Grade 8 Unit 8 Project - Teacher Guide

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Project Overview

This culminating performance task invites students to use mathematics to investigate patterns and relationships in climate data. Across the project, students pose their own statistical questions, collect and analyze data, and use mathematical models to interpret trends in real-world climate variables. Students work with bivariate data, exploring how two quantitative variables change together. They create scatter plots, describe patterns of association, and model relationships using linear equations. These tools allow students to analyze relationships such as how temperature changes over time, how atmospheric carbon dioxide levels relate to temperature, or how precipitation patterns change in a specific region.

The project emphasizes reasoning about patterns, trends, and variability in real-world data. Students use mathematics to identify associations, build models, and consider the limits of those models when making predictions. The project is intentionally open-ended. Students choose the climate variables that they want to investigate. This allows students to connect mathematical analysis to real-world environmental questions while building independence in statistical investigation.

Sample investigative variables:

- Carbon emissions vs. average temperature over time
- Distance from coastline vs. frequency of flooding events
- Vehicle miles traveled vs. air quality index
- Median income level vs. exposure to extreme heat days
- Energy use per capita vs. CO_2 emissions
- Year vs. number of climate-related natural disasters
- Year vs. public belief that climate change is real
- Year vs. money invested in clean energy
- Year vs. air pollution in major city/cities

Students can refine variables, time spans, scales, etc. They may choose to investigate variables at the local, state, national, or global level. As an extension, students synthesize their work into a final presentation that communicates their statistical question, data analysis, mathematical model, and conclusions about the relationship they observed.

Standards

8.SP.A.1
— Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association.

8.SP.A.2
— Know that straight lines are widely used to model relationships between two quantitative variables. For scatter plots that suggest a linear association, informally fit a straight line, and informally assess the model fit by judging the closeness of the data points to the line.

8.SP.A.3
— Use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercept.
For example, in a linear model for a biology experiment, interpret a slope of 1.5 cm/hr as meaning that an additional hour of sunlight each day is associated with an additional 1.5 cm in mature plant height.

Foundational Standards

6.SP.B.4
7.SP.A.1
7.SP.B.4
8.F.A.3
8.F.B.4
8.EE.B.5

Project Timeline & Sequence

Across five lessons, students move through the full cycle of a statistical investigation: posing questions, collecting data, representing relationships, modeling patterns, and interpreting results.

Lesson	Focus / Student Work
Day 1 **Ask a Question**	Explore climate graphs, generate noticings and wonderings, develop a bivariate statistical question.
Day 2 **Plan & Collect Data**	Identify variables, locate reliable sources, and collect paired climate data.
Day 3 **Represent Relationships**	Create scatter plots and describe patterns of association.
Day 4 **Model with a Line**	Draw and calculate a line to fit data and interpret the slope and y-intercept.
Day 5 **Interpret Findings**	Use evidence from graphs and equations to make predictions and draw conclusions. Discuss limitations of linear models.
(Optional) **Communicate Findings**	Prepare a presentation and communicate ideas to peers and community. Discuss real-world implications.

Data Overview

In this project, students investigate relationships between two quantitative variables by collecting paired numerical data that can be represented in a scatter plot and modeled with a line. Students may collect their own climate data or use a curated dataset provided by the teacher (see next page). Students may choose to investigate patterns over time or relationships between two different climate-related variables. Some investigations may focus on drivers of climate change, while others may focus on impacts of climate change on ecosystems or communities. **Possible variable pairings include:**

Changes Over Time	• Year vs. global temperature anomaly, atmospheric carbon dioxide concentration or global sea ice extent • Year vs. average summer temperature, annual precipitation, or number of extreme heat days in a specific city or region
Climate Drivers and Indicators	• Atmospheric carbon dioxide concentration vs. global temperature anomaly • Atmospheric carbon dioxide concentration vs. ocean temperature • Ocean temperature vs. sea ice extent
Environmental Impacts	• Sea ice extent vs. polar bear population estimates • Ocean temperature vs. coral bleaching events • Temperature anomaly vs. frequency of extreme heat events

Teachers may support students in refining questions so that both variables are quantitative and measurable, allowing the data to be represented in a scatter plot. Students should be able to collect 15–30 data points in order to produce a meaningful scatter plot and identify patterns in the data.

