

Resources for Teaching and Learning about Climate Change¹

This annotated list includes resources that can help your students to develop a scientifically accurate understanding of the causes and consequences of global warming and climate change. This list also includes resources for learning about how to reduce greenhouse gases and how to cope with the harmful effects of climate change. When learning about climate change, it is important for students to engage with proposals to mitigate and adapt to climate change, so they can feel energized, instead of powerless.

Given the nature of the topic, the approach is interdisciplinary with a major focus on earth and environmental science. These resources are appropriate for middle school, high school and/or college students.

I have not personally used these resources in a classroom. Instead, I have chosen resources based on materials that are available online, with an emphasis on resources that seem to be the most informative and do a good job of engaging students in active learning and analysis. I welcome your comments and suggestions for revision (iwaldron@upenn.edu).

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Climate Change Curricula

Turning Misinformation into Educational Opportunities: Climate Change

Curriculum: 6-8 60-minute periods; for high school, but can be adapted for middle school. This curriculum is aligned with the Next Generation Science Standards. Students analyze evidence and models concerning climate change, identify the flaws in published misinformation about climate change, and evaluate possible solutions.

<https://ncse.ngo/supporting-teachers/classroom-resources>

What is the future of Earth's climate?

Web-based curriculum: 235 minutes; for high school. This curriculum is aligned with the Next Generation Science Standards. Students are challenged to think analytically as they experiment with climate models and learn about greenhouse gases, positive and negative feedback, and what can and can't be predicted about future climate change.

<https://learn.concord.org/resources/627/what-is-the-future-of-earth-s-climate>

The Carbon Cycle and the Science of Climate

Curriculum: 3 units with 5 lessons each; for high school. Students are actively engaged in learning about the carbon cycle, trends in atmospheric CO₂ concentrations and temperature, the effects of human activities, and the use of models to test hypotheses. The lessons include hands-on investigations, data analyses, and reflect-and-connect questions.

<https://carbonconnections.bsccs.org/>

¹ By Dr. Ingrid Waldron, Department of Biology, University of Pennsylvania, © 2022. These Teacher Notes are available at <http://serendipstudio.org/exchange/bioactivities/ClimateChange>

Climate Change Education

Curriculum: 17 days; for middle school or high school. Students learn how increasing atmospheric CO₂ concentrations contribute to climate change, the impact of climate change, and the process of science. The lessons include investigations, group analysis of data, and a concept map.

<https://earth.stanford.edu/climate-change-ed/curriculum>

Next Generation Climate

Curriculum: 15 50-minute periods days for grades 6-8. This curriculum is aligned with Next Generation Science Standards. Students analyze readings about topics such as trends in temperature and atmospheric CO₂ concentrations, effects on ecosystems, and ways to minimize climate change.

<https://climategen.org/resources/36169/next-generation-climate-for-grades-68/>

Can planting trees effectively reduce climate change?

Curriculum: 25.5 50-minute periods. This high school biology curriculum is aligned with Next Generation Science Standards. Topics include photosynthesis, the biology of trees, and the efficacy of tree planting to reduce carbon dioxide in the atmosphere.

<https://www.colorado.edu/program/inquiryhub/curricula/inquiryhub-biology> – click on “Go to the iHub Biology Course Materials Google Drive”; then click on “How do small changes make big impacts on ecosystems?”; skip to lesson 11

Additional Resources for Teaching about the Causes and Consequences of Climate Change **A Changing Arctic Ecosystem**

In this 2-week model-based inquiry activity, high school or middle school students analyze a variety of evidence to develop a model that predicts the effects of declining sea ice on populations of Arctic organisms.

<https://cires.colorado.edu/outreach/resources/unit/changing-arctic-ecosystem>

Act to Adapt

Game for ages 12-17 concerning local impact of climate change and how to address these challenges

<http://climatecentre.org/resources-games/act-to-adapt>

Arctic Feedbacks: Not All Warming Is Equal

In this 3-week model-based inquiry activity, high school or middle school students develop a model that explains why temperature increases have been substantially higher for the Arctic than for the earth as a whole.

