Climate Change: How can we make an impact?

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Overview/Synopsis

What is climate change? What causes this global phenomenon, and what is the largest contributor to the problem? How can we effect the most change towards this problem? Through statistical/data analysis and interpretation, this unit will guide students through a mathematical exploration of this concept and determine interpretations, conclusions, and possible solutions.

It is challenging for fifth grade students to see environmental changes over time in part due to their age, or that it does not pose immediate problems to them in their daily lives. One of the goals in this unit is to be able to identify with a global problem through the examination of the contributions in their daily lives. Throughout this unit, the intention is for students to gain a new perspective on how their choices affect the world around them and a larger scope/picture. This unit will have a mathematical focus with also some informational text comprehension skills. A great deal of information will be data driven, data creation, and analysis. Students in this unit will collect and create representations of short and long term data to draw conclusions. They will focus on determining a problem and based on a variable analysis, target solutions. Students will calculate their beginning impact on their carbon contribution to the atmosphere, as well as analyze changes to predict longer term impacts. Students will draw a conclusion on their most impactful solution and collaboratively determine a policy that they would implement based on their data examination. Technology will be integrated for students through use of classroom computers/iPads to collect and display data, QR codes for helpful resources, and Prezi/Keynote/PowerPoint to organize and present their findings. Students will be performing mathematical operations (multiplication, use of formulas, converting between percents, decimals, comparing and ordering numbers, correlating values, and charting data) in order to create predictable long term data to display, explain, and present findings. They will also analyze various areas of the world and determine their contribution to the climate change problem. Throughout their study, they will gather evidence to support their thinking and be able to present their findings in a classroom setting. Students will focus on specific energy emission areas that are causing problems with our environment and experiment mathematically with possible solutions.

John F. Kennedy once said, “One person can make a difference, and everyone should try”. Throughout this unit, students will explore the differences that they can make in our changing world.

School Information

This unit is directed towards fifth grade math and reading Common Core curriculum, however, this unit can easily be adapted for older grades as well. My grade level has an iPad 1:3 ratio, and a goal throughout this unit is to incorporate technology through a collaborative learning environment.

Content Objectives and Teaching Strategies

"Save our home! It's up to you. We can all do our part, no matter how small. I have nothing to offer but blood, toil, tears, and sweat. But I say to you: Never, never, never give up." -Winston of Churchill One Bear's Battle Against Global Warming.[i]

Our main objective throughout this unit is to determine what change we could make in our lives that would have the largest impact on our changing climate. When approaching this topic from a Math specific perspective, I wanted to use relevant data to explore climate change, and implore students to evaluate energy calculations to answer the essential question, "What is the problem and how can I make the biggest difference in its solution?" Incorporating a variety of learning strategies and opportunities for student collaboration were considered when utilizing teaching methods. Methods are used but not limited to the following:

Use of Technology

Students will use iPad devices, online collaboration tools (such as Edmodo) to communicate with their groups, and video to evaluate the climate change problem. Students will visit sites to gather and analyze data, calculate their carbon footprint, and use presentation tools (such as PowerPoint, Prezi, and Keynote) to present their findings to their peers for review.

Student Collaboration

Students will work in collaborative groups throughout this unit to examine their contributions to an area of CO_2 emission and how to determine the biggest environmental impact. Students will be responsible for working as a team, delegating tasks, asking questions, and contributing positively to a final presentation. Students will need to track specific carbon dioxide emission data and predict long term outcomes. Together they will come together to evaluate various changes and options to determine the best long term solution based on their experimentation.

Oral/Visual Presentation

After students have gathered data and projected it over the longer term (calculating short term and use current trends to multiply and solve for long term estimates), as well as experimented with various changes they could make, they will formally present their findings to the class. Students will use their visual representations (all graphs, data, and reflections in Prezi, PowerPoint, or Keynote) and speak to the class regarding why their energy use change would make a large impact.

