Turning Misinformation into an Educational Opportunity

Grade level: Multiple - grade appropriate options will be developed for 5th, middle, and high school applications. High school accommodations will also be developed for 9th grade bio, AP Bio, and Envi Sci applications. Earth and Space Science.

Instructional time: 5 x 60 minute periods (this will also be flexible within the requirements for each application, ranging from 45-110 minutes)

Instructional strategy: Practice-based learning (adapted to the CLEAN 3D learning [unit](#))

This unit will prepare students to examine multiple climate change topics. Upon completion of all 5 lessons in the unit, students will discover for themselves the following aspects of climate change:

1. A scientific consensus has formed that humans are causing climate change
2. Climate models have made many successful predictions of long-term warming and specific climate patterns.
3. Modern climate change is abrupt and driven by human activity, distinguishing it from past climate change.
4. Risk from extreme weather is increasing.
5. There are multiple strategies to reducing carbon emissions.

Lesson 4: Extreme Weather

Age Level	Grade 5-12 (three options will be developed for 5th, middle, and high school applications. High school accommodations will also be developed for 9th grade bio, AP Bio, and Envi Sci applications)
Time Needed	3 60 minute periods
Vocabulary	● **Extreme weather:** Unusually severe weather at the extremes of the range of weather seen in the past. Often, extreme events are defined as lying in the most unusual ten percent. ● **Heatwave:** defined as at least three consecutive days where the daily maximum temperature is in the top 10 percent of warmest temperatures for that calendar date.
Student Learning Outcomes	● Students will learn of the various ways that a heat build-up in the climate system affects weather systems. ● Students will examine misinformation about extreme weather
Disciplinary core ideas	● HS-ESS2.D3: Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. ● HS-PS3.A1: Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. ● HS-PS3.B1: Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. ● HS-PS3.B4: The availability of energy limits what can occur in any system. ● HS-PS3.D1: Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment.
Performance expectations	● HS-ESS3-5: Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.
Educator Prep	● Difference between weather and climate - https://cleanet.org/resources/43434.html ● Extreme weather and climate change - https://cleanet.org/resources/46148.html

	● Climate reanalyzer - https://cleanet.org/resources/45145.html ● Your Warming World - http://paldhous.github.io/climate-change/ ● FLICC: Five characteristics of science denial ● Blue and red dice (ideally one for each student, or at least half a dozen of each color) ● Local databases
Fact	Risk from extreme weather is increasing, albeit some forms of extreme weather are more confidently linked to global warming than others.
Myth	Extreme weather always happens, so warming isn't making extreme weather worse.
Fallacy	**Jumping to conclusions:** Just because extreme weather happened in the past doesn't mean climate change isn't having an influence now.

Explore the facts exercise

Reflect on how greenhouse gases are trapping heat and that this has flow-on effects through our climate system. Explain how global warming is affecting all weather - from the heat build-up making heat waves worse to more moisture in the atmosphere affecting precipitation. However, the effect is more direct and clear for extreme weather like heat waves, and less direct and clear for other effects like wildfires.
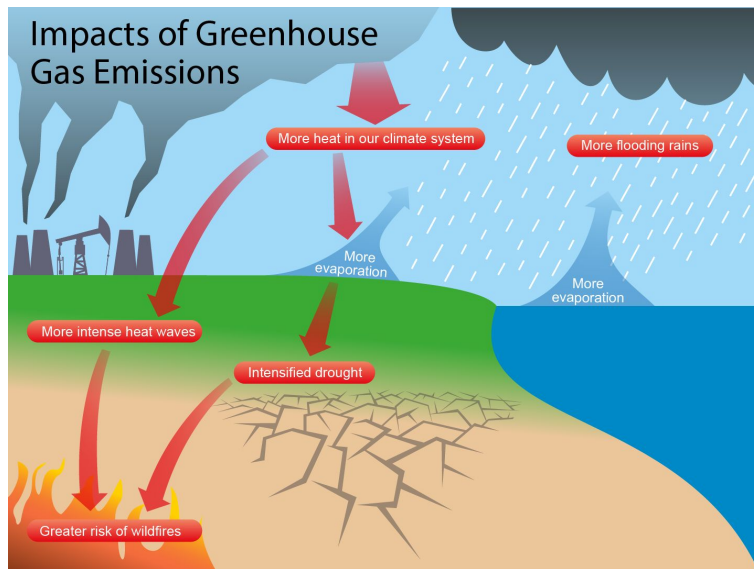
Explain that weather is unpredictable, which can lead to misunderstandings into how climate change can influence weather. To demonstrate, distribute dice to students. Blue dice are normal, red ones have two sixes. Explain that the dice is like weather, where a six is an extreme event. Have students roll dice, ask all sixes to raise hands. Point out that the red die has two sixes, increasing odds of extreme weather. Explain that the red dice is like a climate with global

warming, while the blue dice is like climate without global warming, and that global warming increases the odds of extreme weather. There should be more sixes among red dice.

