

# What Do U.S. Students Know About Climate Change?

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Ask introductory-level undergraduate students about climate change science, and you are likely to get some eyebrow-raising responses. For example, you may hear, “The greenhouse effect is caused by the hole in the ozone layer, which allows in more sunlight,” “The melting of floating sea ice will result in catastrophic flooding of our coastal areas,” or “Humans are not the main cause of climate change.” While students are clearly concerned about climate change (83% of students polled by *Theissen* [2008] were), recent work suggests that many have significant misconceptions about the fundamental science behind it. Considering the urgent nature of the issue and the important role that students will play as informed citizens and decision makers, geoscientists and educators may want to consider using strategies that better ensure students’ climate literacy.

Despite prior instruction in their secondary and even elementary schooling, many students enter courses with significant misconceptions about fundamental climate concepts. Perhaps the best documented of these involves confusion between stratospheric ozone destruction and the greenhouse effect [e.g., *Jeffries et al.*, 2001]. Student misconceptions about the difference between weather and climate, the relationship between air pollution and climate, and the consequences of climate change have been documented at all educational levels as well (see an excellent review by *Shepardson et al.* [2011]).

Students face a second challenge in the form of climate myths and misinformation that are perpetuated by a small but vocal group of politicians and climate change skeptics. Relative to climate experts, the skeptics have an unreasonably large platform in the media and on Web sites. In her study at the University of Vermont, *Dupigny-Giroux* [2010] found that most undergraduates cited some form of media, such as the Internet, newspapers, television news, or even movies, as their primary source of information about climate. Certainly, many

students are finding reputable sources of information, but ongoing confusion about climate change suggests that certain myths are alive and well. For example, when asked what they view as reliable evidence of climate change, some students instead repeat myths like “it’s part of a natural cycle” or that volcanic sources of carbon dioxide are equivalent or greater than human sources [*Theissen*, 2008] (Table 1). Moreover, many students and roughly half of the general public believe that there is no scientific consensus about climate change [*Doran and*

*Zimmerman*, 2009] despite much evidence to the contrary [*Oreskes*, 2004].

How might geoscience educators respond to these challenges? As a first step, geoscientists can do more to identify and address important misconceptions directly. Developing and contributing to a more comprehensive list of misconceptions is a key objective of an ongoing study of student cognition in geoscience courses at the University of St. Thomas. Some climate change textbooks have started to directly address misconceptions (e.g., *Mann and Kump* [2009] take on misconceptions about the greenhouse effect and the causes of the destruction of stratospheric ozone). *United States Global Change Research Program* [2009] has Web-published a useful climate literacy brochure, and the ongoing development of concept inventories

**Table 1. Examples of Student Misconceptions From a Written Assignment on What They Viewed as Reliable Evidence of Climate Change in an Introductory Course on Climate Change and Paleoclimatology<sup>a</sup>**

Student Perception in First Week of Class	Problem or Misconception
“Another small example is how fast people get sunburnt these days compared to even the 1970s. My mom told me she used to run around all day on the farm in the summer and not burn like kids do today...”	<i>Anecdotal evidence; example does not apply.</i> If there is increased incidence of sunburn, this is more likely to be due to destruction of stratospheric ozone, an important but different issue.
“I think that the weather changes in the last 20 years are proof that global climate change will continue and progressively get worse.”	<i>Time scale is too short.</i> Student may be correct that climate change will get worse, but 20 years of data are not enough to support this. Must take a longer view.
“Although I do believe that this is a cycle of the Earth, it is only made worse by us humans.”	<i>Climate change is primarily or entirely natural or part of a natural cycle.</i> Data for the past 50 years indicate that human influence has been the primary driver of climate change over that time.
“There is no reason to believe it isn’t natural. Each year, volcanic eruptions produce more carbon dioxide than human activities do.”	<i>Climate change is primarily or entirely natural or part of a natural cycle.</i> This is an example where the student is factually incorrect. Human emissions of carbon are an order of magnitude greater than volcanic sources.
“So many scientists and climatologists disagree on what is causing global warming, to what extent greenhouse gases are affecting climate, and so on.”	<i>Scientific disagreement about the causes of climate change.</i> There is overwhelming consensus on the causes. Existing disagreements are about specific future impacts and consequences.

<sup>a</sup>From *Theissen* [2008].

(such as the Geoscience Concept Inventory, <http://geoscienceconceptinventory.wikispaces.com/>) provides instructors with peer-reviewed material to assess entry-level student understanding of climate and other geoscience concepts.

As a second step, the science community should consider offering more courses with a primary focus on past and present climate change at the introductory level. Such courses have had success in deepening student understanding about climate and bringing about conceptual and attitudinal change [e.g., *Rebich and Gautier*, 2005; *Theissen*, 2008]. But many geoscience departments do not offer such courses at the introductory level, where enrollments are by far the highest. For example, only a third of the geoscience programs at 4-year Minnesota colleges and universities offer a climate-related course at the introductory level. Instead, climate and other global change sciences are often relegated to the final chapter of the textbook and left to be covered in the last several weeks of a typical introductory geoscience course. An obvious benefit of offering a course focused on climate is greater time for instruction on fundamental concepts with which students struggle. A second and perhaps less obvious benefit is that geoscience courses on climate provide important perspectives on time and rates of change. After learning about the comparatively slow rates that characterize most

episodes of climate change in Earth history, students have a better appreciation for the anomalous nature of the change that has occurred during the epoch of human control of the environment, which many scholars now call the Anthropocene.

Even with these efforts, student misconceptions will not die easily. *Gautier et al.* [2006] found that while students' depth of understanding of the greenhouse effect increased in a course on climate change, the majority of their misconceptions about this process remained after focused instruction on the topic. Given the challenges and time limitations that instructors have in addressing sometimes hard-wired misconceptions, they suggest that the Earth science community should consider agreeing on a set of "accepted explanations" that serve as minimum knowledge that students can be expected to have about key climate principles such as the greenhouse effect. As a start, such explanations could be submitted by the community to an online repository for peer review before eventual posting on a Web site maintained by AGU or another professional science organization for use by educators and students.

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