Analyzing, Creating, and Comparing/Contrasting Data

Various charts and graphs are used to generate questions and conclusions on climate change. Charts that display percentage of carbon dioxide emissions as a greenhouse gas and carbon dioxide emissions per capita of global locations are utilized to draw the conclusion that carbon dioxide is our area of focus and control. Global locations are compared and contrasted based on their numerical emissions, but also the state of their country as a whole that may contribute to their status (i.e. developing vs. non-developing, industry, access to modern technology, etc.). Graphs that are viewed are created are bar/line graphs, pie charts, coordinate grids, and tables. Data will be represented in a variety of ways to determine likenesses, differences, and trends.

Graphic Organizers

Graphic organizers and outlines are used throughout the unit to allow students to maintain organization and focus on mathematical calculations. They will be used in order to gather data and all graphic organizers would be submitted at the final presentation.

Background Information:

What is climate? Climate is an average weather pattern in a place over time. Climate data is continuously collected in many areas including but not limited to temperatures, wind patterns, storms, and precipitation. Overall trends and changes in climate for various global locations is tracked and analyzed for changes that affect all environmental systems.

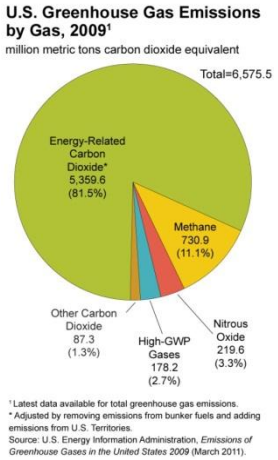
How does the Earth maintain its balance in order to sustain livable climate? A greenhouse is made of glass and is used to grow various plants in a hospitable environment. Heat from the sun is transmitted through the glass, but becomes converted to heat trapped inside and sustains warmth for the plants inside. Cars out in the sun all day perform this same task. As the solar energy gets transmitted through the glass, as the seats and dashboard absorb and reradiate this energy, the interior of the car continues to

heat up. In the same way, the Earth's atmosphere allows various gases (water vapor, H_2O, carbon dioxide, CO_2, methane, CH_4, and nitrous oxide, N_2O) to assist in insulating the globe. [ii] This natural process on the Earth's surface is crucial to sustaining life. However, too much of anything is a bad thing, and balance is key to survival. The Earth's greenhouse (atmosphere) is key to our planet maintaining a hospitable environment for life.

So is this a problem? The solar energy that radiates and heats the Earth is 70% absorbed by plant life, oceans, etc., and the remaining is emitted directly back out into the atmosphere to cool the planet and maintain temperature[iii]. With increased CO_2 levels being released or created by humans, the atmosphere has become unbalanced.
The major greenhouse gas emissions are carbon dioxide, methane, nitrous oxide, and fluorinated gases. Carbon dioxide is the highest contributor (81.5%) to greenhouse gas emissions but can also be absorbed and removed from the atmosphere through biological plant absorption.(Figure 1) Even though carbon dioxide and other gases (H2O) occur naturally in our environment, the levels of CO_2 have increased in levels over time.

Levels of atmospheric concentrations of CO_2 have increased over 36 percent since 1750 and scientists have concluded that it is due primarily to human activity.[iv]Human activities such as deforestation, change in land use, and burning of fossil fuels have increased the levels of carbon dioxide in our atmosphere, resulting in a warmer planet.
Human activities are making impacts on our global climate by releasing these heat-trapping gases into the atmosphere on a regular basis. As these activities increase, the greater impact to our climate and future is pending. A goal would be to become "carbon neutral", or removing as much carbon dioxide as we contribute.

FIGURE 1:



SOURCE: www.eia.org

Since the Industrial Revolution, carbon dioxide concentrations have increased approximately 22%.[v] The human activities that affect this concentration include our food choices, electrical devices, age and status of appliances, and how far and often we drive or travel.

Looking specifically at electricity, on average, one kilowatt of electricity emits a little over 1 pound of CO_2[vi]. This amount is averaged and can vary based on Energy Company and source. For example, coal emits an average of two pounds per kilowatt hour as compared to natural gas which averages a little over one. (Figure 2) [vii] Energy that is produced from a coal burning plant will emit more carbon dioxide than a hydro or nuclear plant.[viii] Carbon dioxide emissions are related to the content of the carbon and hydrogen in the energy source, and when burned and combined with oxygen, directly relates to the CO_2 emissions of the fuel.