Next ask a student who rolled a red dice from a six whether it was due to the red dice having an extra six or would they have rolled a six anyway. The purpose of this exercise is to demonstrate that it's difficult to say global warming caused a single event, but that it increases the likeliness of extreme events.

Reinforce this lesson with a [2-minute video](#) on how climate change's influence on weather is like steroid influencing a baseball batter.

Local Lessons

Each participant will identify a local issue related to climate change. Issues may include changes in weather patterns and subsequent increased frequency of flood, fire, drought, or other phenomenon; changes in agricultural yields/planning; changes in other resources related to climate such as impacts on fisheries, hunting, sporting activities, and or other recreational activities; and/or changes in traditional observations and activities including local ecology, invasive species, seasonal patterns, etc.

Introduction to Climate Change and Extreme Weather:

Determining what they already know and getting their attention

As students enter the class there will be a Kahoots already being projected on the board with the number for log in , 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 power point with individual dry erase boards for students to write and raise their answers for you to seen at one time.
The questions should developed with by the teacher 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 at extreme of the ranges of weather seen in the past. In the most unusual 10% is called
    Obtuse Weather,
    Broken Weather
    Extreme Weather*

2.At least 3 consecutive days when max temp is in the top 10 % of warmest temps for that date is considered a
    Heat wave *
    Desert Wave,
    Ocean Wave

3. A type of storm called a tropical cyclone, which forms over tropical or subtropical waters. When a storm's maximum sustained winds reach 74 mph, it is called a
    Tornado,
    Hurricane   *
    Thunderstorm

4. Thermal expansion of the water in the oceans and by melting of ice sheets and glaciers on land.
    Is known as Sea level rise *
    is known as fat Waters is known as cold waters
    is known as Broken Waters

5.GMSL is an acronym for
        Global Mean Salt Level
        Global Mean Sea Level *
        Global Mean Soup Level

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

  Ike

  The 1900 Storm

  Harvey *

  Katrina

9. 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 Huricane destroyed the Oyster Beds

10. Hurricanes take heat from the oceans and convert it to the energy of their _____. They are taking thermal energy and making mechanical energy out of it.

  Winds*

  Heart

  Light

  Heat

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

  Hurricanes

  Typhoons*

  Cyclones

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

  Cyclones *

  Hurricanes

  Typhoons

13. In the northern Indian Ocean, they're called severe _____storms.

  Cyclonic *

  Hurriconic

  Typhonic

14. In the southwestern Indian Ocean, they're just called _____ cyclones.

  Indian

  Tropical*

  Ocean

15. 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

16. The worst Hurricane in Galveston's History was called

   Ike

   Carla

   Harvey

   The 1900 Storm*

17. 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

18. A Hurricane with a wind speed of _____or higher is consider to cause Catastrophic damage at landfall and have storm surge of 19+ feet.

   111 mph

   130 mph

   157 mph*

19. Texas Parks and Wildlife Department deputy director and former director of the agency's coastal fisheries division, said of the record-setting weather that saw air temperature along the coast fall into the teens and remain below freezing for five days to obliterate about _____ coastal finfish and other marine life and leave fisheries managers and anglers facing daunting challenges.

   20 thousand

   20 million*

   200

20. Below-freezing temperatures swept across Texas and Louisiana the evening of January 16 and into January 17, causing several _____as refineries and local infrastructure contended with the frigid conditions.

Disruptions, closures and damage *

Explosions

pickets

Research and Identify Extreme Weather Events in Local Area

Following the introduction engagement activiity, 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 or 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 One 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 tgulf 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

Sea level rise taking a look at the data and the impacts of the rising sea level specifically on the Gulf Coast Area taking a look at flooding, beach loss,
The current and historical affects
The projected affects
Taking a look at specific areas for individual projects
Galveston Island
Bolivar Peninusla
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 over time and Graph that information
Taking a look at specific areas for individual projects
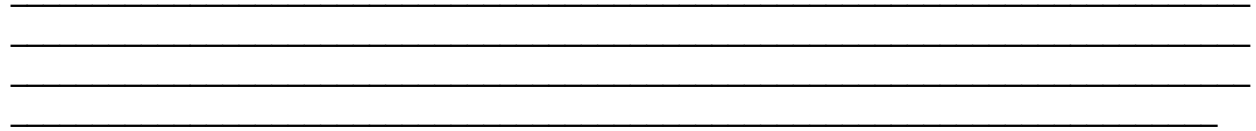Galveston Island
Bolivar Peninusla
Houston
Corpus Christi

Students will spend one day with the introduction and doing the research on their individual research topic.
Students will th 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.

