Lesson 4: Local Climate Impacts

Supplemental Material

Introduction: This document will help you adapt **Lesson 4: Local Climate Impacts** 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.

We included quite a few examples of how this lesson can be presented, so this supplemental document will focus more on additional activities that can be used to introduce and/or reinforce important concepts. This document will also provide more information about the activities shared in the webinar by **NCSE Ambassador Teachers Bonnie Bourgeous, Nina Corley,** and **Erin Stutzman**.

Different Age Groups

Younger Age Groups

The easiest way to adapt this lesson for younger age groups is to build on the analogies used in the lesson, such as comparing the increased risk of extreme weather to the increased occurrence of home runs during the steroid era in baseball.

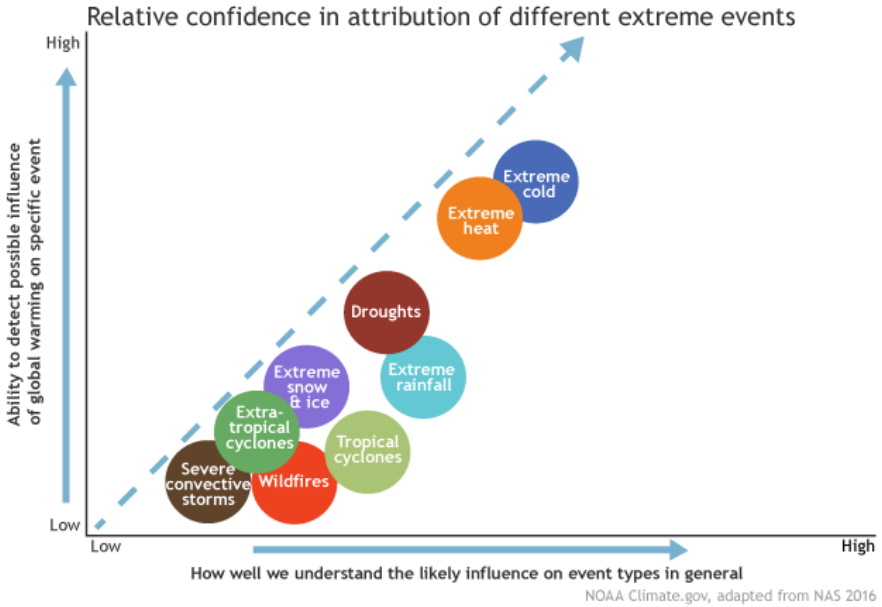
What do home runs and weather extremes have in common?

Here is the link to the video: Steroids, Baseball, and Climate Change:

Guide a classroom discussion that helps your students understand the following:

- Greenhouse gases are trapping heat in the atmosphere, and this has flow-on effects throughout our climate system.
- Global warming is affecting all weather - from the heat build-up in the atmosphere making heat waves worse, to more moisture in the atmosphere affecting precipitation, to increased heat in oceans making hurricanes bigger.
- The effect is more direct and clear for extreme weather like heat waves, and less direct and clear for other effects like wildfires.
- Weather can be unpredictable, which can lead to misunderstandings into how climate

change can influence weather



You could also use this activity from the National Geographic to help students understand how climate change is changing the parameters that continue to extreme weather:

https://www.nationalgeographic.org/activity/extreme-weather-on-earth/

Or this interactive quiz from NASA:

https://climate.nasa.gov/quizzes/extremeweather-quiz/

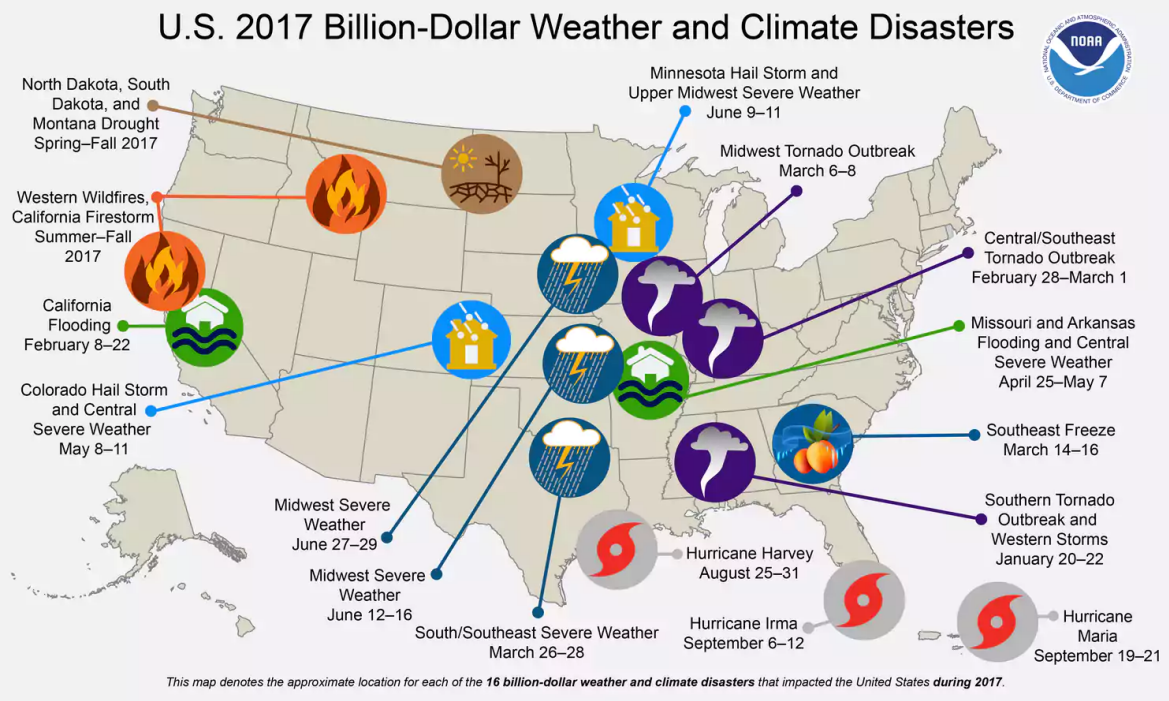
More Advanced Groups

One way to make this lesson more challenging for advanced groups is to introduce more data and have the students manipulate the data themselves.

This activity comes from **NCSE Ambassador Teacher David Amidon**.

The map below shows the most damaging extreme weather events in 2017.

1. Do you remember any of the events noted? If so, what stands out about it?
2. Would you expect a similar map for 2016 or 2018 to look exactly the same? Why or why not?
3. How might this map look different in a cooler climate? In a warmer climate?



You can use this link to identify specific extreme weather events in the U.S.:

https://www.ncdc.noaa.gov/sotc/

You can generate maps like the one shown above by selecting the type of event and time frame you are interested in.

The next section uses maps generated by David. They are included in the supplemental folder with the title, USA-ANOMALIES AND WEATHER EXTREMES.

As a class, brainstorm the following questions:

- What are some types of extreme weather events that occur in the United States?
- What events do we worry about the most where we are?
- Are these events increasing in frequency or severity?

Open a general discussion about how extreme weather events could be impacted by climate change. Ask the students to make predictions about the events they identified.

Split students into partners and distribute the printed USA maps and colored pencils. With the colored pencils, create a color-code key to reference the extremes the class identified.

Distribute the USA-ANOMALIES AND WEATHER EXTREMES maps provided in the Supplemental Folder to the partner groups. Instruct the students to examine the maps and compare the various years to each other and the predictions made by the class.

Using the color-code, students should use the printed maps to show the patterns and comparisons they observed. New colors can be used to represent weather conditions not predicted by the class.

More Advanced Groups

Another great way to adaptt this lesson for more advanced groups is provided by **NCSEAmbassador Teacher Bonnie Bourgeous**. She had students keep a dialectic journal and then led the class through a Socratic discussion. This type of approach can be tailored to any topic. Here's how Bonnie did it:

Dialectical Journal

As students enter the room hand them a ½ sheet of paper with the following questions to answer as class begins. Allow only 5 – 10 minutes for students to work independently, then build on their concepts in pair share or small table groups. After 5 – 10 minutes of small group work, ask groups to share their responses.

1. What is a drought?

2. On a scale of 1 to 10 with 10 being the worst possible drought conditions, how would you rate our local climate in terms of current drought conditions? Why?