FIGURE 2

Fuel	Lbs of CO_2/Million Btu	Heat Rate (10^6 Btu/kWh)	Lbs CO_2/kWh
Coal			
Bituminous	205.573	0.010142	2.02
Sub-bituminous	212.700	0.010142	2.10
Lignite	215.400	0.010142	2.12
Natural gas	117.080	0.010416	1.12
Distillate Oil (No. 2)	161.386	0.010249	1.57
Residual Oil (No. 6)	173.906	0.010249	1.70

Source: www.eia.gov

Upon combustion, a gallon of gasoline emits approximately 14 pounds of CO_2 into the atmosphere. When gasoline combusts, the chemical reaction creates useful energy for the vehicle. Gasoline (a formula of hydrocarbons) combines with oxygen and produces carbon dioxide, water, and energy. Other airborne elements are burned in this process, but the volume of gallons with 93% octane (1) can be converted into gallons of octane consumed (0.93), which translates to 2,826.91 grams of octane (3,039.69 grams/gallon), and leads to 0.625 kg/pound, and 14.1 pounds of carbon dioxide emitted. [ix]

So how can we impact change? The average person in the United States contributes 18.0 of CO_2 metric tons annually[x], however the average can range anywhere between 10-20 metric tons. With this measure of each individual's impact on the environment calculated, we can determine pounds of CO_2 on average based on changes in our daily lives.There are hundreds of offsets to this global impact, such as using energy efficient

light bulbs, appliances, conserving use of all electronic devices, carpooling, traveling less, etc.

Making changes can adjust our CO_2 emissions by thousands of pounds each year. As population continues to increase, each person contributing to a decrease in carbon dioxide emissions will continue to save our planet from severe storms, changes in agriculture, and increases in temperatures.

Classroom Activities

Activity 1: Is the Climate Changing? What's the Problem?

Objective: Students will create and analyze various representations of data to draw conclusions about changes in global temperatures.

The teacher will present students with the following question: What is climate? Students will be challenged to determine their own definition of climate. (According to Webster's dictionary, climate refers to: "the average course or condition of the weather at a place usually over a period of years as exhibited by temperature, wind velocity, and precipitation")

Students will review global locations on a classroom map to determine a global location for each group of 3-4 students. Each group will use the temperature site historical data and iPads to collect data from a 50 year period of time (some locations offer more historical data than others). Students will use the completed graphic organizers and a coordinate grid to determine a trend in climate. Students will determine the average temperature over the time period and years of largest percentage of change.Students will need to draw a conclusion that a 50 year period of time is not broad enough to see an accurate trend and be presented with their region's historical graph.

Classroom Map Link:
http://ngm.nationalgeographic.com/map/atlas/united-states-geopolitical.html

Temperature Resource Links:
http://www.wunderground.com/history/,
http://www.climate-charts.com/world-index.html

Global Climate Tracking Data

____ axis	____ axis
Year	**Temperature**

Once students have prepared their coordinate grids, they will be presented with the response and questions regarding the historical trends of their location (below in response sheets).

Technology will be integrated in this activity through the use of online resources and teacher provided materials to gather and present data. Students will photograph coordinate grids with iPads and write conclusions and interpretations using the iPad application "Pages or Keynote".Students will upload a pdf version of their document and create a QR code to attach to a classroom global map. Students will scan QR codes on classroom map to collaborate as a team, analyze data, and answer the response questions. Time should be spent during this activity to instruct students how to create a QR code (use of any online QR code generators) and upload their pdf file to an accessible website.

Extension: Students can also plot the precipitation for their location.

Student Materials (Link: Is the Climate Changing Student Response Sheets)

Location: _____

Is the Climate Changing? - Temperature Analysis

Use the codes below and your charts to determine the following about your location. Present all answers and your data in Pages or Keynote in the format organized below for other students to interpret! Create a pdf to email to your teacher when completed!

