Climate Literacy in Education

Climate Change Denialism: Critical Analysis of Arguments in Confrontation with Climate Science

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Abstract

Climate denialism is a spectrum spanning outright denial and degrees of skepticism about the reality of climate change. Denialism is fueled by disinformation or imprecise information that finds fertile ground on social media and takes advantage of the users' fears and vulnerabilities, such as a lack of climate literacy and critical thinking. In this article, we offer examples of how to refute climate change denialism and expand notions of climate literacy to include the capacity to both identify and respond to climate disinformation.

Keywords

Climate change, climate literacy, education, climate change denialism

Climate deniers and the real science

Scientists overwhelmingly agree that climate change exists and is caused by anthropogenic phenomena (Lynas et al., 2021). The consensus can be found in thousands of scientific studies from prestigious journals as well as entities recognized

for their scientific capabilities and veracity, such as NASA and the Intergovernmental Panel on Climate Change (IPCC), which report that temperatures have been rising over the last century (NASA, 2015). All the same, since at least 1979, oil companies have paid scientists to deny the realities of climate change (Reed et al., 2021). These oil industry-funded scientists have produced studies that deny climate change—a total of 3% of all published articles in the climate sciences (Rasmus et. al, 2015). These studies have been analyzed by Rasmus et al., (2015), who found them marred by several flaws, including fallacies and misrepresented results. Despite the overwhelming consensus on the reality of climate change, these publications continue to feed climate denialism, a term that encompasses both outright denial and different forms of skepticism about the reality of climate change. But denialism can be resolved. Below, we summarize a few common arguments posed by climate denialist. We also offer educators tools and resources to respond.

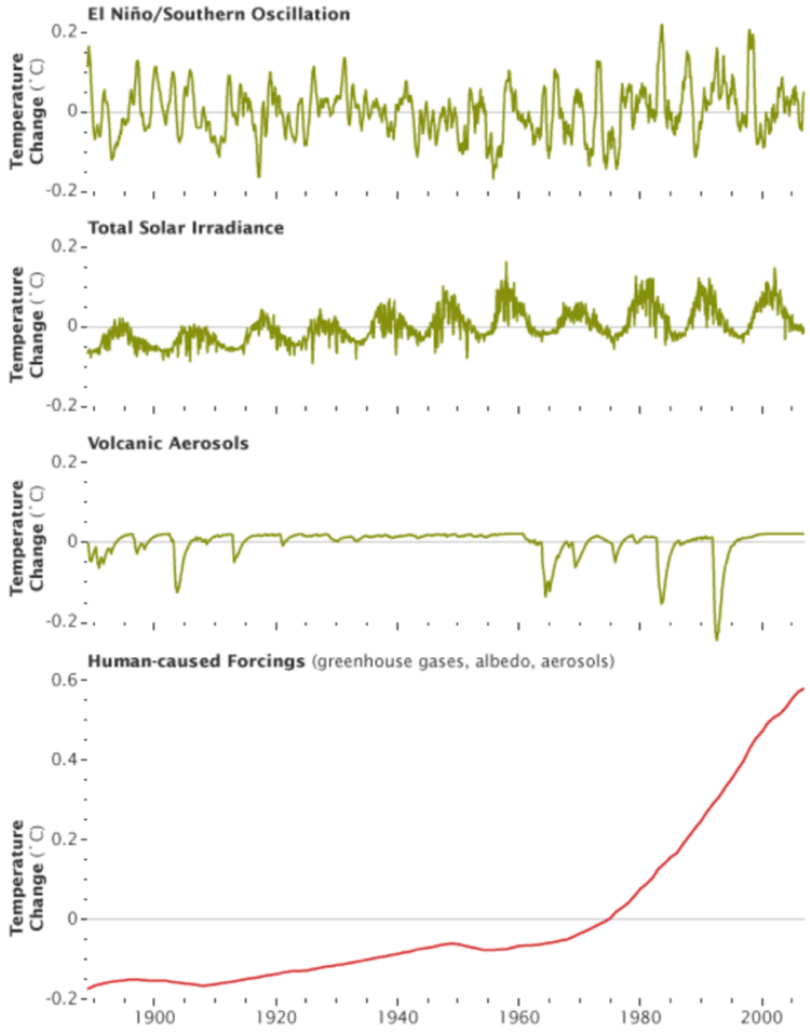
Is the influence on the climate only caused by natural factors?