Curated Data Set (Optional)

Teachers may choose to provide a dataset to some or all students in order to reduce time spent searching for data, ensure consistent units and measurements, and/or support students with additional scaffolding. Using a shared dataset can also allow students to investigate different questions within the same data, creating opportunities for comparison during presentations.

Link to curated data set: Simulated Climate Data Set.

- This dataset combines real-world climate trends with lightly simulated data to create a coherent and usable classroom experience. Core variables such as atmospheric CO_2 concentration and global temperature anomaly are based on well-established historical trends from sources like NOAA and NASA. Other variables (e.g., regional temperatures, extreme events, and ecological indicators) are modeled to reflect realistic patterns and relationships.
- Some values may not align perfectly across all years, and small inconsistencies are intentional. These create opportunities for students to reason about data limitations, variability, and the challenges of modeling real-world systems.

Students should treat this dataset as a reasonable representation of real climate patterns, while also recognizing that all models and datasets have limitations.

Student-Friendly Climate Data Sources

This list is a starting point for students to explore. It includes reliable, accessible sources for temperature, precipitation, CO_2, sea ice, and wildlife trends. Additionally, encourage students to consider or look at patterns at local, state, and national levels, not just global trends.

General Climate Data

- **NOAA Climate Data Online**
  A large, searchable database of temperature, precipitation, and weather data from thousands of stations, useful for U.S. and global trends.
- **NOAA Climate.gov Data & Maps**
  Provides interactive maps and simplified datasets (temperature, precipitation, CO_2, sea ice) that are more digestible for students.
- **NOAA OneStop Data Portal**
  A centralized tool to search across many NOAA datasets including weather, oceans, and climate indicators.

Temperature & CO_2

- **NASA Global Temperature Data**
  Offers global temperature anomaly datasets and visualizations based on long-term climate observations.
- **NOAA Global CO_2 Data (GML)** Provides atmospheric carbon dioxide measurements from monitoring stations worldwide, updated regularly.

Precipitation & Regional Climate

- **NOAA U.S. Climate Divisional Dataset (NClimDiv)**
  Long-term U.S. temperature and precipitation data (1895–present) organized by region, useful for comparing locations.
- **NOAA Arctic Report Card – Precipitation**
  Shows long-term trends in precipitation and extreme weather patterns, especially useful for discussing climate change impacts.

Sea Ice & Polar Systems

- **NOAA Arctic Indicators – Sea Ice Extent**
  Tracks long-term changes in Arctic sea ice with downloadable data and interactive graphs.
- **NOAA Arctic Data Portal**
  Aggregates datasets on Arctic systems, including sea ice, ocean conditions, and ecosystem changes.

Wildlife & Climate Impacts

- **Polar Bears International**
  Provides accessible population estimates, habitat data, and explanations of how climate change affects polar bears (good for student research and context).

Mathematical Practices in the Project

This project naturally embeds multiple Mathematical Practices throughout the investigation.

- **MP.1: Make sense of problems and persevere in solving them**
  Students navigate a multi-step investigation, making decisions about how to organize data, represent relationships, and refine their models.
- **MP.2: Reason abstractly and quantitatively**
  Students interpret slopes, equations, and graphical patterns in the context of climate data.
- **MP.3: Construct viable arguments and critique the reasoning of others**
  Students justify their interpretations of trends and relationships using evidence from graphs and equations.
- **MP.4: Model with mathematics**
  Students consider, analyze and interpret data to represent real-world climate patterns.
- **MP.5: Use appropriate tools strategically**
  Students use graphing tools, spreadsheets, or calculators to represent and analyze data.
- **MP.6: Attend to precision**
  Students define variables clearly, label graphs carefully, and interpret mathematical models with accurate language.