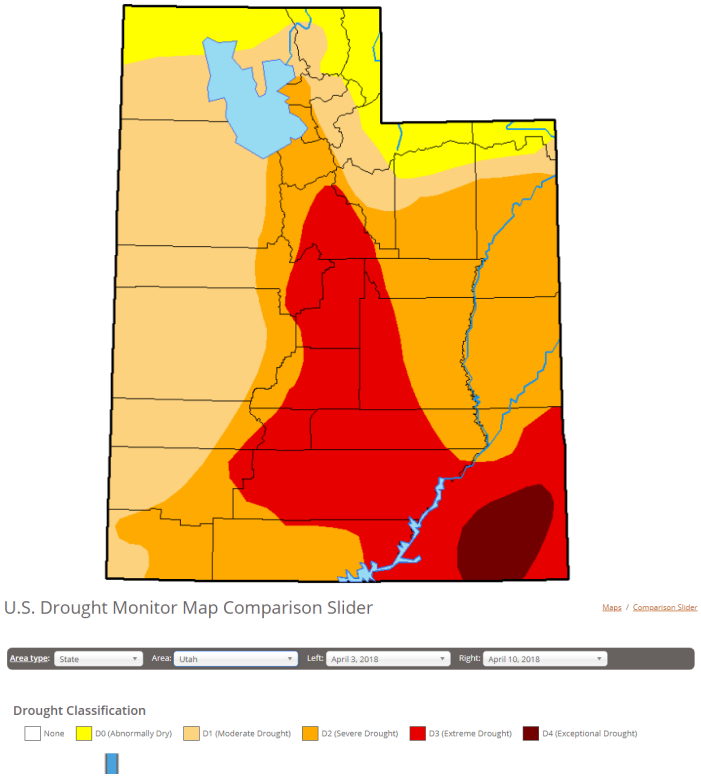
3. Create a graphic organizer to visually represent causes of drought and the impact of drought on our local ecosystem and economy.

Socratic Class Discussion:

Show the current drought map for your region and have a class discussion about what causes drought and how it relates to climate change and extreme weather events and fires. You can have your students generate maps using the interactive U.S. Drought Monitor Map Comparison Slider, or produce maps like the ones shown below before class.

http://droughtmonitor.unl.edu/Maps/ComparisonSlider.aspx

An example for Utah is shown below. The settings used to generate the map are included below the map.



You may want to have your students watch the following two short video clips after generating their maps.

1. Extreme Weather and Climate Change by Earth Now http://sphere.ssec.wisc.edu/20140305/

2. Climate Change Fueling Wilder Weather https://www.youtube.com/watch?v=MNdF-eVRWX4

Research: Assign the following research topics (this may be done in small groups or as individuals). Each group/ individual will have a different month to collect data for 50 years of data

1. Temperature max and min
2. Precipitation
3. Snow depth
4. Snow fall
5. Number of forest fires / acres burned
6. Reservoir levels
7. Atmospheric CO_2 levels.

Note: Use the Utah State Climate Center Data Base:

https://climate.usu.edu/index.php

and Utah Weather annual averages:

https://www.currentresults.com/Weather/Utah/average-yearly-precipitation.php

for # 1-4.

You can find information about the number of forest fires and acres burned at the Utah Division of Forestry, Fire & State Lands:

https://ffsl.utah.gov/index.php/fire

The USDA provide data for reservoir levels and streamflow forecasts:

https://www.nrcs.usda.gov/wps/portal/nrcs/detail/ut/snow/?cid=nrcs141p2_034248

Data Interpretation

Students will graphically represent data and share data with the class

Assign small groups to extrapolate and graph the following from the collected data. Graphically representing changes in decade averages of temperature changes and precipitation and fire frequency will allow students to identify connections between extreme weather and extreme events such as fire.

