Existence of Climate Change Module

In the following module, there is a list of activities and interactive websites that can be utilized to have conversations about the existence of climate change. The first activity is a reading on the history of climate science and predicted climate change via MIT's Climate Primer website. The second activity is a set of lessons on visualizing temporal and spatial changes on Earth's surface using MASCON. The third activity is the Climate Explorer, in which students will visualize future temperature changes in Monongalia County and the contiguous US.

Activity 1.1 - Climate Primer

The following website, developed by MIT, summarizes the existence of human-caused climate change. The website helps to discuss complex topics such as climate change uncertainty and provides information on risk management and future action. Here, we will be focusing on climate science and climate change, the first two chapters. You can access the website here: https://climateprimer.mit.edu

1. Scroll down the homepage to see different modules. Your screen should look like this.

2. Select 'Climate Science' and read through the history. Further, it discusses the greenhouse effect and the existence of climate change based upon increased CO2 concentrations in the atmosphere.

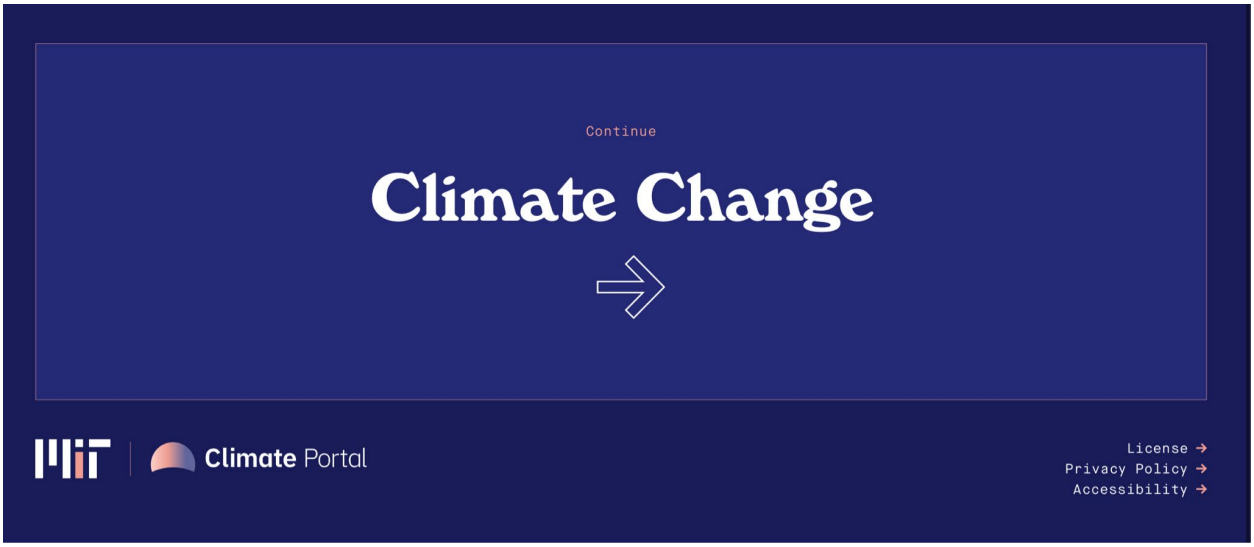
Question: How did ‘climate science’ come to be? Who are the most influential contributors mentioned?

Question: Provide a brief explanation of the greenhouse effect.

Question: What are some of the ways in which CO2 concentrations have increased?

Question: What are ways in which prehistoric records of past temperatures have been collected?

3. Once you have read through all of the information under ‘Climate Science’, there is a button at the bottom of your screen that brings you to ‘Climate Change’. Your screen should now look like this.



4. Read through the ‘Climate Change’ chapter and answer the following questions.

Question: What are Relative Concentration Pathways (RCPs)? What are the different RCPs utilized in climate science?

Question: What are the three cycles which influence natural climate changes?

Question: How has the temperature changed in the Arctic? What should temperature look like if only natural climate changes occurred?

Question: Why are observed carbon dioxide levels ‘unnatural’? How did levels change at the start of the Industrial revolution?

Question: Why are climate change predictions uncertain?

Question: What will happen if nothing is done to stop emission increases?

Activity 1.2 - WV ClimateLink

WV ClimateLink is an online atlas, tool, and educational resource that provides educators, communities, and decision makers with data, maps, visualizations, and learning activities that explore the effects of changing air temperature and precipitation on West Virginia's communities, economies, and ecosystems. The activities below can be modified for any of the climate variables and related to just about any topic including floods, droughts, household and business heating/air conditioning costs, hatch emergence (e.g. for fly fishing), ticks and mosquitos, fall leaf colors, etc.