ELA Connections and Extensions

The final presentation aligns closely with ELA skills related to argumentative writing, use of evidence, and audience awareness. Students must:

- Clearly state a claim (W.8.1.a)
- Evaluate sources (W.8.8)
- Support it with multiple forms of evidence, including graphs and numerical summaries (W.8.1.b, RST.8.7)
- Explain limitations and uncertainty (W.8.1.e)
- Consider why their findings matter for an audience (W.8.4, SL.8.6)

Possible extensions include:

- Writing a short reflection or commentary explaining how their thinking changed.
- Revising conclusions for a specific audience (e.g., media creators, consumers, or peers).
- Connecting findings to themes of identity, belonging, or representation explored in ELA texts.

If students are also using Fishtank ELA, this work connects to the 8th Grade ELA unit on climate change, where they analyze complex texts about environmental impact, human experiences, and global responsibility. Students can draw on that knowledge to strengthen their claims, incorporate relevant evidence, and deepen their reasoning about why their findings matter in real-world contexts.

Culturally Responsive Math Teaching (CRMT) Connections

Climate change affects communities around the world in different ways. This project allows students to investigate data connected to places or environmental issues that are meaningful to them.

Opportunities for culturally responsive teaching include:

- Allowing students to choose geographic regions or climate variables they care about
- Encouraging discussion about how climate patterns affect different communities
- Highlighting how mathematical tools help analyze complex environmental systems

Teachers can support this work by emphasizing that mathematical models help describe patterns in data, but they cannot fully capture the complexity of environmental or social systems. Students are encouraged to view mathematics as a tool for understanding global challenges and making informed decisions.

Project Assessment Checklist (Sample)

Student projects will vary. Look for evidence of the following:

Data Representation

- ☐ Scatter plots accurately represent the dataset.
- ☐ Graphs clearly show the relationship between the two variables.
- ☐ Axes, titles, and units are labeled clearly and support interpretation.

Quantitative Reasoning

- ☐ Students describe the direction of association (positive, negative, or no association).
- ☐ Students interpret the slope of the line fit to data in context.
- ☐ Students explain what the equation of the line means for the relationship between variables.
- ☐ Reasoning reflects an understanding of patterns, variability, and limitations in real-world data.

Informal Inference

- ☐ Conclusions are supported by multiple pieces of evidence (graph + equation + interpretation).
- ☐ Claims use careful, data-informed language (e.g., suggests, tends to, is associated with).
- ☐ Students acknowledge variability, outliers, or uncertainty when appropriate.

Impact, Importance, and Recommendations

- ☐ Groups explain why their question matters or why the relationship they studied is important.
- ☐ Conclusions connect mathematical findings to real-world climate patterns or impacts.
- ☐ Groups raise new questions, discuss limitations, or suggest how the data could be used to inform decisions.

Communication & Clarity

- ☐ The group presentation is organized and easy to follow.
- ☐ Mathematical decisions and conclusions are clearly explained.
- ☐ Visuals and written or spoken explanations work together to communicate ideas.

Sample Project

This sample project shown below reflects the Student Responses from the Unit 8 Project. This is intended to show what an on-track group's work might look like. Projects will show variation in questions, samples, and conclusions.
(See sample slide deck for example of corresponding presentation slides.)

Lesson 10: Statistical Question

Our group noticed that many graphs about climate change show both rising carbon dioxide levels and increasing global temperatures over time. We wondered whether these two variables appear to change together in measurable ways.

We know that atmospheric carbon dioxide is one of the greenhouse gases that scientists study when analyzing climate change. If CO_2 levels and temperature anomalies tend to increase together, this could help explain why many climate reports show similar upward trends.

Because climate change is often discussed in terms of rising temperatures and greenhouse gas emissions, understanding whether these variables appear to change together could help us better interpret the evidence scientists use to explain climate change.

Our statistical question is:
What is the relationship between atmospheric carbon dioxide concentration (ppm) and global temperature anomaly (°C)?

We predict that as atmospheric carbon dioxide concentration increases, global temperature anomalies will also tend to increase.

Lesson 11: Data Collection

To investigate our question, we collected paired data values representing atmospheric carbon dioxide concentration and global temperature anomaly for several years between 1980 and 2020. We chose this time period because reliable measurements exist for both variables, and it provides enough data points to look for patterns. We collected data for every other year to select a wide range with a reasonable number, without introducing bias by selecting years that appear to match our expectations.