1. Annual extremes (max / min temperature) (max / min precipitation)
2. Earliest snowfall
3. Last ski date
4. Temperature, precipitation and number of fires
5. Current year totals for snowfall, snowpack and snowmelt and reservoir levels and number of fires in the local region
6. Overlay/ compare this data to decade averages for weather / climate trends and CO2 levels (both local and global averages) Students will construct models from these trends and impact on extreme events such as fire and economic impact

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. You may recall some of the activities demonstrated by NCSE Ambassador Teachers in the webinar that could be used to extend the basic lesson. You can find all of the lessons and activities the Ambassador Teachers utilized in the **Supplemental Folder**:

https://drive.google.com/drive/folders/1IxVIkAXkO7p07U8ijeE-dEc7P7nGJMIN

A few specific examples are included here.

Local Lesson: Wildfires

Localized to focus on Wildfire and Mountain Pine Beetle Infestation in the Intermountain West by **NCSE Ambassador Teacher Kim Parfitt**, Central High School, Cheyenne, Wyoming

Overview: Students will use text, graphs, diagrams, and images to make connections between fire, drought, pine beetles, and climate change. They will create a graphic organizer or connection circle to show relationships and then evaluate which data is most convincing to create their own claim and support it with evidence. In addition, students will identify the strategy used to perpetuate the misconception that extreme events in weather are normal.

Phenomenon: Image of Rocky Mountain National Park with massive beetle kill.

The effects of the mountain pine beetle outbreak are very visible parkwide. - NPS

Ask students to decide if the colors are simply fall colors or something else. Brainstorm ideas on sticky notes and sort by categories that emerge. Beetle kill, drought, and other categories should emerge.

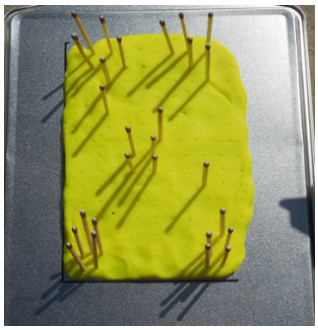
Pose the question: Is climate change influencing fire and beetle infestation in our western forests?

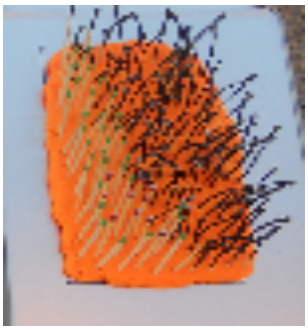
More information about diseases that threaten the Rocky Mountain region, and which climate change may make worse, can be found at this **alert** from the National Park Service.

Engage: What factors contribute to wildfires in the Western U.S.? What trends are we seeing regarding wildfire intensity and occurrence?

Here are links to two activities that can be used to introduce this lesson, or as extensions of the lesson:

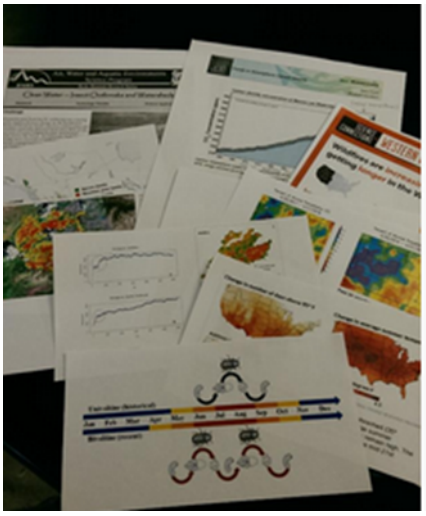
This lab activity by Alex Ruff demonstrates the impact of less rainfall on forests and the increased risk of fires - Matchstick Forest Lab. This activity takes about 40 minutes to complete. Here are some photos of what the students will create:

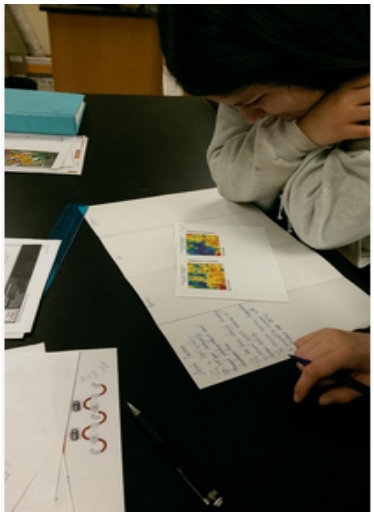




This classroom activity from NovaTeachers can help students understand the conditions necessary for fires to start - Fire Wars