WV ClimateLink provides information on West Virginia's historic (1980-2010) and future (2020-2099 in 20-year periods) air temperature and precipitation. Future climate is for two emission scenarios, RCP 4.5 and RCP 8.5. The following climate variables are included in standard (e.g., degree Fahrenheit, °F) and metric (e.g., degree Celsius, °C) units:

- Average annual precipitation
- Average annual air temperature
- Average # of days below freezing threshold
- Average # of days above high heat threshold
- Average monthly precipitation for winter over January, February, March
- Average monthly precipitation for summer over June, July, August
- Average monthly air temp for winter over January, February, March
- Average monthly air temp for summer over June, July, August

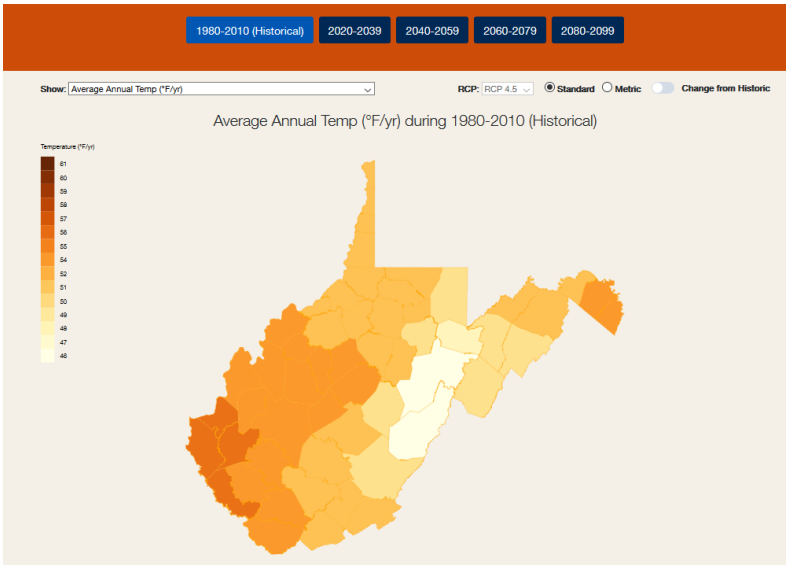
All data can be dowloaded using the 'Download RCP 4.5 Data' and 'Download RCP 8.5 Data' tabs located below the map.

Access THE CLIMATE MAP on WV ClimateLink - https://wvclimatelink.sandbox.wvu.edu/home

Part 1.

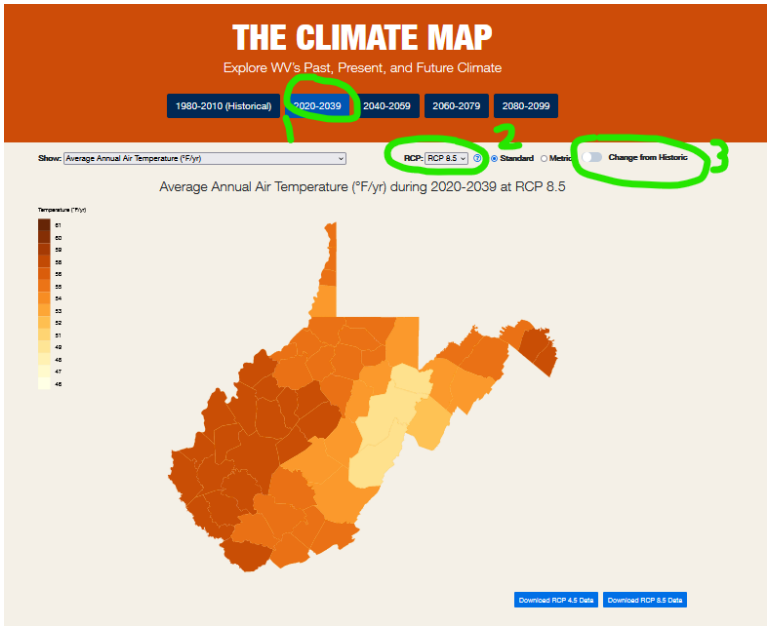
1. 'THE CLIMATE MAP' shows various climate variables for counties throughout WV. The default display is for 'Average Annual Air Temperature (°F)' for the 1980-2010 (Historical) period.

   Question: Do you notice any patterns in Average Annual Air Temperature for counties throughout WV? What would explain the differences in cooler vs warmer counties?



Question: What county did you select? What is the historical Average Annual Air Temperature for this county?