Another possible topic would be taking a look at the data for birds and trees and the impact on them

Name_____Date_____

Research Topic_____

Group to which assigned_____

Notes on Research Topic be sure to include at least 3 different references

Must include data collection and at least one graph created from data collection.

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Graphic created from data collection

cited references

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Recap FLICC

Recap the five techniques of science denial: Fake experts, Logical fallacies, Impossible expectations, Cherry picking and Conspiracy theories (summarized with the acronym FLICC). Explain that you will shortly give an example of misinformation and see if the students can detect the technique used. Recap the techniques under logical fallacies such as jumping to conclusions and red herring.

Spot the fallacy exercise

Introduce the students to an example of misinformation arguing that extreme weather has happened in the past, without human-caused global warming, so any extreme events we see today must be natural, just like they've always been. Clarify that the chief argument is that global warming has no influence on weather. Split the students into groups and assign them the task of resolving the conflict between the dice analogy and the past extreme weather argument. Can students spot the technique of denial used?

Students are likely to present a range of different answers and sometimes multiple answers will have a degree of validity due to the informal nature of logical fallacies. Nevertheless, the best fit in this case is the technique of jumping to conclusions, also known as non sequitur. Noe that this argument also commits the single cause fallacy, arguing that if nature was once the cause, it must always be the cause.

Links to references for activities and research for individual and group projects

state climate and energy maps
http://www.georgetownclimate.org/clean-energy/state-energy-profiles-and-data-maps.html
using website to find local climate and energy profile
http://www.georgetownclimate.org/clean-energy/clean-energy-and-climate-data.html?state=TX
Preparing for climate change in Texas
http://www.georgetownclimate.org/adaptation/state-information/overview-of-texas-climate-change-preparations/overview.html
http://www.glo.texas.gov/coastal-grants/projects/files/Master-Plan.pdf
The Solutions project
http://thesolutionsproject.org/why-clean-energy/
clickon Texas for 5050 projected vision for transition to 100% wind, water & solar energy
https://tidesandcurrents.noaa.gov/sltrends/sltrends.shtml
Sea level trends from Galveston Pleasure Pier TX
6.62mm/year 1957-2011

The mean sea level trend is 6.62 mm/year with a 95% confidence interval of +/- 0.69 mm/year based on monthly mean sea level data from 1957 to 2011 which is equivalent to a change of 2.17 feet in 100 years.

http://www.beg.utexas.edu/coastal/thscmp/support/SeaLevelRiseLesson.pdf
https://toolkit.climate.gov/#climate-explorer
Sea level changes and texas coastal environment
https://www.houstonchronicle.com/news/houston-texas/houston/article/Sea-swallowing-Galveston-faster-than-thought-4160081.php
newspaper report on sea swallowing Galveston faster than thought
https://www.ucsusa.org/global_warming/science_and_impacts/impacts/galveston-county-texas-sea-level-rise-storms#.Wxc2li2-Icg   Galveston County sea level rise
Climate Explorer
https://toolkit.climate.gov/climate-explorer2/
 choose zipcode for Galveston 77550
https://toolkit.climate.gov/climate-explorer2/location.php?county=Galveston+County&city=Galveston,%20TX&fips=48167&lat=29.4345626&lon=-94.68120859999999

http://paldhous.github.io/climate-change/

your warming war and take it to the place where you are located on map and gives local data

Since Ike more damage because storms are bigger, so much water, moisture in the air so looking at ways to reclassify them, because of the amount of water involved
Harvey affected salinity of water because of so much rain and decimated oyster industry
https://www.houstonchronicle.com/business/retail/article/Harvey-decimated-Galveston-Bay-s-oyster-population-12218312.php

Cold Snap…. Hard Freeze on Galveston Island
closing fishing areas because of cold weather

https://tpwd.texas.gov/newsmedia/releases/?req=20180101a

http://www.galvnews.com/news/free/article_7fd12ae6-a6db-53e9-97fc-fcecb4edd2b3.html

two fishing areas closed because of cold weather
hard freeze jan 16   water shortage due to freeze and pipes broken
https://www.usnews.com/news/best-states/texas/articles/2018-01-23/water-saving-mandate-lifted-for-galveston-after-hard-freeze

https://www.click2houston.com/news/frozen-pipes-cause-unprecedented-water-loss-in-city-of-galveston-city-manager-says

http://www.publicnow.com/view/920678348B72DC62D71AE72346824964378B3BEC

https://galvestontx.gov/913/Report-your-leak

https://www.chron.com/sports/outdoors/article/Effects-lessons-of-1983-freeze-evident-on-Texas-5092926.php
affects of a freeze on the ecosystem on gulf coast
https://www.genscape.com/blog/freezing-temperatures-disrupt-refinery-operations-products-demand-across-padd-3
closing of refineries and malfunctioning of hydrogen plants due to freeze on gulf coast in 2018
How Texas Rebuilt After the Deadliest Hurricane in U.S. History
http://time.com/4918607/texas-hurricane-harvey-galveston/

