies of climate change coming true? Yes. In many respects the Earth is changing—in temperature, ice and **glacier** melt, storm frequency, and many other respects—in ways projected by climate scientists.

⁸ Tropospheric (ground level) ozone is considered a form of pollution, forming from reactions between certain carbon compounds with nitrogen oxide. It can irritate lungs, especially if there are pre-existing conditions such as asthma.



Reality Check

wind energy • electrical energy derived from the mechanical energy of a **TURBINE** which moves due to the action of the wind.

sea level • global sea level is the average height of Earth's oceans. Local sea level is the height of the ocean as measured along the coast relative to a specific point on land.

But there are hopeful signs. US carbon emissions have declined; alternative energies, particularly **wind energy**, are increasing exponentially in the US and globally; and plans for new power plants, building designs, and transportation systems promise greatly improved efficiencies within coming decades. Many towns and cities, colleges and universities, and businesses have set ambitious low to zero carbon emissions goals within the coming decades. And there is such global awareness of climate change as a significant issue, that major treaties have been signed by a substantial fraction of world's nations.

There is also, however, considerable uncertainty.⁹ Because of the nature of complex systems, it's challenging to quantify the degree or likelihood to which specific events (heat waves, droughts, floods, wildfires and so) can be attributed to climate change. And, though climate scientists can project within meaningful confidence intervals what will happen to global atmospheric temperatures, ice melt, and **sea level** rise given specific inputs (CO₂ and CH₄ levels, for example), there remain many uncertainties about what will happen to, for example, precipitation at very local scales, and to parts of the system such as individual species. This uncertainty arises both because the climate system is complicated and because we don't know how humans, at a planetary scale, are going to respond environmentally in the next 50 to 100 years.

Part of teaching climate change will be taking into account the strong possibility that the near future will hold some ongoing uncertainties and surprises. This is, after all, part of the nature of complex systems science. Almost certainly different parts of the climate system will change at different rates, either more slowly or more quickly than we expected, and these changes will be geographically varied. If some climate projections are, in the near-term, not as severe or as rapid as what we expected, that could be very good news—but such news might also add to complacency or skepticism even while climate change impacts continue. Apocalyptic projections of climate change are not inevitable, but as new information becomes available we need to be aware that the impacts of climate change are not binary, solved or world-ending: we will need to (and can) mitigate climate change, in many steps, over many years.

5. Reality Check: A Personal Perspective

Teaching about climate change can be horribly depressing work. It seems as though we are marching headlong into hellish times, and are not sufficiently rising to the challenge. This, to some degree, is the natural state of things. We have always lived in horrible times, if you choose to look at things that way. We've also always lived in marvelous times. Sometimes we can see that too, but reminders are helpful. When the situation becomes dire, as seems to be happening, we do have a history of rising to meet the ominous challenges. It is my hope we are in the process of doing that now.

To consider the concept of wonderful horrible times, I'll quickly step through five generations of my own family history. My great-grandfather, Adgate Loomis, was born December 4, 1843, in Lebanon, Connecticut and my great-

⁹ Read more about uncertainty and motivation in Rutjens, Bastiaan T, Joop van der Pligt, and Frenk van Harreveld. "Regulating Psychological Threat: The Motivational Consequences of Threatening Contexts," 2012, 38–56.



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grandmother, his wife, Melissa “Minnie” Bridget Hardy, was born Dec. 13, 1847 in Hoskinsville, Ohio. Slavery was still firmly entrenched in the American South, and Adgate and his brother Lucius both fought for the Union Army, and Lucius died at the Andersonville Prison Camp. Clearly, these were horrible times.

The Civil War ended, and my great-grandfather marched in front of President Lincoln. Horrible times were not over, but the abomination that was slavery did come to an end. Adgate and Minnie married in 1871, and honeymooned in Niagara Falls. They went on to have five daughters and four sons, and were married for more than 50 years. The brood included twins - Ruth and Ralph, born in 1891. Ralph was my grandfather. I don't know if their life was wonderful, but it did have some wonderful outcomes.

My grandfather also saw the tragedy of war, serving in a machine gunners' unit in World War I. He also saw pestilence - helping to manage an impromptu hospital during the Spanish Flu epidemic. His twin, Ruth, died as a young woman. But, as these horrible things were going on, wonderful things were happening too. Nellie Brown, my grandmother, was the only woman in the University of Missouri's Rocky Mountain field camp. And Grandpa went on to earn a Master's degree in agricultural economics and then a divinity degree. As an extension agent, he was effective in helping bring an end to swine cholera. He married Nellie and they had four children, including twins of their own, Carolyn and Marilyn (my mother), who were born in 1931. And my grandparents were married for more than fifty years. Grandpa managed a dairy co-op and preached in several churches, and returned to Agricultural Extension work for the University of Missouri in 1936. And Grandma taught physical geography and more.

And Hitler rose to power in Europe, and the Japanese bombed Pearl Harbor, bringing the US into World War II. And my grandfather was fired from the Extension as, “The Extension didn't need any pacifists.” A few years later, my father, Roger Haas, enlisted in the Navy, though, fortunately, the war was in its final year. These were horrible times. But the war ended, though my dad served until just before the Korean War began. My folks met at the University of Missouri, Dad attending on the GI Bill.