3. Select a future time period (2020-2039; 2040-2059; 2060-2079; 2080-2099) by clicking on a future time period tab (1) then use the RCP dropdown menu (2) to select the RCP 8.5 high emissions scenario.



Question: What is the projected future Average Annual Air Temperature *for your selected county in (°F)? [Additional activity – convert from °F to °C].*

Select the 'Change from Historic' tab (3) to calculate the absolute change (Future-Historic) between your selected future period and the historic period. How is Average Annual Air Temperature for your selected county expected to change?

4. Repeat 1 and 2 for 'Average Annual Precipitation'.

   Question: *What does the map of West Virginia look like under a high emissions scenario? What types of changes do you see in different regions throughout the state?*

   Question: Now select your county. What is the historical Average Annual Precipitation for your selected county?

   Question: *How does Average Annual Precipitation change in the future for your selected future period in your county?*

5. A helpful way to understand future changes are to compare them to the past. For air temperature, this is done by calculating the absolute change, the difference between future and past air temperature: Future-Past. Absolute changes are expressed in the original units of air temperature. Changes in precipitation are expressed as the relative change as a percent change from the past: (Future-Past/Past) x 100. Calculate the absolute and relative changes for air temperature and precipitation for your selected county and future time period.

   Question: Calculate the absolute change in future air temperature and relative change precipitation based on RCP 8.5 compared to the past. How are future air temperature and precipitation projected to change in the future?

6. 'Average # of Days Below Freezing' describes the number of cold days in a year that are below freezing. Repeat the above analysis for the 'Average # of Days Below Freezing' for RCP 8.5.

Question: Historically, on average, how many days have been below freezing for your selected county?

Question: Describe how the 'Average # of Days Below Freezing' are projected to change for your county and time period based on RCP 8.5?

7. Select 'Change from Historic' and toggle through the different future time periods. Describe how the 'Average # of Days Below 32°*F*' are projected to change across the state of WV.

   Question: Describe how the 'Average # of Days Below 32°*F*' are projected to change across time periods and the state based on RCP 8.5. Describe any patterns you see.

8. Repeat the above analysis for the 'Average # of Days Above 95°*F*' for RCP 8.5.

   Question: Describe how the 'Average # of Days Above 95°*F*' are projected to change across time periods and the state based on RCP 8.5. Describe any patterns you see.

Activity Summary Questions:

Question: What are some of the ways that changes (increases or decreases) in air temperature and precipitation can affect the quality of life for West Virginians? What about ecosystems?

Question: What are some of the ways that changes (increases or decreases) in freezing (<32°*F*) and hot (>95°*F*) can affect the quality of life for West Virginians? What about ecosystems?

Question: What are some factors that contribute to higher emissions?

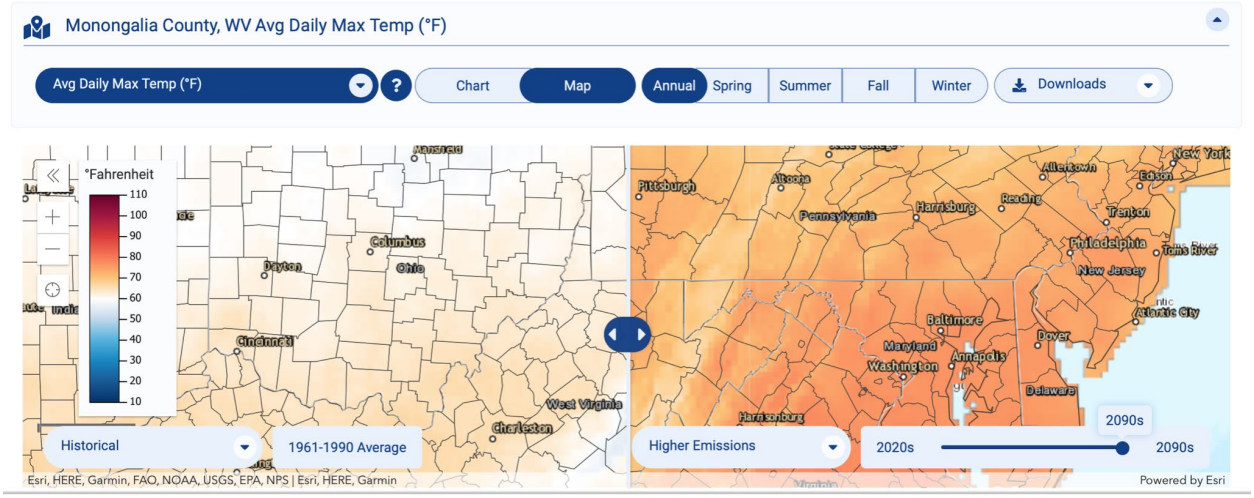
Question: Given the predicted changes climate variables, how can citizens, business owners, and decision makers in your county use this information?