One of the arguments most used by climate change denialists is the natural variability of the climate. Denialists argue that fluctuations in the climate are mainly the result of natural processes and that current climate changes are not unusual. Granted, the climate *has* changed in the past, long before the industrial revolution. The planet *has* gone through several warm and cold periods (glaciers and interglacial eras). So, denialists think, if global temperatures have already changed naturally, long before human beings even thought of polluting, then the current warming must be of natural origin.

Below, Figure 1 shows both natural factors that influence climate change (volcanoes, solar radiation, and El Niño) and their influence on the earth's temperature versus anthropogenic, human-caused influence.

Figure 1

Main influencers of the Earth's climate



Source: Lean and Rind, 2009

So, despite there being a natural influence on the increase in the Earth's temperature, the greatest influence is anthropogenic (Lynas et al., 2021). In addition to using this chart to illustrate this distinction, educators can also use En-Roads Simulator: an online platform that allows students to adjust levels of various factors, such as energy, transport, and land use, to then simulate variations in temperature increase. This also allows students to explore possible future scenarios.

I don't notice that the sea is rising.

Worldwide, the average sea level has risen around 9 cm between 1993 and 2021 (Copernicus, 2022). But this is not evenly distributed globally, as sea level fluctuations vary from region to region. However, the advance of the sea in the Western world, thanks to technology and engineering, may have a "solution." The most severe sea level rise is experienced largely in developing countries, where people have migrated in the face of the advance of the sea (Sea Level Rise, 2020).

Even if students do not live in proximity to rising seas, educators can lead them through several activities to show the consequences of rising sea levels. Several examples can be found at the National Center for Science Education, or on the NASA website. It's helpful to use a short video "sea level rise" by NASA, which introduces the concept of sea level rise its connection global warming. The video is brief, basic, and clear. Students can also play the game "My Coastal Future", which explores climate change impacts and encourages students to reflect on adaptation and resilience.

The planet has experienced greater heat in the past and terrestrial life has prospered.

The last period in which temperatures were higher than they are today was the Eocene geological era (56 to 34 million years ago). During the Eocene, the increase in global temperatures was due to multiple causes, but the main ones were strong volcanic activity and gas emissions (Gradstein et al., 2020). This period was not conducive to a thriving biosphere: of the five mass extinctions that have occurred on our planet, four were caused by climate change, which extinguished between 75% and 86% of terrestrial life (Barnosky et al., 2011). From the history of the great extinctions on Earth, we can see that the increase in the planet's temperature was often influenced by gases such as methane and carbon dioxide, the same gases that are still released today because of human actions.

To explore this notion, educators can use BioInteractive's EarthViewer, an interactive map that enables students to explore the science of Earth's deep history, from its formation 4.5 billion years ago to modern times. EarthViewer dynamically shows how continents grow and shift as students scroll through billions of years.

Additional layers let students explore changes in atmospheric composition, temperature, biodiversity, day length, and solar luminosity over geologic time.

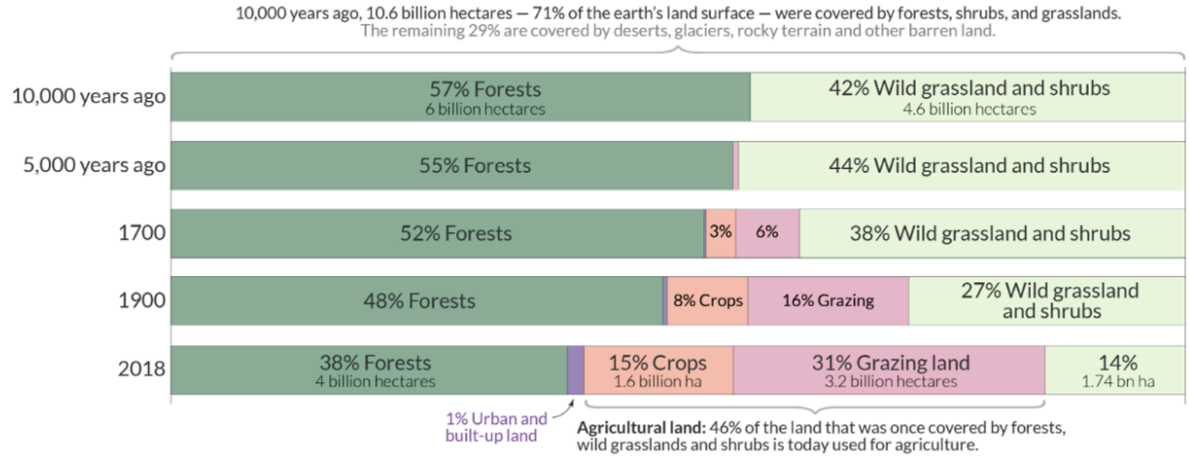
Don't plants do better in environments with very high CO2?