Helpful Resources to start:

1. Insert a map (source cited) into your document and answer the following using helpful resources.

2. What is the latitude and longitude coordinates of your city/region?

   Latitude _____ Longitude _____

3. Calculate the range of temperatures over time: _____

4. Calculate the years of largest temperature change (in percent and decimal form):

   Temperatures _____ Years _____

   % Change _____ (Decimal Form: _____)

5. What is the mean (average) temperature for your location? _____

6. What fractions of temperatures have been above and below the mean temperature for your location?

   Above: Below:

Is the Climate Changing? - REVIEWING PEER DATA

Scan the QR Codes from the classroom map to determine and respond to the following:

1. Which location has the largest range of temperatures (What is the range)?

2. Which location has the highest fraction of temperatures above the mean? Below?

   Highest Location Above: _____ % Difference _____

   Highest Location Below: _____ % Difference _____

3. Compare two cities or locations that are near the same latitude, but on different continents.
   A. Which cities or locations did you compare?

   Location 1 _____

   Latitude: _____

   Location 2 _____

   Latitude: _____

   B. How is the climate different between them?

4. What do you think may be causing large changes in location temperatures?

5. What conclusions can you draw about temperature changes across the globe?

Activity 2 – What is the Greenhouse Effect? What is Carbon Dioxide and what does it have to do with temperature?

Objective: Students will be able to relate data from a greenhouse effect experiment and mathematical calculations to temperature and change.

Using a flipped classroom model, students will be responsible for reading Greenhouse Effect articles in the student resources section (choice based on student need and ability) and watching the video to enter class with Greenhouse Effect background knowledge: http://youtu.be/VYMjSule0Bw[xi]

Students will work in collaborative groups to perform a temperature experiment and determine how the atmosphere controls temperature and what variables contribute to this modification. It is important for students to convert temperatures between Fahrenheit and Celsius, as well as compare and contrast temperatures with and without the use of a simulated "atmosphere".

Conversions between Fahrenheit and Celsius:

°F to °C	Deduct 32, then multiply by 5, then divide by 9
°C to °F	Multiply by 9, then divide by 5, then add 32[xii]

Students will be given the following materials: thermometer (2), light/heat source (light bulb, flashlight, etc.),and a baggie or plastic cellophane to enclose one thermometer. In order to simulate an "atmosphere", students will place one thermometer inside a bag and one outside under the same heat source. Students will take Celsius temperatures every 5 minutes and record their data in a graphic organizer. (one for each thermometer) Students will draw and write conclusions after 30-40 minutes about the changes in temperature. Students should be able to draw the conclusions that the enclosed thermometer increased temperature at a faster rate than that not enclosed. Students will hypothesize about why this may have occurred. (the baggie represents the gases that absorb the long wavelength gases and keep the heat inside – gases include: chlorofluorocarbons, water vapor, carbon dioxide, methane, nitrous oxide)

Time	Degrees Celsius	Degrees Fahrenheit (converted)

Teachers may use the sample activity as a resource: Greenhouse Effect Activity[xiii]

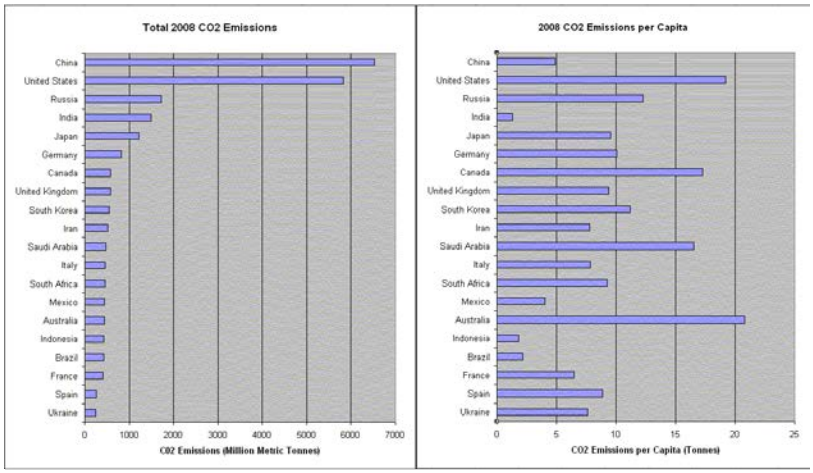
Activity 3 - Emissions Around the Globe – National and Global

Objective: Students will be able to compare data and determine that CO_2 is the most prevalent greenhouse gas and formulate possible reasons/causes for variations in emissions around the globe.