Described in <https://www.nsta.org/science-teacher/science-teacher-marchapril-2022/arctic-feedbacks-not-all-warming-equal>. The instructional materials are available at <https://cires.colorado.edu/outreach/resources/unit/arctic-feedbacks-not-all-warming-equal/>.

Climate Change Inquiry Lab

These experiments for middle school students simulate the effects on temperature of increased carbon dioxide in the atmosphere and decreased reflectance as ice melts, and the effects of melting sea ice vs. land ice on sea level.

<https://myasadata.larc.nasa.gov/lesson-plans/climate-change-inquiry-lab>

Climate Science Investigations

Introduction to weather vs. climate, causes and impacts of climate change, and addressing the claims of climate skeptics.

<http://www.ces.fau.edu/nasa/>

Ecochains: Arctic Crisis

Card game (~\$9 each, although cheaper in bulk); NGSS aligned for middle school or high school; includes food webs and impact of warming climate.

<http://ecochainsgame.com/>

Food and Climate Change – How can we feed a growing world population without increasing global warming?

Analysis and discussion activity for high school and middle school students; this activity is aligned with Next Generation Science Standards. Students learn how food production results in the release of three greenhouse gases – carbon dioxide (CO₂), nitrous oxide (N₂O), and methane (CH₄). Students analyze carbon and nitrogen cycles to understand how agriculture results in increased CO₂ and N₂O in the atmosphere. Students interpret data concerning the very different amounts of greenhouse gases released during the production of various types of food; they apply concepts related to trophic pyramids and learn about CH₄ release by ruminants. Finally, students propose, research, and evaluate strategies to reduce the amount of greenhouse gases that will be released during future production of food for the world's growing population.

<https://serendipstudio.org/exchange/bioactivities/FoodClimateChange>

Habitat

Web-based Activities using Habitat the Game (requires Unity Web Player) for middle school and high school. Topics include climate change and species habitats, eco-footprints, weather vs. climate, climate science and global warming, alternative energy and renewables.

<http://www.habitatthegame.com/teachers/curriculum-materials/>

Introduction to Global Warming

Analysis and discussion activity for high school and middle school students; this activity is aligned with Next Generation Science Standards. Students learn about the correlated increases in global temperatures and CO₂ concentrations in the atmosphere. They evaluate an example that illustrates that correlation does not necessarily imply causation. Then, students analyze several types of evidence to test the hypothesis that increased CO₂ in the atmosphere has been a major cause of the increase in global temperatures. The activity concludes with a very brief discussion of how global warming has contributed to harmful effects (e.g., increased flooding) and possible actions to reduce these harmful effects.

<https://serendipstudio.org/exchange/bioactivities/IntroGlobalWarming>

Our Changing Climate

Lesson; 55 minutes; for high school. Includes weather vs. climate, effects of climate change on agriculture. Students also analyze food system greenhouse gas emissions and propose interventions to reduce them. Extensions include analyzing student's carbon footprint and ways to reduce it.

<http://www.foodspanlearning.org/pdf/changing-climate/lesson-plan.pdf>

The Winners and Losers of Climate Change

Lesson: homework + ~35 minutes of class time; for high school. Students are assigned two articles to read and then answer questions about these articles. In the first article, students learn how climate change produces not only hotter temperatures, but also extreme weather events. In the second article students learn about phenotypic plasticity and look at several examples of genetic changes that have already occurred in species due to climate change. In class, students predict the vulnerability to climate change for eight species, based on information in a set of species cards.

pages 9-22 in https://www.cpet.ufl.edu/media/cpetufl.edu/pdfs/curriculum/cpet-curriculum/evolution-and-climate-change/DrowsyDrosophila2017_LoRes-Full-Curriculum.pdf

Additional Resources for Teaching about How to Reduce the Amount of Global Warming and/or How to Cope with the Harmful Effects of Climate Change

Climate and Resiliency Education

Design Challenge Unit; for high school or middle school students; ~9 50-minute periods.

