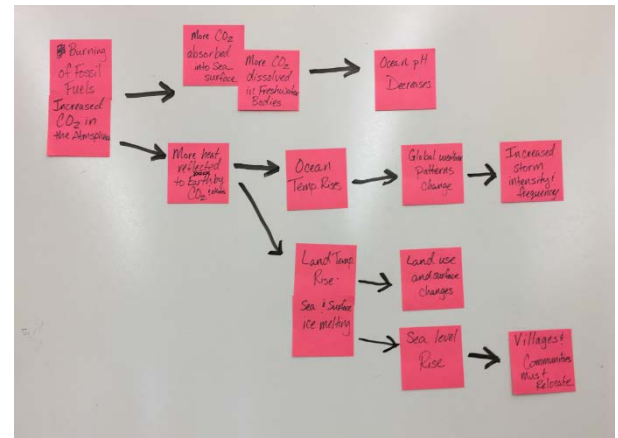


Causes and Effects of Climate Change

(Grades 6-12)

Overview

This session focuses on the causes and effects of climate change, starting with opportunities for students to access and connect to their prior knowledge through developing cause and effect flow charts. Students engage in an activity to reinforce that a good scientific explanation is supported by strong and reliable evidence, the evidence is based on carefully collected data and information, and the evidence is from a reliable source. Small groups then add evidence to their global cause and effect flow charts as they engage in additional activities, access new information, and deepen their understanding of climate change. Finally, local causes and effects are discussed and added to the flow charts.



Learning Outcomes

Students will be able to:

- Build a model (cause and effect flow chart) of global causes and effects of climate change;
- Recognize and gather evidence from reliable sources to support explanations of climate change;
- Determine how global impacts of climate change manifest their effects on local economies, cultures, and communities.

NGSS Connections

- **Disciplinary Core Ideas:** MS.ESS3.C: Human impacts on Earth's Systems, MS.ESS3.D: Global Climate Change, HS.ESS2.D: Weather and Climate, HS.ESS3.D: Global Climate Change
- **Science and Engineering Practice:** Constructing explanations and designing solutions, Developing and Using Models
- **Crosscutting Concepts:** Cause and Effect

Climate/Ocean Literacy Connections

- 3.F: Changes in the ocean-atmosphere system can result in changes to the climate, that in turn, cause further changes to the ocean and atmosphere. These interactions have dramatic physical, chemical, biological, economic, and social consequences. Also, 3.A and 3.G



This activity was prepared by the Lawrence Hall of Science and Padilla Bay National Estuarine Research Reserve under award nos. NA14SEC0080004 and NA15SEC0080001 from the Environmental Literacy Program of the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce. The statements, findings, conclusions, and recommendations are those of the author(s) and do not necessarily reflect the views of NOAA or the U.S. Department of Commerce.



Causes and Effects of Climate Change

Overview

This session focuses on the causes and effects of climate change, starting with opportunities for students to access and connect to their prior knowledge through developing cause and effect flow charts. Students engage in an activity to reinforce that a good scientific explanation is supported by strong and reliable evidence, the evidence is based on carefully collected data and information, and the evidence is from a reliable source. Small groups then add evidence to their global cause and effect flow charts as they engage in additional activities, access new information, and deepen their understanding of climate change. Finally, local causes and effects are discussed and added to the flow charts.

Learning Objectives

Students will be able to:

- Build a model (cause and effect flow chart) of global causes and effects of climate change;
- Recognize and gather evidence from reliable sources to support explanations of climate change;
- Determine how global impacts of climate change manifest their effects on local economies, cultures, and communities.