Denialists often argue that carbon dioxide (CO2) cannot be considered a pollutant because it is a gas that is indispensable to life, as flora require carbon dioxide for photosynthesis. Granted, under controlled conditions of temperature, humidity, water, and nutrients, more CO2 indeed induces more photosynthesis (Dusenge et al., 2018). But not all plants like extra carbon. And for those carbon enthusiasts in the plant kingdom, CO2 is not the only factor controlling growth. Moreover, as a result of climate change, we don't always have controlled conditions, like in a greenhouse. If we change some of these parameters, especially temperature and humidity, then, regardless of whether there is more CO2, a particular plant will become stressed, even decreasing its level of photosynthesis (Bostrom, 2015). At this point, CO2 becomes a pollutant, as it "disturbs the ecosystem" (Hadipoor et al., 2021).

As Figure 2 shows, the rise in atmospheric CO2 levels has not led to an increase in green areas or forests, woodlands, and the like (Wallache, 2022). In fact, the amount of green areas has decreased as a result of the expansion of agriculture or acid rain resulting from excessive pollution.

Figure 2

Deforestation process for agricultural expansion



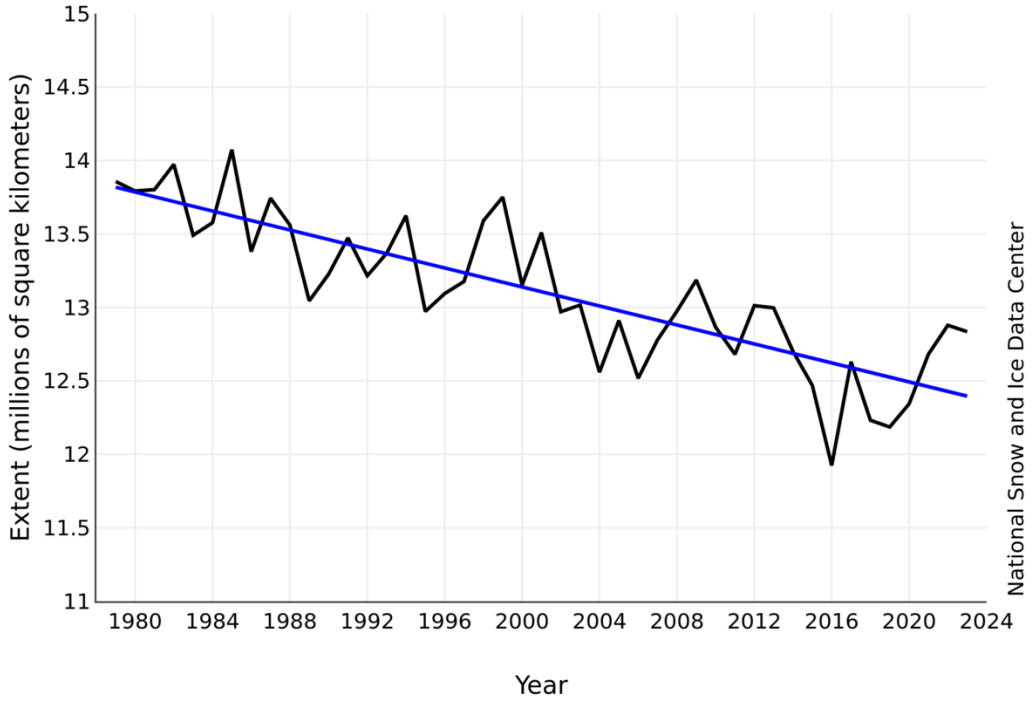
Source: Ritchie, 2021

Has the amount of ice really *been decreasing? If so, what's the big deal?*

As you might expect, ice recovers and decreases depending on the time of year, but the trend has been downward over the decades. When we consult credible websites such as the National Snow & Data Center (NSIDC, 2023), and NASA (NASA, 2023), we see that the amount of Arctic ice has been decreasing, as shown in Figure 3 below.