Teacher instructions, slides, and student handouts provide a structured sequence that guides students to develop specific proposals to reduce greenhouse gas emissions that result from waste in their school food system. (This resource also provides units that introduce middle school or high school students to global warming.)

<https://cires.colorado.edu/outreach/resources/curriculum/climate-and-resiliency-education>

SMARTIC (Strategic Management of Resources in Times of Change)

Stakeholder role-play game to develop sustainable marine management strategy for Arctic Ocean; with lesson plan.

http://camelclimatechange.org/camel/activities/Game_SMARTIC_Arctic_Case_Study

19 Climate Games That Could Change the Future

Role-playing, computer and board games that challenge players to reduce climate change and cope with the effects.

<https://www.climateinteractive.org/policy-exercises-and-serious-games/19-climate-games-that-could-change-the-future/>

Sources of Information²

² You can convert these information sources to learning activities by providing your students with appropriate questions. A more ambitious approach would be to use the following steps to carry out a jigsaw activity using several of the articles on the same topic or related topics (adapted from <https://www.nsta.org/science-teacher/science-teacher-march-2020/novel-coronavirus>).

- Tell your class that they will read one article in their small group, summarize the main conclusions and evidence, and then share this information with a group of students who have read other articles.
- As students complete the reading individually, each of them should prepare a summary and possibly annotate the article and/or answer any questions that you may have prepared.
- Have students who read the same article briefly share their findings with one another and discuss the article. This will help students prepare to briefly summarize their article in the mixed group.
- Regroup students so that one representative from each article is in each group. Ask students to briefly summarize their articles in their new groups. When sharing the summaries, students should make connections to what they have heard in the other students' summaries. They should talk through anything that is unclear or seems inconsistent from one article to the next. Students should take notes during this sharing, listening, and discussion process.
- The whole class then discusses the main takeaways from the jigsaw reading. Ask students what questions they are still wondering about and try to follow up.

Climate Change: Evidence and Causes: Update 2020

Informative introduction (36 pages)

<https://www.nap.edu/catalog/25733/climate-change-evidence-and-causes-update-2020>

Climate Modeling 101 Website

Good introduction to climate modeling. What are climate models, how are they made, and why are they important?

<http://nas-sites.org/climate-change/climatemodeling/>

Climate Solutions 101

Six videos (roughly 15 minutes in length) and interviews with experts analyze how to stop climate change by reducing sources and increasing carbon sinks.

<https://drawdown.org/climate-solutions-101>

Climate Solutions by Sector

Evaluations of multiple specific proposals to reduce climate change in sectors such as food, agriculture and land use, industry, transportation, and electricity.

<https://drawdown.org/>

Global Climate Change

Provides a wealth of information about climate change, including “What is climate change? – Evidence, Causes, Effects, Solutions”

<https://climate.nasa.gov/>

NASA Global Climate Change

Resources for educators, Spanish-language resources, and graphic and multimedia resources; see, e.g., How Global Warming Stacks Up (https://climate.nasa.gov/climate_resources/144/), an excellent video of animated graphs, which shows the trend in global temperature since 1880 and how various natural and human-caused factors affected this trend.

<https://climate.nasa.gov/resources/graphics-and-multimedia/>

News articles

Regularly updated news articles from reliable sources are available at

<https://serendipstudio.org/oneworld/climate>.

We’re teaching kids the wrong ways to fight climate change.

An interesting analysis of the most important individual actions for young people to take.

Available as a popular summary article (<https://www.sierraclub.org/sierra/we-re-teaching-kids-wrong-ways-fight-climate-change>) and as a research article that is open access and will be

appropriate for some high school students (<http://iopscience.iop.org/article/10.1088/1748-9326/aa7541>).

Carbon Footprint Calculators

Multiple links for carbon footprint calculators, with brief descriptions of each. Carbon footprint calculators can be used, together with the article in the preceding item, to inform a discussion of actions the students can take to reduce their contributions to climate change.

<https://nabt.org/Resource-Links-Ecology-Environment> (scroll down to Environmental Topics, Carbon Footprint Calculators)