And Jim Crow was still festering in the south, and Joe McCarthy was feeding the Red Scare. And Rock-and-Roll was coming up, and life expectancy was growing. And the skies were black with smoke and smog and rivers caught fire. And my parents married and had six kids, beginning with my brother in 1952 and ending with me in 1963, just a few months before President Kennedy was killed. And Dad worked on technologies to see people through the forests of Southeast Asia, and my brothers worried about (but were not called for) the draft. And Mom was a university librarian who wrote books about books. And Martin Luther King, Jr. and Bobby Kennedy were killed. And riots. And there was Woodstock and the Civil Rights Act, and the Environmental Protection Agency. They were wonderful horrible times. And Mom and Dad were married for more than 50 years.

And Richard Nixon and Kent State. And Free Love. And disco. And the lakes and rivers got cleaner and the bald eagle came back. And, eventually, I married Katy Duggan and we had two wonderful kids, Kiana born in 2001, just a few



months before September 11, and Nellie in 2004 as the country grew more and more mired in America's longest war.

All along, we worried about the fate of our children in these turbulent times, whatever time it happened to be. All along, horrible things were happening that looked like the end of the world. And each time it looked like the end of the world we did things to make it not be the end of the world. And, ok, it never really looked like the end of the world, though it may have looked like the end of civilization.

Yes, horrible things are happening now—I first wrote this in 2016, in the aftermath of a series of horrible shootings, and it looked to be an unending series of horrible shootings. But violent crime is actually at its lowest level in decades, which is pretty wonderful. And, 2016 was the hottest year on record,¹⁰ which brought unprecedented droughts and floods and fires to various parts of North America, which is pretty horrible. And my daughters are kind, hardworking, smart, happy, engaged in things that make the world a better place, and beautiful. And hopefully, your kids are too, and so are you.

There are horrible things in the world. When the horror becomes clear to enough people, we do something about it to make it less horrible. Let's do that now. And celebrate the wonderful things too.

6. Science Teaching Toward a Sustainable World

While plenty has gone horribly wrong in the world and with civilization, both the world and civilization live on. The world will go on for a very, very long time - likely much longer than civilization. Earth is about 4.5 billion years old. Civilization is about 10,000 years old. At time scales that humans can easily understand, civilization will likely last quite a while too. Though it stands a good chance of getting pretty awful in various ways, times, and places in the future, if we act wisely, we have the capacity to reduce the potential horrible outcomes a great deal.

Each case that moved from horrible to less horrible involved people taking action to make things better. Ultimately, people made coalitions of institutions and organizations that helped us collectively behave responsibly. That means people assumed responsibility or were held responsible for the problems we faced, and they changed course. History shows that action is required to make things better and that, in numerous instances involving the environment, people have improved the environment through scientific understanding, education, and action. Perhaps the Onceler's repentance in *The Lorax* says it best: "*Unless someone like you cares a whole awful lot, nothing's going to get better. It's not.*"

We will need to use numerous strategies make changes to mitigate climate change, some of which will be social and political. But at the core must be basic public understanding of the science of Earth systems, and of climate in

¹⁰ 2016 was the warmest year for average global temperature, 0.94 degrees C above the 20th century average (<https://www.ncdc.noaa.gov/sotc/global/201613>).



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particular, in order to facilitate good decision-making. No one is more important than teachers to help future generations understand Earth's systems, and to help students work with each other toward stewardship of the Earth's future climate.



Resources

Books With Apocalyptic Rhetoric

If you don't have familiarity with the stories of Genesis and Revelation, start at the source. The Holy Bible, "King James Version." Texas: National Publishing Company, 2000. <http://www.biblesfree.org/ruth.html>.

Carson, Rachel. *Silent Spring*. Houghton Mifflin Harcourt, 2002. The classic book that is thought by many to be the start of the environmental revolution that led to the Clean Air and Clean Water Acts, and the founding of the Environmental Protection Agency. https://books.google.com/books?hl=en&lr=&id=HeR1l0V0r54C&oi=fnd&pg=PR8&dq=silent+spring&ots=1taaXokV5z&sig=JgF_fxl2s7DHQEfyjxpl4TU1IYQ.

Seuss. *The Lorax*. New York: Random House, 1971. The classic children's book.

Books That Address Some Problems With Apocalyptic Rhetoric

Davis, Kenneth C. *Don't Know Much about the Bible: Everything You Need to Know about the Good Book But Never Learned*. Harper Collins, 2009. Reading the Bible has challenges. This book offers a good overview of every book in the Bible with some interpretation and a bit of a sense of humor.

Olson, Randy. *Don't Be Such a Scientist: Talking Substance in an Age of Style*. Washington, DC: Island Press, 2009. Scientists are notorious for speaking above the heads of their audiences or being too dry in their communication style. Whether you're a scientist, a science teacher, or just someone who wants to be more clear and engaging in talking about science, this book is helpful.

Romm, Joseph J. *Language Intelligence: Lessons on Persuasion from Jesus, Shakespeare, Lincoln, and Lady Gaga*. CreateSpace, 2012. A thoughtful, helpful and amusing look at how to engage an audience in your writing and speaking.

Online Resources

You can find more information about stratospheric ozone at NASA's website "Ozone Hold Watch": <https://ozonewatch.gsfc.nasa.gov>.

Climate Change 101 with Bill Nye | National Geographic: <https://www.youtube.com/watch?v=EtW2rrLHs08>.

Bill Nye's Global Meltdown Climate Change Documentary, National Geographic Explorer <https://www.youtube.com/watch?v=wmrby3MCZs>.



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The Climate Reality Project, <https://www.algore.com/project/the-climate-reality-project>, Al Gore

The Canadian news site, Global News, has a regularly updated page on Fort McMurray wildfires and the ongoing issues associated with the most expensive disaster and largest evacuation in Canadian history: <http://globalnews.ca/tag/fort-mcmurray-wildfire/>.