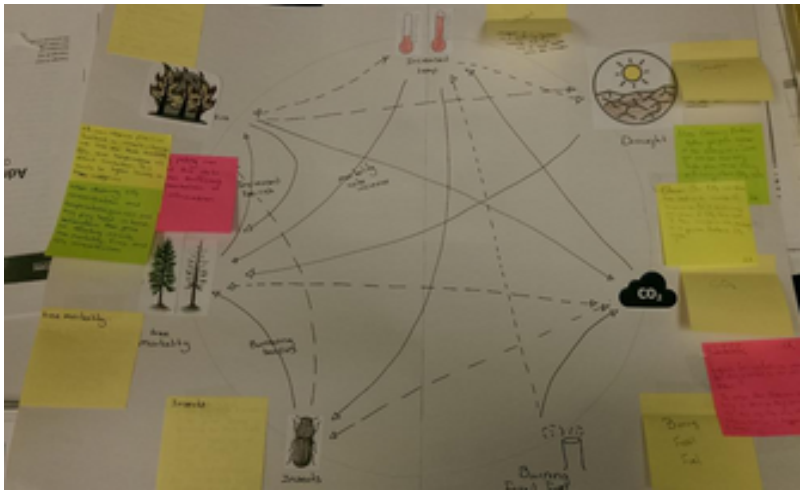
Explore: In groups of 2-3, have students investigate data packets (graphs, text, images, maps) that will help them learn more about changes in western forests and occurrence of wildfires. Students should sort the materials into 3-4 categories that make sense to their group.





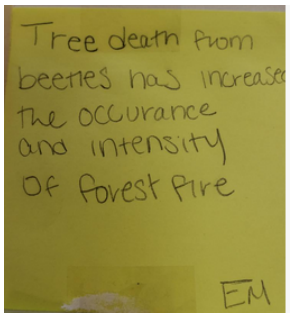
On a large piece of paper (11x17 or larger), students create a table with the categories across the top and space below in which to summarize what they have found out by examining the data. Students can share out with other groups to compare which categories and what data they found significant.

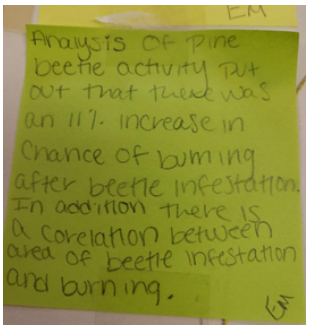
Explain: Students then create either a concept map (lines that link concepts must be linking verbs or phrases) or a connections circle (with a paragraph explanation for each anchor of the circle).

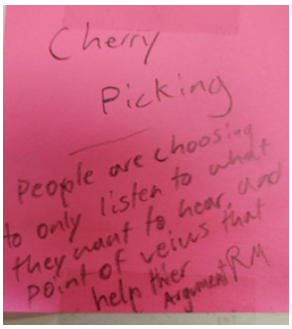


Evaluate: Display the concept maps/connection circles so students can view the work of their peers. Review the overarching question: Is climate change influencing fire and beetle infestation in our western forests?

Then using three different colored sticky notes, have each individual create a claim and evidence statement based upon the data they found most convincing related to the overarching question. Use the third color sticky note to relate the student's conclusions to the misconception that wildfires have always occurred, so recent fires are normal.







Local Lesson: Lake Effect Snow

This activity comes from **NCSE Ambassador Teacher David Amidon** who teaches in Syracuse New York**.**

Climate Change in the Northeast worksheet. Students will be directed to a website to explore the impact of climate change on a local weather extreme localized in the Northeast - Lake Effect Snow.

Using the guided worksheet, Climate Change in the Northeast, students will explore articles from ClimateCentral.org and describe the mechanisms that create Lake Effect Snow, as well as the changes in patterns predicted in a warming world.

Additionally, students will explore how climate change is predicted to impact the range of a local species of bird and/ or plant using the United States Department of Agriculture Forest Service Northern Research Station website.