Materials Needed

For the class:

- PowerPoint presentation and Digital/data projector
- Whiteboard or chart paper and colored markers
- Masking tape

For each small group of 3-4 students:

- Sticky notes, multiple colors and sizes (at least 3x5”),
- 2-3 Sharpies or other fine-tipped markers
- One dark colored marker (Permanent or other thick marker)
- One sheet of chart paper or 11” x 17” sheet



ACLIPSE Climate and Data Literacy Activities

For each student:

- 1 lined sheet of 8.5” x 11” paper
- Pen or pencil

Session at a Glance

Task	Description	Time (minutes)
A. Science briefing and brainstorm: <i>What we know about climate change</i>	A science briefing introduces four important things to know about climate change: the climate is changing, humans are responsible, impacts are already visible, and we can do something about it. Students then engage in a modified Think Pair Share and the class develops a list of global effects of climate change.	30
B. Activity: <i>Global causes and effects flow chart</i>	Students make a global cause and effect flow chart to represent their prior knowledge and growing understanding of climate change.	40
C. Activity: <i>Making evidence-based explanations</i>	Students consider what makes a good explanation and examine the strengths and weaknesses of five different explanations.	15
D. Activity: <i>Adding evidence and local causes and effects to flow charts</i>	Participants add to and/or modify their global climate change flowcharts to add evidence and incorporate some local effects of global climate change.	40

Session Details

A. Science briefing & brainstorm: *What we know about climate change*

Science briefing

1. **Display Four points about climate change.** Display the four points about climate change and read them aloud, or have the students read them:



ACLIPSE Climate and Data Literacy Activities

- a. Climate is changing -
 - *It's happening, right here, right now*
 - b. Humans are responsible
 - *We're causing it*
 - *Scientists agree about this*
 - c. Impacts are serious and already visible
 - *We can't wait (if things continue on with business as usual, we're locked in on a certain trajectory)*
 - d. We can do something about it and we need to act now
 - *We can fix it.*
2. **Table Talk: Discuss Four Points about climate change.** Ask students to discuss the following prompts with their table group:
- a. What do you think each of the points mean?
 - b. What evidence have we gathered that supports these points?
 - c. What questions arise for you?
3. **(Optional) Show animation.** Show the following animation from National Geographic to emphasize the main points and provide more context:
<https://www.nationalgeographic.com/magazine/2017/04/seven-things-to-know-about-climate-change/>

Think Pair Share plus two

1. **Introduce and display directions for Think Pair Share plus two.** Display directions for the Think Pair Share plus two and walk through the directions as follows:
 - a. Join a group of three, and spend about two minutes individually recording your ideas about the following prompts:
 - *List all the global effects of increasing atmospheric CO₂ that you can think of.*
 - *Pick 2 and briefly describe why you think these are important to have your students learn about.*
 - b. Pass your paper to the person in your group sitting to your left.
 - c. Review the ideas from your peer and add at least one idea and one comment to their paper.



ACLIPSE Climate and Data Literacy Activities

- d. When ready, repeat by passing the paper to your left again and adding one idea and one comment to your peer's paper.
 - e. When ready, pass the paper back to the originator.
 - f. Discuss the ideas with your small group – compare and contrast your lists and ideas about what is important for your students to learn.
 - g. Consolidate your lists and be ready to share whole group.
2. **Whole group discussion.** Ask each small group to share their lists with the class as you record on the whiteboard. If groups share similar ideas, put a check mark by the previously recorded idea. For each idea, ask the class if this is a global effect; if so, circle it to call it out for later. If it doesn't come up, be sure to add additional effects, e.g. ocean acidification, sea level rise, warming atmosphere and ocean.

B. Activity: Causes and Effects Flow Chart

[Educator Note: This activity is modified from the Ocean Sciences Sequence: Ocean–Atmosphere Connection and Climate Change, Session 3.6. The OSS activity provides more scaffolds for students, including cause and effect cards for students to cut out to use on their flow chart.]

1. **Project slide, Flow Chart Example.** Tell students that they will now use the class list of important things they brought up about climate change effects to make a cause and effect flow chart with their table group. Explain that this is a simple example of how a flow chart might look. Let students know that their flow charts will begin with “Burning of fossil fuels is increasing CO₂ in the atmosphere”, as shown on the slide. Ask, “*What might we put in the cause and effect flow to replace the “?” box?*” Accept a few ideas.
2. **Arrows connect causes and effects.** Point out the arrows connecting the different effects and leading to a series of causes and effects. Tell students that in this example, one cause leads to one effect. Note that it's also possible for one cause to lead to multiple effects, and for two causes to lead to one effect. *[Instructor Note: You might want to display a more complex example as a model.]*
3. **Distribute materials and explain cause and effect flow chart activity.** Distribute a diverse collection of sticky notes, 1 sheet of chart paper, and colored markers to each small group of 3-4. Explain that they should write one effect on each sticky note and attach it to the blank sheet of chart paper. They should work together and discuss how to move each sticky note to create a flow



ACLIPSE Climate and Data Literacy Activities

chart. Once their sticky notes are arranged satisfactorily and everyone agrees, they can add the arrows that go from causes to effects.