Summary Activity: Create your own exercise than can be used by your family, church, school, and community members to understand West Virginia's climate past and future climate.

Activity 1.3 - Climate Explorer

The Climate Explorer is a tool that provides graphs of observed and predicted temperature, precipitation, and other related climate variables by county in the United States. Graphs show both high emissions and low emissions scenarios for predicted changes.

1. Access the Climate Explorer here: https://crt-climate-explorer.nemac.org
2. In the search bar, type in “Monongalia County, WV”
3. Click on ‘Climate Maps’. Below is a screenshot of what your screen should look like. It is currently displaying ‘Avg. Daily Max Temperature’

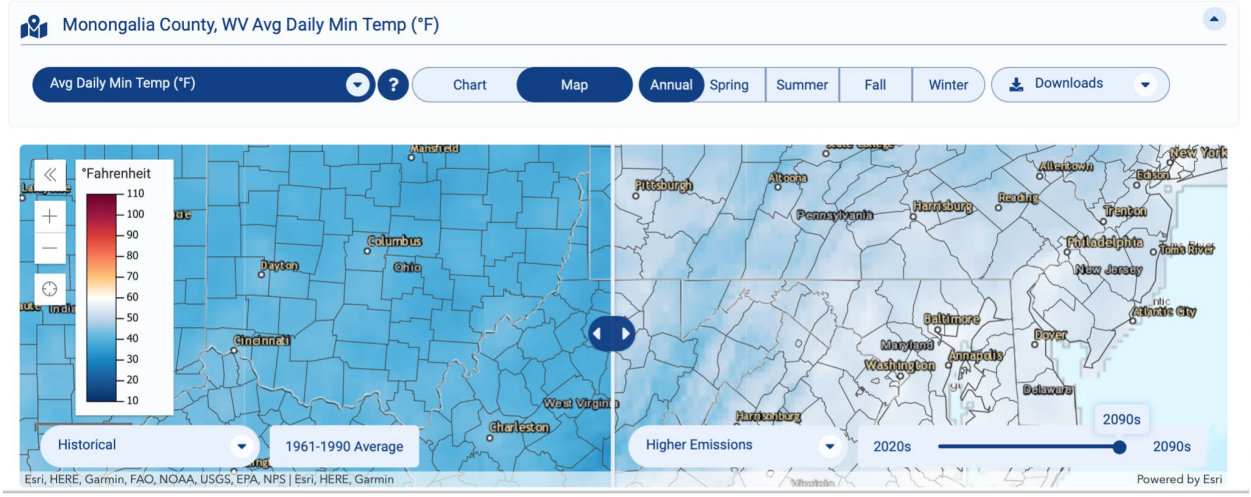


Question: What is the historical average daily maximum temperature for Monongalia County? How will this change under a high emissions scenario?

4. Click where it says ‘Higher Emissions’ and change it to ‘Lower Emissions’

Question: How does the average daily maximum temperature for Monongalia County change under a low emissions scenario?

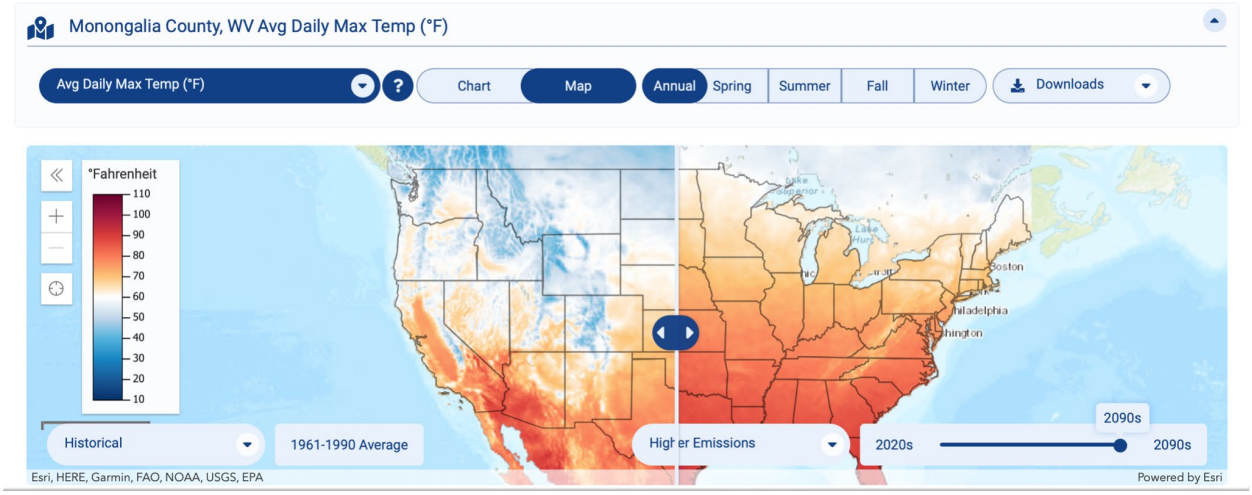
5. At the top left-hand corner, click the drop down menu of ‘Avg Daily Max Temp’
6. Select ‘Avg Daily Min Temp’. Your screen should look like the one below.