Our dataset includes the year for reference, but our scatter plot will compare CO_2 concentration and temperature anomaly.

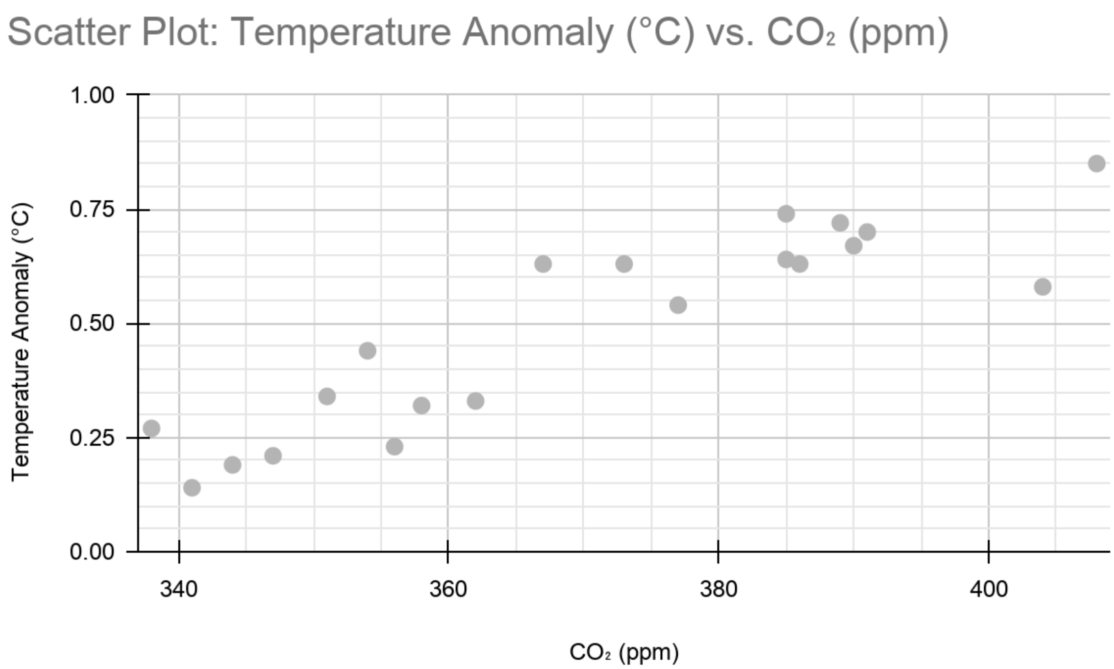
Year	CO_2 (ppm)	Temperature Anomaly (°C)

1980	338	0.27
1982	341	0.14
1984	344	0.19
1986	347	0.21
1988	351	0.34
1990	354	0.44
1992	356	0.23
1994	358	0.32
1996	362	0.33
1998	367	0.63
2000	385	0.74
2002	373	0.63
2004	377	0.54
2006	386	0.63
2008	385	0.64
2010	389	0.72
2012	390	0.67
2014	391	0.70
2016	404	0.58
2018	408	0.85

This gives us 20 paired data points, which should allow us to create a scatter plot and look for patterns in the relationship between the two variables.

Lesson 12: Representing and Describing the Data

We created a scatter plot with CO_2 concentration (ppm) on the x-axis and temperature anomaly (on the y-axis).



Our scatter plot shows a positive association between the two variables. As atmospheric carbon dioxide levels increase, the temperature anomaly generally increases as well.