4. **Small groups build cause and effect flow chart.** Encourage students to begin building their model (cause and effect flow chart) of climate change. Remind them of the following:
 - a. refer to the global effects (the circled ideas) they brought up about climate change from the think pair share recorded on the whiteboard,
 - b. write one effect per sticky note
 - c. begin with “Burning of fossil fuels”
 - d. discuss the placement of each item, listen to each other, and work cooperatively
 - e. use arrows to connect to all of the effects they include; more than one arrow can be drawn from a cause and effect.

5. **Describe future work on the flow chart.** Let students know they will revisit the flow chart throughout the study of climate change and add to it as ideas and knowledge change. Eventually they will add solutions, but for now, they should focus on effects and describing mechanisms.

C. Activity: Making Evidence-Based Explanations

[Educator Note: *This activity comes from the Ocean Sciences Sequence: Ocean–Atmosphere Connection and Climate Change, Session 1.4]*

1. **Introduce the activity.** Tell students that they are about to apply what they already know or have learned about climate change and ocean acidification, to add evidence to their cause and effect flow charts.

2. **Introduce Evaluating Five Explanations.** Tell students that before adding evidence to their flow charts, they’ll first look at five explanations given by five different students and discuss whether these explanations are backed up with evidence and if the evidence cited is reliable.

3. **Project slide, example: Mystery Locations.** Orient students to the two temperature line graphs by pointing out the x axis (months of the year) and the y axis (average temperature). Ask students the interpretation questions of “**Which graph shows generally warmer average temperatures?**” [Location 2.] “**Which graph shows a bigger change in temperature from winter to summer?**” [Location 1.]



ACLIPSE Climate and Data Literacy Activities

4. **Turn and Talk about Mystery Location example.** Have students turn and talk about which of the temperatures would match Hawaii and which would match Alaska to begin to synthesize the information from the graphs. Remind them to discuss evidence that supports their ideas. After about two minutes, ask a few pairs to share out. Accept all ideas, probe for evidence, and don't correct students' ideas at this time.
5. **Display Kinds of Scientific Evidence.** Draw students' attention to the Kinds of Scientific Evidence.
 - Evidence is a clue that helps answer a question or explain something.
 - Evidence can come from...
 - our own investigations
 - other people's investigations
 - Evidence includes reasoning about WHY or HOW the data help to answer the question or explain something.
 - Scientific explanations are based on evidence.

Emphasize that evidence can come from our or from other people's investigations, and it includes reasoning about why it counts as evidence.

6. **Project five explanation slides, What's wrong with this explanation?** For each slide, lead a brief discussion about what's wrong with each explanation:
 - **Explanation #1.** The explanation provides no evidence, only opinion.
 - **Explanation #2.** The explanation provides no evidence, just saying "the evidence" is not specific enough.
 - **Explanation #3.** No reasons are given for the temperature difference. Some evidence backs up the explanation, but the evidence is based on personal opinion (warm vs. cold instead of actual temperature readings; one person's cold may be another person's warm) and observation during a single point in time. It would be better if there were evidence from careful investigations over time.
 - **Explanation #4.** This is a good explanation because it uses evidence and tells where the evidence came from. The evidence fits the explanation and makes sense. However, this isn't a complete explanation because it contains no reasoning.
 - **Explanation #5.** This is a complete explanation because it includes reasoning as well as the evidence.