Carbon dioxide emissions vary greatly across the globe (Figure 4). Students will work with a team (3-4) on a selected country to display CO_2 emission data per capita (per person) and interpret what may cause a low or high emissions amount. Students will calculate the total CO_2emissions for each country and complete the team graphic organizer.Students will use total population and per capita data to calculate annual CO_2 emissions from 1990-2008. The materials needed are coordinate grid paper, iPads/student devices/computers as research tools, and team country analysis sheet.

Students will present their findings to create a list of reasons why their country might produce more or less CO_2. Responses may be written, typed, or via video interviews from each individual on their collaborative team. Students can reflect on developed vs. undeveloped, economy, population, etc. Teams must work cooperatively to draw one conclusion based on their data.

FIGURE 3:



SOURCE: www.ucsusa.org

Resources for Activity 3:
http://en.wikipedia.org/wiki/List_of_countries_by_carbon_dioxide_emissions_per_capita
http://world.bymap.org/Population.html

*Student Response Materials (Link:*Team Country Analysis Sheet)

Emissions Around the Globe – Team Country Analysis

My Country _____

Plot all CO_2 emission data on your coordinate grid from 1990-2008.

What is the trend? _____

Response/Further Calculation

Range of CO_2 Emissions per Capita from 1990-2008 _____

What is the average CO_2 Emissions per Capita ? _____

My country's population: _____

Create a table displaying your data of total emissions for the country each year.

Which years were the highest and lowest?

If you were to plot your new data based on total population, would it be similar or different than your per capita chart? Why or why not?

_____

_____

_____

What are items that cause CO_2 emissions? (Can use articles as a reference)

a._____

b _____

c._____

d. _____

Conclusions

What factors do you think contribute to the CO_2 emission data for your country? Will it be higher or lower than other countries? Why do you think so? **(What information can you find about your country to support your thinking?)** Video tape each team member's response and/or write/type your response and attach to the analysis form.

Activity 4 - What is your Carbon Footprint? How does it measure up?

Objective: Students will calculate their CO_2 contribution to the atmosphere through an online survey and compare their data with the average. Students will calculate their annual emissions target based on a 450ppm global standard.

In order to determine the impact we can have on a problem, we will look into how much we are affecting the problem. Students will complete their own carbon footprint and determine areas where they could see the most impact. (Figure 4) Students will compare their average to that of an average American citizen and determine how they can reduce their emissions.

Students will use their data collected to determine their need for change and be presented the following problem: If the global target is to remain below 450ppm CO_2 in order to prevent an increase of 2°C in atmospheric temperature, what should your individual contribution not exceed?

Carbon Footprint Calculator for Students (Select based on students):
http://www.carbonfootprint.com/calculator.aspx
http://www.pbs.org/teacherline/courses/common_documents/stem/030/kidprint/

FIGURE 4:

Lbs. CO_2/Yr	mT CO_2/YR	Result
<6000	<2.72	Much less than average
6,000-11,010	2.72 – 4.99	Less than average
11,010 – 21,010	4.99 – 9.53	Average
21,010 – 26,005	9.53 – 11.79	More than average
>26,005		Much more than average

SOURCE: www.pbs.org

Activity 5 - What is the Impact of my change?

Objective: Students will be able to use variables of change and calculate the area that would affect the greatest change in personal CO_2 emissions. Students will work in collaborative groups on a focus area based on their largest areas of opportunity from their own carbon footprint analysis.