5 Ways Climate Change May Be Making Hurricanes Worse

http://time.com/4933743/hurricane-irma-climate-change-global-warming/

Comparing harvey and 1900 storm
As Terrible As Harvey Is, The Galveston Hurricane Of 1900 Was Much, Much Worse
https://www.forbes.com/sites/kevinmurnane/2017/08/27/as-terrible-as-harvey-is-the-galveston-hurricane-of-1900-was-much-much-worse/#13736d342594

Hurricane Harvey versus Katrina and other Monster storms: Understanding the Devastation

http://www.newsweek.com/hurricane-harvey-katrina-monster-storms-understanding-devastation-657079
https://www.ucsusa.org/global-warming/science-and-impacts/impacts/hurricanes-and-climate-change.html#.WpG9M7a-KYU

Union of Concerned Scientist
Hurricanes and Climate Change Increasingly destructive hurricanes are putting a growing number of people and structures at risk observed trends in hurricanes Factors that increase the destructive potential of hurricanes Rising Ocean temperatures fuel stronger North Atlantic Hurricanes , The role natural cycles in hurricanes and what the future holds

https://nca2014.globalchange.gov/report/our-changing-climate/changes-hurricanes#intro-section-2

a chapter which summarizes how climate is changing, why it is changing, and what is projected for the future. While the focus is on changes in the United States, the need to provide context sometimes requires a broader geographical perspective. Additional geographic detail is presented in the regional chapters of this report.

https://www.gfdl.noaa.gov/global-warming-and-hurricanes/
The geophysical Fluids Dynamics Laboratory   Global warming and hurricanes current research results. lead to more intense hurricanes   anthropogenic warming over the next century increase the occurrence of very intense tropical cyclones globally 2-11 percent increase in storm intensity

https://www.c2es.org/content/hurricanes-and-climate-change/
Center for climate and energy solutions Climate basics to Extreme weather Hurricanes and climate change

Warmer sea surface temperatures could intensify tropical storm wind speeds, potentially delivering more damage if they make landfall. Based on sophisticated computer modeling, scientists expect a 2-11 percent increase in average maximum wind speed, with more occurrences of the most intense storms. Warmer seas also mean more

precipitation. Rainfall rates during these storms are projected to increase by about 20 percent and, as Hurricane Harvey showed in 2017, this can sometimes be the more destructive impact.

http://www.climatecentral.org/gallery/graphics/warmer-air-means-more-evaporation-and-precipitation

Climate Central….. Warmer air means more precipitation and the results of that hurricanes will produce more rain like what happened in Harvey…. in our area

https://www.scientificamerican.com/article/was-the-extreme-2017-hurricane-season-driven-by-climate-change/
Scientific American   Was the Extreme 2017 Hurricane Season Driven by Climate Change? Global warming already appears to be making hurricanes more intense

https://earthobservatory.nasa.gov/Features/RisingCost/rising_cost5.php

Nasa Earth Observatory   The impact of climate change on Natural disasters, a glimpse of future

http://www.chicagotribune.com/news/nationworld/science/ct-global-warming-hurricane-harvey-20171213-story.html

Global warming boosted Hurricane Harvey's rainfall by at least 15 percent, studies find
http://www.chicagotribune.com/topic/weather/hurricane-harvey-EVWAN0099-topic.html

https://www.hcfcd.org/hurricane-harvey/

Harris county flood control district   Harris County has never seen a hurricane like Harvey

FEMA risk map for flood control
http://maps.riskmap6.com/TX/Galveston/

http://wxshift.com/news/blog/harveys-rain-and-surge-flooding-could-be-catastrophic
predictions and how different from Ike

Hal Needham is a storm surge scientist who specializes in data driven storm surge analysis and founder of marine weather and climate has data to allow you to explore 10 different indicators of climate change in different areas around the world.
flood maps
https://projects.propublica.org/graphics/harvey-maps

https://www.fema.gov/climate-change

This page provides information about climate change and links to related tools and documents. The page is intended for anyone interested in learning more about our resources and other federal government resources to support climate preparedness and resilience.

http://www.judgeemmett.org/Docs/Emmett_Flood_Proposals/Emmett_Flooding_Proposals.pdf
suggestions for what to do for Houston after flooding from Harvey
https://www.fs.fed.us/nrs/atlas/
United States department of Agriculture Climate Change Atlas. The Climate Change Atlas documents the current and possible future distribution of **134 tree species** and **147 bird species** in the Eastern United States and gives detailed information on environmental characteristics defining these distributions.