Question: What is the historical average daily minimum temperature for Monongalia County? How will this change under a high emissions scenario? How will this change under a low emissions scenario?

Question: Outside of Monongalia County, why might some areas experience hotter average maximum and minimum temperatures in the future? Think about population density and land use change.

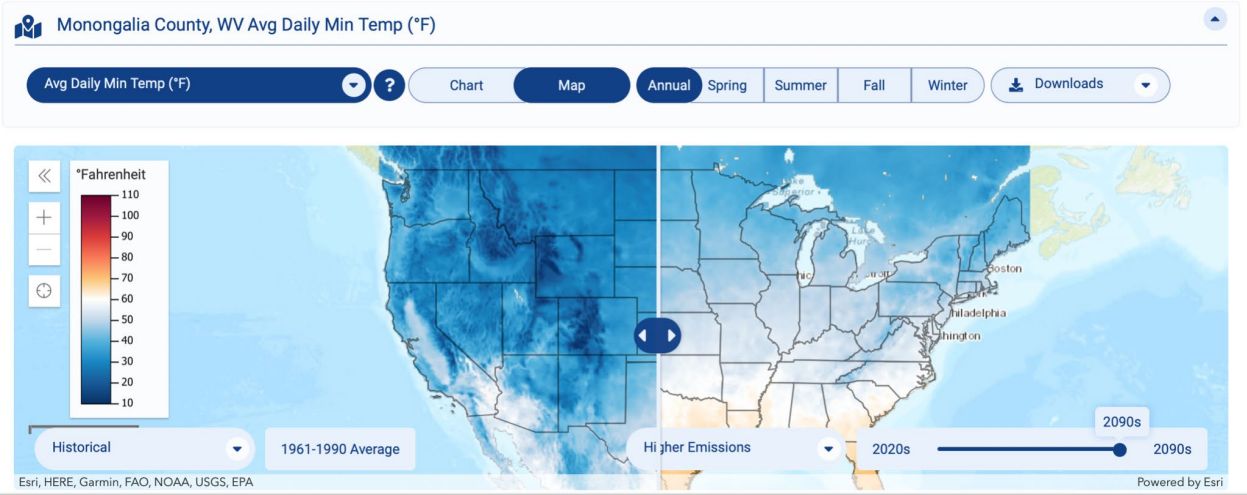
7. Go back to ‘Avg Daily Max Temp’ in the left-hand corner and use the ‘-’ icon to zoom out to the entire US.
8. Use the cursor in the middle of the screen to toggle between historical data and a high emissions scenario. Your screen should look similar to the one below.



Question: What does the map of the US look like under a high emissions scenario? What types of changes do you see in different regions of the US?

Question: Compare each of the four quadrants of the US and their predicted changes under a high emissions scenario to one another. How do the Northeast and Southeast compare in changes? What about the Southwest and the Northwest?

9. Change the map to 'Avg Daily Min Temperature' in the left-hand corner and use the '-' icon to zoom out to the entire US.
10. Use the cursor in the middle of the screen to toggle between historical data and a high emissions scenario. Your screen should look similar to the one below.



Question: What does the map of the US look like under a high emissions scenario? What types of changes do you see in different regions of the US?

Question: Compare each of the four quadrants of the US and their predicted changes under a high emissions scenario to one another. How do the Northeast and Southeast compare in changes? What about the Southwest and the Northwest?

<u>Activity Summary Questions</u>:

Question: Why are daily maximum and minimum temperatures important to map? How might temperature changes influence other changes (such as precipitation)?

Question: What are some factors that contribute to higher emissions?

Question: What are some ways in which scenarios can be reduced in the US?

Question: Given the predicted changes in temperature, how can Monongalia County utilize this information?