Lesson 1: Scientific Consensus

Supplemental Material

Introduction:

This document will help you adapt **Lesson 1: Scientific Consensus** for different age groups, different time spans, and different educational settings. It will also point to additional resources and strategies for helping students find their footing with this challenging lesson.

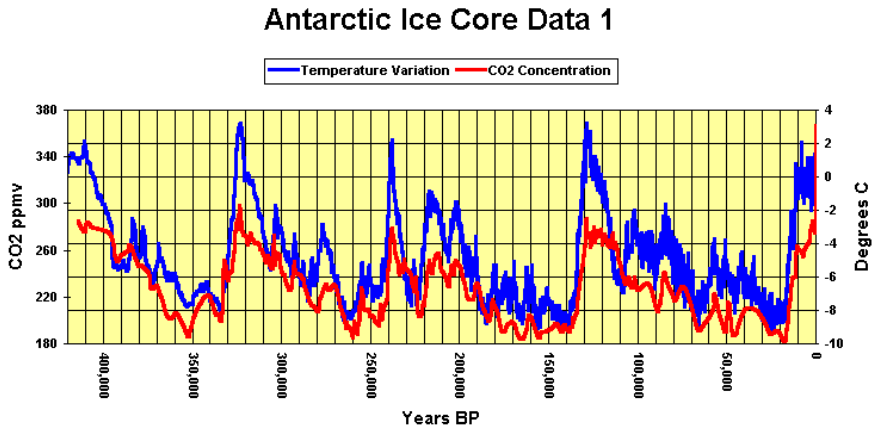
Different Age Groups

Younger Age Groups

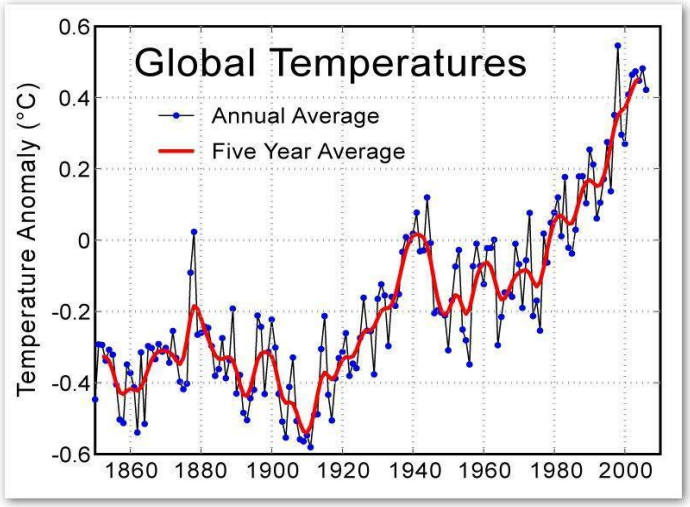
The easiest way to adapt this lesson for younger age groups is to use different data sets that require less sophisticated problem-solving skills. The main lesson focuses on data sets that present trends that can only be explained by human impacts. This ensures the students will come to this conclusion when guided through their analysis by proper inquiry. Additional data sets show trends that are also clearly impacted by human activities, but which are too broad to address human impacts in isolation. These include atmospheric temperature, ice core data, tree ring data, accumulated cyclone energy, and others. These data sets allow you to point to recent trends in comparison to historical trends to show students how human activities have impacted these trends over time. It is important to guide the students in these observations to focus on the entire record and not just parts of the record. In fact, cherry-picking of these data sets produces misconceptions that the overall trends are ephemeral, absent, or even opposite of what scientists claim.

Here are a few additional data sets that can be used:

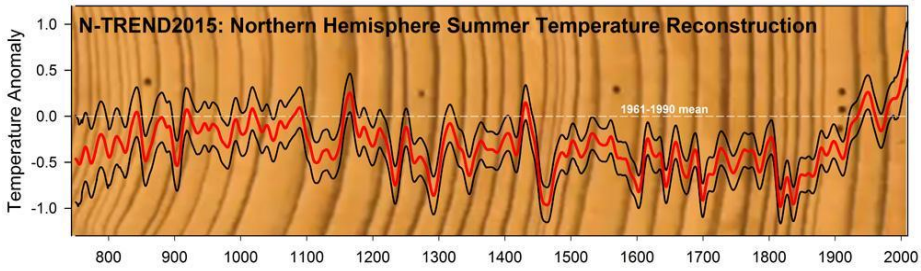
Ice core data



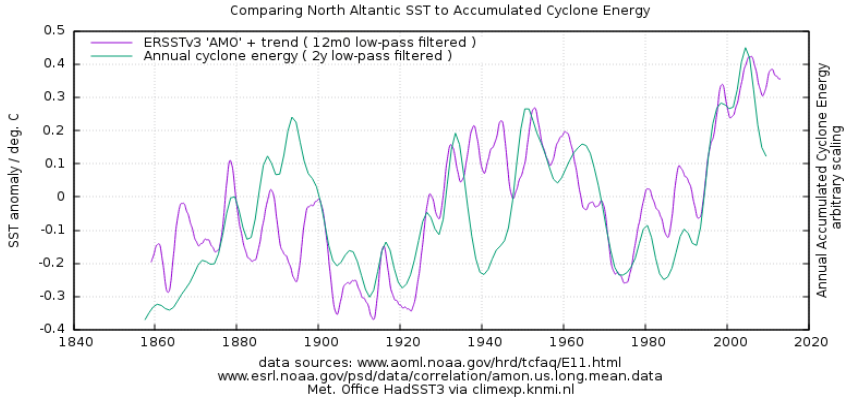
Temperature anomalies (see CLEAN activity)



Tree ring data



Accumulated cyclone energy



More Advanced Groups

The best way to adapt this lesson for students who have a stronger background in climate science already is to acknowledge the context of the lesson from the start and focus the students on the data analysis. This lesson attempts to capture the student's attention before they have formed preconceptions, and possible misconceptions. This is not always possible for advanced classes, or within teams of students that include those who have studied climate science previously. Without the opportunity to have the students consider the data without prior understanding, the opportunity to achieve inoculation is already lost, so it's okay to admit that the focus in on those data sets that cannot be explained any other way than as the result of human activity and have the students challenge this assertion through more thorough analysis.

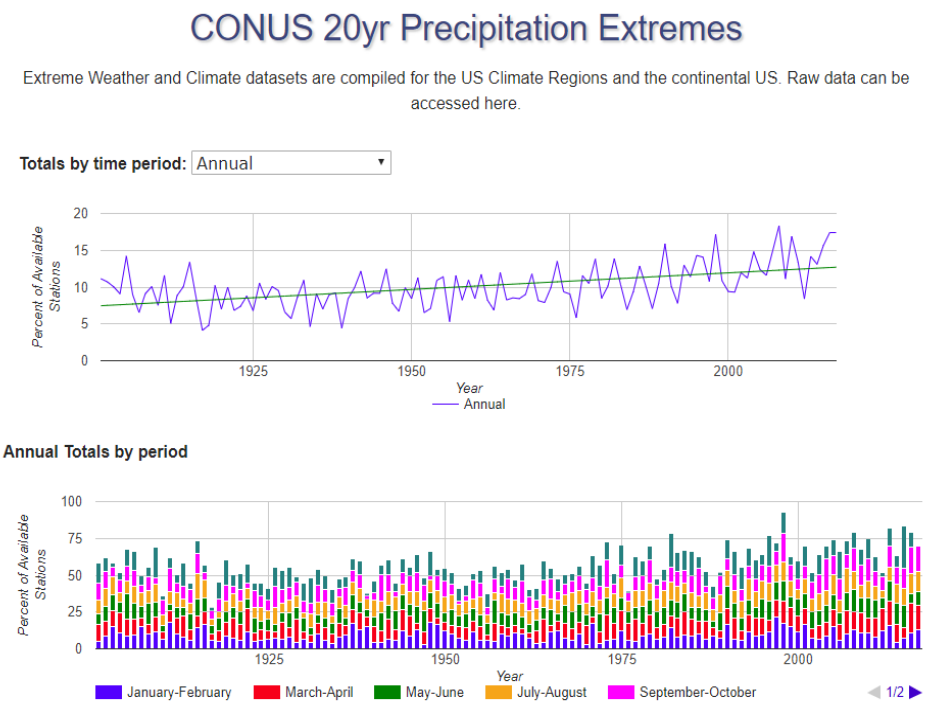
An Excel spreadsheet included in the Supplemental Resources folder titled "Teacher Sheets" provides links to the data used to generate the graphs used to show each pattern. Advanced students could explore these datasets to test challenges by working to recreate these graphs or alternate graphs. Teachers should guide the students through the process of determining the reliability of the data and subsequent authentic representation of the data as a tool for science process.