Students will work in groups to adjust their usage and track impact in pounds of CO_2 emissions on a weekly basis. Students will graph and adjust their data, as well as extend this snapshot into change over time. For example, students may focus on the area of car travel. If they change a variable of carpooling 2 days/week, how would that affect their CO_2 emissions over the course of a year? (Example Calculation: If I decreased the miles driven daily (13) twice each week, I know that for each gallon that I save, 14.1 pounds of CO_2 will be emitted into the atmosphere and my car gets 25 miles to the gallon: 14.1 x

(26/25 = 1.92 gallons consumed) = 27.078 pounds of CO_2 saved, which equates to an annual savings of 1408.06 pounds or 0.639 metric tons)

EPA Calculation Formulas: http://www.epa.gov/cleanenergy/energy-resources/refs.html

Helpful Calculation Data: http://www.stewartmarion.com/carbon-footprint/html/carbon-footprint-kilowatt-hour.html

Electronics Data: http://www.tpcdb.com/

Student groups will complete the graphic organizer testing three variable of change and conclude which change made the largest impact in their area of focus. Students will research areas and determine how to calculate the carbon dioxide emissions from their particular change (ex. Students in the packaging collaborative group may change the variable of bringing baggies to lunch each day and using a reusable container. Through research, students may find that the carbon footprint of plastic is approximately 6 kg of CO_2 per kg of plastic.[xiv])

Groups will begin to formulate a "policy" that they could put in place to ensure that their change can be made by others. Students will prepare to present their policy and data in presentation form (Prezi, Keynote, PowerPoint, or student choice).

Student Graphic Organizer Documents (Link: What is the Impact of the Change Student Pages)

What is the Impact of My Change? – Data

AREA OF FOCUS (Circle): Food Travel Home Energy

Electronic Devices Packaging

Select three impactful variables in your area of focus. Use the formulas to predict and calculate change and annual impact of each. Show all calculation equations in the boxes below each variable.

Variable A: _____

Current Daily CO_2 Emission _____
Projected Change _____
Calculated Daily Change: _____
Annual Impact: _____

Variable B: _____
Current Daily CO_2 Emission _____
Projected Change _____
Calculated Daily Change: _____
Annual Impact: _____

Variable C: _____

Current Daily CO_2 Emission _____
Projected Change _____
Calculated Daily Change: _____
Annual Impact: _____

What is the Impact of My Change? – Policy and Presentation

After reviewing the results of your variable of change, which had the most impact? Clearly state a policy that would assist in carbon dioxide emission reduction for others? Collaborate as a team and determine your policy proposal. Data must be used to support your reasoning, and your policy and data must be presented in an organized format.

Policy Proposal:
Data to Support:
Presentation Format Planning: Format: _____

Activity 6: What is the Most Efficient Policy?

Objective: Students will analyze data from presentations to determine which policy would be easiest and most effective in reducing CO_2 emissions.

Students will present their data analysis and policy to the class and turn in all graphic organizers for teacher review. Students in the audience will examine the data and determine if the data presented makes sense, it would be easy to implement, and would impact enough change. Students will then vote on policies they would like to approve and send to the "Climate Change Board".

Sample Debate/Presentation of Policy Activity for Advanced Classes:
http://serc.carleton.edu/sp/library/roleplaying/examples/34147.html

Rubric for Student Presentations:

		Mathematical Practice	Content Quality/Organization	Communication/Collaboration
	4	All calculations are accurate and there is clear evidence of thought process behind the calculations	All discoveries and findings are clearly recorded, organized and evidence of thorough investigation and exploration are evident	Student communicates clearly and frequently contributes in a positive way to the project and partner; Team effort and process is evident
	3	All calculations are accurate and there is some clear evidence of thought process behind calculations	Most discoveries and findings are clearly recorded, organized and evidence of thorough investigation and exploration are evident	Student mostly communicates clearly and frequently contributes in a positive way to the project and partner; Team effort and process is mostly evident
	2	All calculations are accurate but there is not clear evidence of thought process behind calculations	Some discoveries and findings are clearly recorded, organized and evidence of investigation and exploration is evident	Student somewhat communicates clearly and frequently contributes in a positive way to the project and partner; Team effort and process is somewhat evident
	1	Not all calculations are accurate	Discoveries and findings are recorded, and some evidence of investigation and exploration is evident	Student communicates and contributes to the project and partner; Team effort and process is somewhat evident
self-evaluation				
teacher evaluation				

Have We Made an Impact?