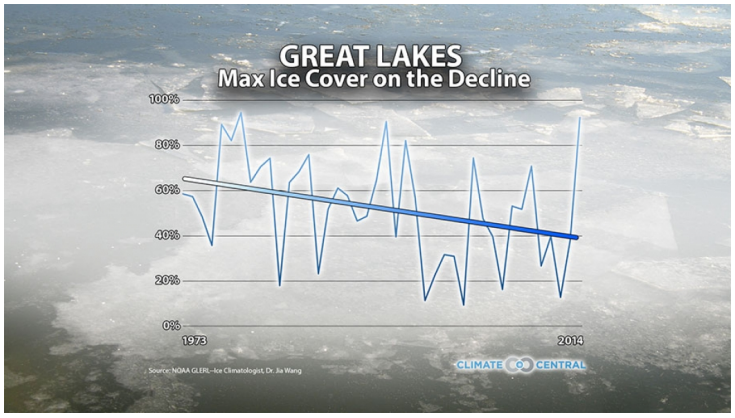
Lake Effect Snow: Visit the CLIMATE CENTRAL post from 11/21/14:

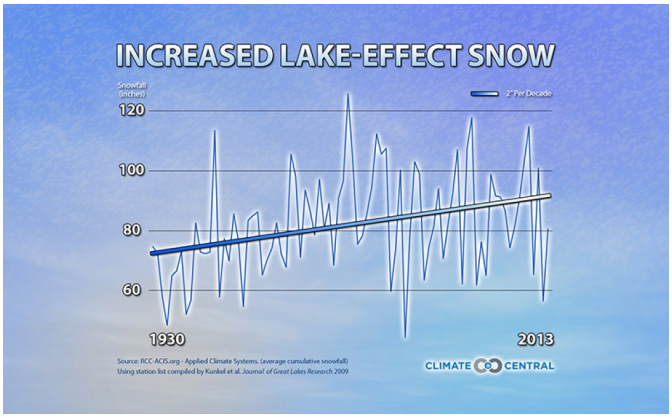
http://www.climatecentral.org/news/global-warming-lake-effect-snow-18366

What significant weather event is highlighted in this post?

How is Lake Effect Snow created? Why does it only fall in certain locations under certain conditions?

Use the graphs below to explain how increased CO2 levels might be contributing to new Lake Effect Snow patterns.





Climate Central posted a more recent article on 11/15/17:

http://www.climatecentral.org/gallery/graphics/less-lake-ice-more-potential-lake-effect-snow

According to this article, how could patterns of Lake Effect Snowfall change in a warming climate?

SUBTLE CHANGES

How would predicted changes due to Climate Change impact the habitats of organisms in the Northeast?

Visit the United States Department of Agriculture Forest Service Northern Research Station website.

Select a species of bird or a plant from the atlas.

Use colored pencils to shade in the current range on the map on the LEFT side.

CURRENT

https://commons.wikimedia.org/wiki/File:Eastern_US_range_map_blank.png

FUTURE

Choose the “Projected Future Habitat” tab. Analyze how the range changes using the different models. Select a model and shade in the map on the RIGHT. Be sure to label the model used.

CONCLUSIONS

Why are the ranges different based on the different models?

How might these different models impact the Lake Effect Snow in the Northeast?

Will the future model we ultimately follow play a role in the number and intensity of Extreme Weather events in the future? Explain your thoughts.

Local Lesson: Galveston Island, TX

This lesson was demonstrated in the webinar by **NCSE Ambassador Teacher Nina Corley**.

Introduction to Climate Change and Extreme Weather using Kahoots:

As students enter the class there will be a Kahoots already being projected on the board with the number for login. Students will take out their cell phones and log in to the current Kahoot.

Kahoot.com it is free to use and teachers may create their own kahoots. If a classroom does not have access to internet for students, the teacher can present the questions on a PowerPoint with individual dry erase boards for students to write and raise their answers for you to seen at one time.

The questions should be developed by the teacher ahead of time to include area specific information about climate change, vocabulary and area specific information about extreme weather events that will be used to determine what the students already know about the subject and engage the students before starting the lesson for the day.

The following questions are an example of questions which were developed for Galveston Island Texas. The correct answers are starred.