The lesson can also be used in a team-based learning approach by assigning the data analysis as homework and having the teams compare their interpretations in class. This would not shorten the lesson, but would allow for the students to spend more time discussing their independently derived views to reach a team consensus to share with the class.

More advanced groups could also consider evidence for increased frequency of extreme weather events as evidence for human impacts on climate change.

Extreme Weather Events

https://www.esrl.noaa.gov/psd/repository/entry/show?entryid=5f1b1ce0-674a-4714-a947-54af9239944b



Different Time Spans

The lesson presented in the webinar is intended to take **50 minutes** to complete. Many of our teachers have expanded the lesson over 2-3 class periods, however. Rather than try to include each different strategy in this this single document, we will make each version of the lesson developed by each NCSE Ambassador Teacher available in a shared folder. We encourage you to explore each version of the lesson for the one that suits your needs the best.

See all teacher-created lesson extensions in this folder.

Different Educational Settings

This lesson is intended for classroom applications, but it could also be done in informal science settings. The lesson could be used as an after school or summer camp activity, for instance, without modification.

The lesson could also be flipped by starting with the FLICC component and then using the data analysis to support the debunking of the misconception.

If you are interested in discussing additional ways to use this lesson in informal settings, contact Brad Hoge at hoge@ncse.com

Additional Resources

If and when students request additional information and data to evaluate the graphics they are given, this resource on skepticalscience.com provides explanations as well as citations for a warming lower atmosphere and cooling upper atmosphere as well as warming days vs nights.

Lessons in the shared folder also include additional resources such as links and worksheets that can be used with both the data analysis and FLICC portions of this lesson.

NCSE Ambassador Teacher Al Dorsch incorporated this lesson into a larger lesson for 5th grade science and social studies.

NCSE Ambassador Teacher David Amidon provides numerous additional links to CLEAN activities (NOAA, NASA), skepticalscience.com, and the Petition Project.

NCSE Ambassador Teacher Jennifer Broo included a link to a Ted Ed Video "The Carbon Cycle" (Ted Ed The Carbon Cycle) and reviewed previous information students had already learned about the carbon cycle from a photosynthesis and cellular respiration unit.

NCSE Ambassador Teacher - Nina Corley added an engagement activity to the original activity and provided her students raw data having them graph the data themselves before interpreting the data and coming up with the conclusions. This did take an extra day but allowed them to have experience in not only reading the graphs but also creating them.

Quick engagement exercise using a teacher-created Kahoot

This engagement activity should take no more 5 minutes total. Make sure to include important vocabulary in Kahoot. As students participate in the Kahoot, after answers they have immediate feedback on their own device as to whether their answer is correct. (Teachers can create Kahoots at www.kahoot.com. Each questions takes 20 seconds with the correct answer will being shown after all students have answered. Points are assigned to each student who has chosen the correct answer dependent upon how fast they answered correctly. The teacher has access to a spreadsheet at the end showing how each student answered each question. If there is no student access to technology a PowerPoint can be created and students can write and hold up their answers on dry erase boards)

Example questions (Correct answers are starred)

1 **Data or Scientific Evidence is** information obtained from testing hypotheses through controlled experiments.

True* or False

2. Data cannot include statistical, descriptive, and other observational evidence.

True or False*

3. Scientific consensus: overwhelming _____among experts in a field.

Disagreement or Agreement *

4. Anthropogenic global warming: Global warming that is caused by _____.

Human Activity*
Natural Causes
Cows

5.Science denial: _____ of scientific evidence.

Acceptance*
Rejection

6.in the Acronym FLICC: The five characteristics of science denial **F stands for**

Fake Experts*
Fallacy
Four Men

7.in the Acronym FLICC: The five characteristics of science denial **L stands for**

Latent Ideas
Logical fallacies*
Lagging Interest

8.in the Acronym FLICC: The five characteristics of science denial **I stands for**

Impossible expectations*
Impressive Ideas
Irregular Science

9.in the Acronym FLICC: The five characteristics of science denial the first **C stands for**

Coordinated Science
Cherry Picking*
Careful Choices

10.in the Acronym FLICC: The five characteristics of science denial **the second C stands for**

Creative Ideas
Careful Thinking
Conspiracy theories*