By the end of this unit, I hope that students will have gained flexibility in applying their mathematical computation skills to problem solve and manipulate a variable to create the largest impact. It is my hope that they will also be able to analyze their own and their

peer's data to determine usefulness, validity, and relevance. By conclusion, they will have worked collaboratively to collect and use data to support and communicate their solution towards a global problem.

Implementing Common Core Standards

5.NBT.5: Students will be able to perform operations with multi-digit whole numbers and with decimals to hundredths.
Students will need to total or multiply carbon usage over time to create a display of long term data and how various factors have changed our climate.

5.OA.2: Students will be able to write simple expressions that record calculations with numbers and interpret numerical expressions.
Students will evaluate changes in behavior and how that affects their carbon footprint. Students will write number sentences and substitute variables in formulas to calculate carbon dioxide emissions.

5.MD.1: Students will be able to convert like measurements within a measurement system.
Students will convert carbon dioxide emissions from pounds and tons, as well as like measurements of kilograms and grams.

5.G.2: Students will be able to represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane and interpret coordinate values of points in the context of a situation
Students will gather and generate data to display global temperatures over time as well as carbon dioxide emissions per capita. Students will be able to chart their own carbon usage and determine trends over time.

5.RIT.6: Students will analyze multiple accounts of the same event or topic, noting important similarities and differences in the point of view that they represent.
Students will use resources from Student Reading Material list to compare and contrast various aspects of the greenhouse effect and discuss the scientific vs. political points of view.

5.RIT.7: Students will be able to draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or solve a problem efficiently
Students will examine charts, graphs, informational text, and various other sources to gather information for data support. Students will use various websites for data conversion formulas for carbon dioxide emission equivalents as well.

5.RIT.9: Students will be able to integrate information from several texts on the same topic in order to write or speak about the subject knowledgably
Students will use the information and data gathered to present to the class their findings in a class visual and oral presentation.

Annotated Bibliography

"Background on Global Warming | Do Something." Do Something | Largest organization for teens and social cause. http://www.dosomething.org/actnow/tipsandtools/background-global-warming# (accessed November 16, 2012). This very straightforward source will offer facts as background information on global warming and useful strategies for change.

Boone, Susan. "The Greenhouse Effect."The Greenhouse Effect. http://teachertech.rice.edu/Participants/sboone/Lessons/Greenhouse/ (accessed November 1, 2012). This is a great resource for examining climate change through an experiments and series of questioning. This can be utilized with activity 2.

"CO2 Now | CO2 Home."CO2 Now | CO2 Home. http://co2now.org/ (accessed November 2, 2012). This basic site offers up to date monthly carbon dioxide emissions globally and is a great resource for examining carbon dioxide more closely.

"Carbon Dioxide Emissions from the Generation of Electric Power in the United States." doe.gov. www.esrl.noaa.gov/gsd/outreach/education/climgraph/docs/cg_23.pdf (accessed November 16, 2012).

Clayton, Jack. "BlueSkyModel.org | carbon dioxide created by one kilowatt-hour." Stewart Marion - web solutions for small businesses. http://www.stewartmarion.com/carbon-footprint/html/carbon-footprint-kilowatt-hour.html (accessed November 9, 2012). This site was created to offer data on energy use and carbon dioxide emissions. It contains examples of effects of change due to various factors.

"Core Standards Mathematics."Common Core State Standards. www.corestandards.org/assets/CCSSI_Math%20Standards.pdf (accessed October 27, 2012).

Country."CO2 emissions (metric tons per capita) | Data | Table." Data | The World Bank. http://data.worldbank.org/indicator/EN.ATM.CO2E.PC (accessed November 17, 2012).