Introduction/Engagement Questions

1. Severe weather occurs at extremes of the ranges of weather seen in the past. The most unusual weather, which is predicted to occur 10% of the time, or once every 10 years, is called:

   Obtuse Weather
   Broken Weather
   Extreme Weather*

2. A period of time in which at least 3 consecutive days occur when the maximum temperature is in the top 10 % of warmest temperatures for that date is considered a:

   Heat wave *
   Desert Wave
   Ocean Wave

3. In the northwestern Pacific, the same powerful storms are called _____.

   Hurricanes
   Typhoons*
   Cyclones

4. In the southeastern Indian Ocean and southwestern Pacific, they are called tropical _____.

   Cyclones*

Hurricanes
Typhoons

5. To be classified as a hurricane, typhoon, or cyclone, a storm must reach wind speeds of at least _____miles an hour.

34
54
74*
84

6. The intensity, frequency, and duration of North Atlantic hurricanes, have all increased since the early 1980s.

True *
False

7. Global sea level has risen by about _____ inches since reliable record keeping began in 1880.

2 4 6 8 *

8. Thermal expansion of the water in the oceans and by melting of ice sheets and glaciers on land leads to:

Sea level rise *
Fat Waters
Broken Waters

9. GMSL is an acronym for

Global Mean Salt Level
Global Mean Sea Level*
Global Mean Soup Level

10. A recent Hurricane that was known for the excessive amounts of rainfall it dropped over Houston was named:

Ike
The 1900 Storm
Harvey *
Katrina

11. How did Hurricane Harvey lead to the devastation of the Oyster Industry following the storm:

Huge amounts of precipitation led to a lowering of salinity levels killing the oysters*
Huge amounts of precipitation led to cooling of the waters killing the oysters
The winds from the Hurricane destroyed the Oyster Beds

12. Hurricanes take heat from ocean water and convert it to _____energy. (Hint: this process converts thermal energy into mechanical energy.)

Wind*
Heart
Light
Heat

13. The worst Hurricane in Galveston's History was called:

Ike
Carla
Harvey
The 1900 Storm*

14. The greatest Natural Disaster in the History of the United States was:

The 1906 San Francisco Earthquake
The 1900 Storm*
The 1928 Okeechobee Hurricane
1889 Johnstown flood

15. A Hurricane with a wind speed of _____or higher is considered capable of causing catastrophic damage at landfall and have storm surge of 19+ feet.

111 mph
130 mph
157 mph*

Following the introduction engagement activity, students will be divided into 4 separate groups within the classroom.
Each Group will be assigned to research a specific areas of Extreme Weather Events, Sea Level rise, or other affect of climate change in their specific area.

Within each of those groups each individual will be given their own topic to research and will later bring back and present their findings to the group and create a group presentation to the entire class.

Possible topics for Galveston Island Texas

Group 1: Hurricanes

(possible individual assignments)
- 1900 storm
- Ike
- Harvey
- Irma
- Katrina

Group 2: Catastrophic Freezes

1983 and 2018

Individual topics would be to compare and contrast the two different years looking at the following topics:

Freeze and its impact on Gulf Coast industry,
Freeze and its impact on Gulf Coast marine life,
Freeze and its impact on Gulf Coast homes and buildings (frozen pipes etc)

Group 3: Impact of Rising Sea Level on the Gulf Coast Area

Individual topics would be to look at the data and determine the impacts of the rising sea level, specifically on the Gulf Coast area. Students should focus on the impact of sea-level rise on flooding and beach loss, in the following locations:

Galveston Island
Bolivar Peninsula
Houston
Corpus Christi

Group 4: Impact of Temperature Change over Time in the Gulf Coast Area

Students in this group will look at the temperature data and predict the impacts on:

Galveston Island
Bolivar Peninsula
Houston
Corpus Christi

Students will spend one day with the introduction and doing research on their individual research topic. Students will come together the second day and present their findings to the others in their group and together prepare a presentation of their findings to be presented to the entire class on the 3rd day.

Different Educational Settings

This lesson is intended for classroom applications, but it could also be done in informal science settings. Each of these lessons could be used as an afterschool or summer camp activity, for instance, with minimal or no modification other than identifying a local issue to focus on.

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

Additional Resources

Lessons in the shared folder also include additional resources such as links and worksheets.