Figure 3

Ice decrease in the Arctic region since 1979



Source: (NSIDC, 2023)

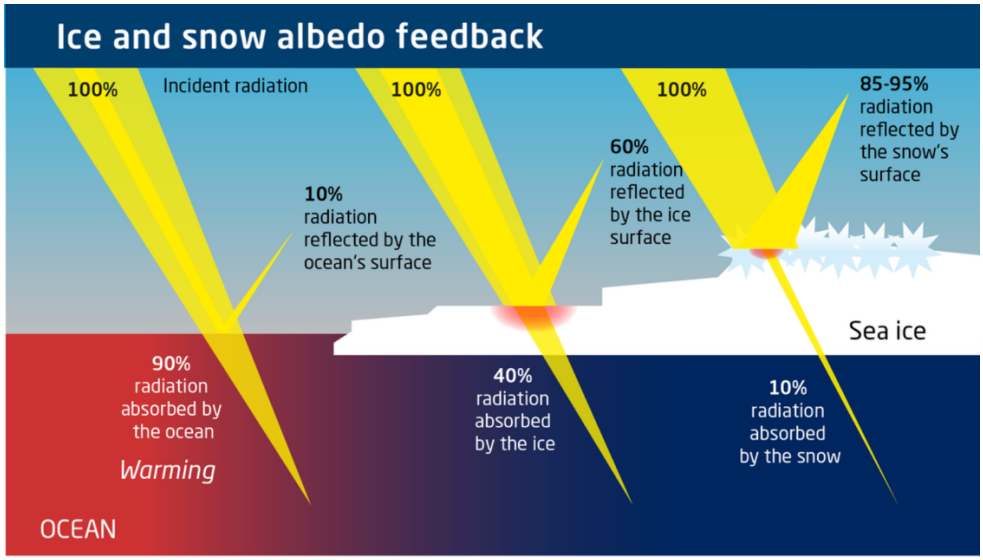
Melting ice caps can have many unexpected effects. Three among them are of particular interest to students: 1) the loss of albedo effect, 2) loss of water, and 3) risk of zombie viruses.

First, the albedo is a phenomenon associated with the white color of snow/ice having the ability to reflect solar radiation, causing heat to be returned to the

atmosphere and not absorbed (NASA, 2012). Using Figure 4 (below), educators can convey this fact to underscore that the loss of white (reflective) zones on the planet means that less of the sun's radiation will be reflected back into space.

Figure 4

Albedo feedback



Source: Bahlburg & Breitkreuz, 2017

Second, water on our planet can be found in a liquid state (oceans, rivers, lakes and underground), a gaseous state (clouds, for example) and a solid state in the form of ice. Many countries depend on glaciers and mountain snows for their water, which slowly melts and forms rivers. But climate change is melting these glaciers so fast that people are starting to run out of water for farming, cooking and other necessities (National Snow and Ice data center, 2018). To explore the implications of melting glaciers, educators can combine several resources, such as experiments, video explainers from the United Nations, and NASA's visualizations of ice loss over time.

Finally, viruses can hibernate for thousands of years in ice caps (Lemieux et al., 2021; Hunt, 2023). Once the glaciers melt, these zombie viruses only need a single host to multiply (Makush, 2020). This video can be used to better explain how viruses that are thousands-of-years-old can become active again.

Final Considerations

Public opinion on climate change is significantly affected by media coverage and social media posts, which may spread disinformation at a very fast pace, reaching people all over the world. Disinformation jeopardizes the efforts needed to mitigate the impacts of climate change. In the face of increasingly frequent and intense extreme weather events, it is crucial to combat climate denialism through accurate and affective climate communication, which is a skill central to climate literacy. In doing so, we can act collectively protect our planet and ensure a sustainable future for generations to come.

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