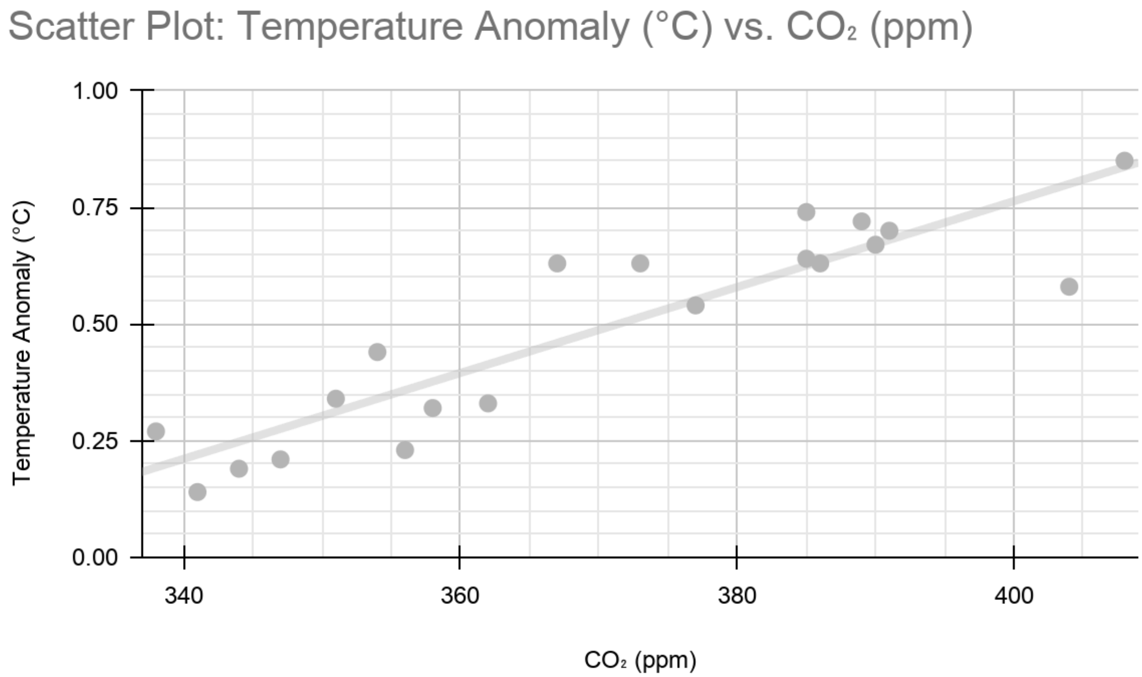
The relationship appears moderately strong because many of the points follow an upward trend from left to right. However, the points are not perfectly aligned along a straight line, which shows that the relationship is not perfectly linear and that other factors also influence temperature.

We also noticed that a group of points appear closer together. Several points with CO_2 levels between 385 ppm and 390 ppm have temperature anomalies between about 0.6°C and 0.75°C, forming a small cluster of values. There also seems to be an outlier at the point (404, 0.58).

Overall, the scatter plot suggests that higher CO_2 levels are associated with higher global temperature anomalies.

Lesson 13: Modeling the Relationship

We drew a line to fit the data that follows the general trend.



Using two points on our line,, we calculated the slope and y-intercept of our line to write an equation:

Points: (335, 0.15) and (360, 0.40)

Slope: $m = \frac{0.40-0.15}{360-335} \rightarrow \frac{0.25}{25} = 0.01$

y-intercept: 0.40 = (0.01)(360) + b → 0.40 = 3.6 + b → b = - 3.2

Equation: y = 0.01x - 3.2

The slope of 0.01 means that for each increase of 1 ppm in atmospheric CO_2 , the global temperature anomaly increases by about 0.01°C on average according to our model. The line does not pass through every point because real-world climate data contains variability, but it helps describe the overall pattern in the data.

Lesson 14: Interpreting the Results

Our investigation suggests that there is a positive association between atmospheric CO_2 concentration and global temperature anomaly. As CO_2 levels increase, temperature anomalies tend to increase as well. This pattern appears consistently across the data points we collected.

Using our equation, if atmospheric CO_2 reached 420 ppm:

$y = 0.01\ (420) - 3.2$

$y = 4.2 - 3.2$

$y = 1$

Our model predicts a temperature anomaly of about 1°C.

However, our model also has limitations. Climate systems are complex, and many factors influence temperature. Our trendline only describes the overall trend in the data we analyzed. Even with these limitations, our model helps show how two important climate variables change together and provides a mathematical way to analyze patterns that scientists study when investigating climate change.