ACLIPSE Climate and Data Literacy Activities

7. **Class discussion about sources of evidence of climate change.** Ask students what kinds and sources of evidence has the class gathered to support our understanding of climate change? Accept all ideas and share the following if they don't come up: a) the work of scientists like Richard Feely; b) personal observations; c) archived and real-time data.
8. **Project slide – What makes a good scientific explanation?** To sum up, emphasize that a good scientific explanation is supported by strong and reliable evidence. Go over three key points: the evidence supports the explanation; the evidence is based on carefully collected data and information, and the evidence is from a reliable source. Point out that a casual observation (such as when the student noticed Hawaii was hot) is not as strong as evidence showing measurements taken over a long time. Leave this slide projected during the next activity.

D. Activity: *Adding Evidence and Local Effects to Cause and Effect Flow Charts*

Adding Evidence

1. **Introduce adding evidence to cause and effect flow charts.** Explain that they will now revisit their cause and effect flow charts and this time they will focus on the evidence they have gathered regarding each of the causes and effects they included. Tell students that for each sticky note on their flow chart, they should ask themselves, “How do I know this?” The answer to that question can provide the evidence for each of the causes and effects.
2. **Small groups add evidence to flow charts.** Tell students that they should write one piece of evidence per sticky note and attach it either along the arrow connecting effects, or near the effect that the evidence pertains to. Emphasize that they should use evidence from today's session and previous activities and talk about their reasoning. For example, the information that Richard Feely shared in the video about ocean acidification could be used as evidence to support the relationship between acidifying oceans and harm to shelled organisms. [*Educator Note: you may decide to show the ppt slide example to model how evidence was added to a cause and effect flow chart.*]
3. **Debrief cause and effect and evidence flow charts.** After about ten minutes, regain the class's attention. As a class, debrief some of the flow charts by having one small group share their chart and explanations, and then have other students comment on it.

Adding Local Effects



ACLIPSE Climate and Data Literacy Activities

[Educator Note: The problem of ocean acidification may seem remote and even abstract to many students. To build connections to local coastal ecosystems and related environmental challenges, students will reflect on their own local or regional coastal communities and how ocean acidification and/or climate change might pose similar challenges to those faced by oyster growers of the Pacific Northwest.

- 1. Table Talk: local effects of global climate change.** Share the following guiding question: "How do global impacts of climate change manifest their effects on local economies, cultures, and communities? Explain that they will address that big question by first discussing more specific prompts. Display the following prompts and encourage students to discuss their ideas about each of them with their table group.
 - *Think about your local ecosystems, natural environments and/or natural resources. What local changes do you think you will see as a result of global climate change?*
 - *What are some of your local communities, cultures, industries, economies and/or businesses that rely on marine resources, the ocean, or other natural resources susceptible to effects of climate change? How will local effects of climate change have an effect on these?*
 - *What effects of climate change are being addressed by local governments, communities and/or individuals?*
- 2. Whole group discussion.** Encourage students to share with the whole group some of the ideas they discussed in their small group. Depending on your local/regional environment, some examples students might share include: 1) shellfish-based seafood industries will need to adapt as lower ocean pH reduces harvest, 2) built infrastructure of commercial waterfronts and industrial docks will need costly upgrades due to sea level rise, or 3) people relying on agriculture for their livelihood may need to relocate, adjust seasonal practices, or find other opportunities altogether.
- 3. Introduce the activity.** Tell students that they will now add to and/or modify their **global** flow charts to incorporate some of the **local effects** of global climate change they just discussed. A future activity will explore solutions to these local and global challenges.
- 4. Small groups discuss local cause and effects.** Have participants return to their cause and effect flowcharts illustrating effects of global climate change. Have them reflect on the table talk discussion and determine what local effect(s) they could add to their flow charts.



ACLIPSE Climate and Data Literacy Activities

5. **Distribute materials and add local effects.** Have participants work in small groups. Distribute sticky notes to each small group to write on and add local effects to their previously made *global climate change cause and effect* flowcharts.
6. **Small groups share flowcharts.** Have participants share their local cause and effect flowcharts with another group to receive feedback.

[Educator Note: *Participants may generate ideas for solutions to their own local challenges. Feel free to encourage this and to have them make note of them, as they will revisit these ideas in an upcoming activity.*]