"Energy Consumption Fueling Catastrophic Climate Change, Report Warns." Science Daily: News & Articles in Science, Health, Environment & Technology. http://www.sciencedaily.com/releases/2007/10/071021114258.htm (accessed October 16, 2012). This article can be used as a teacher resource or as further data resources from global human activities and impacts to climate change.

"Energy Impacts & Adaptation | Climate Change | US EPA."US Environmental Protection Agency. http://www.epa.gov/climatechange/impacts-adaptation/energy.html#Temperature (accessed July 12, 2012). This source displays the relationships between various climate components and provides clear data with regards to percentages and usage (example: energy supply/demand and its relationship to temperature).

GreenBag, Project. " Plastic Bags and CO2: How Much Does One Bag Pollute? | Project GreenBagÂ®." | Project GreenBagÂ®. http://www.projectgreenbag.com/plastic-bags-and-co2-emissions (accessed November 17, 2012).

"Greenhouse Effect: Background Material." UCAR - University Corporation for Atmospheric Research | Understanding atmosphere, Earth, and Sun. http://www.ucar.edu/learn/1_3_1.htm (accessed November 18, 2012). This source offers easy to read and navigate background information for students as well as optional activities relating to the greenhouse effect.

Hansen, James E..*Storms of my grandchildren: the truth about the coming climate catastrophe and our last chance to save humanity*. New York: Bloomsbury USA, 2009. This book is a great teacher resource from the point of view of a scientist and his presentations to government and findings over time.

Hassol, Susan. "Climate Communication."Presidential Climate Action Project. http://climatecommunication.org/wp-content/uploads/2011/08/presidentialaction.pdf (accessed November 1, 2012). This presentation document summarizes a presentation with regards to climate change and effectively displays components of a policy presentation.

"Home | Climate Change | US EPA."US Environmental Protection Agency. http://www.epa.gov/climatechange (accessed November 14, 2012).

Sagar, Ambuj D, Hongyan H Oliver, and Ananth P Chikkatur."Vermont Journal of Environmental Law."Vermont Journal of Environmental Law. http://www.vjel.org/journal/VJEL10041.html (accessed October 16, 2012). This educational journal analyzes, compares, and contrasts the energy supplies in developing countries as compared to other areas of the world.

Steingraber, Sandra. *Raising Elijah: protecting our children in an age of environmental crisis*. Cambridge, MA: Da Capo Press, 2011. This book is a great resource for teachers as an engaging chapter book written from a parent and how science and policy making relate to the daily life of our children.

"United States Energy Usage." eRedux Energy: Sustainable Geoscial Products and Services Network. http://www.eredux.com/states/index.php (accessed November 20, 2012). This source displays energy use data across the United States broken down by state, energy type, and carbon dioxide emissions data.

"U.S. Greenhouse Gas Inventory Report | Climate Change | US EPA." US Environmental Protection Agency. http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html (accessed November 16, 2012). This data driven source provides in-depth information and inventory regarding U.S. greenhouse gases.

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Reading List for Students

Gas Trees and Car Turds: A Kid's Guide to the Roots of Global Warming by: Kirk Johnson, 2007, Fulcrum Publishing, Golden, CO. This easy to understand picture book is great to share with students to better understand the carbon cycle and how all elements relate together.

Winston of Churchill: One Bear's Battle Against Global Warming by: Jean Davies Okimoto, 2007, Sasquatch Books, Seattle, WA. This fun picture book is from the point of view of the polar bear and actions that they took in order to get people to better understand the impacts of climate change.

Human Footprint: Everything you will eat, use, wear, buy, and throw out in your lifetime by: Ellen Kirk, 2010, National Geographic Society, Washington, DC. This picture book offers a very visual representation of all items consumed from each person over the course of a year.

2002. "A Sunny Future?." *Kids Discover* 12, no. 10: 16. *Middle Search Plus*, EBSCO*host* (accessed November 17, 2012). This article details solar power as an energy source, how it works, and how it is used in various formats.

Raloff, Janet. 2009. "Climate Might Be Right For A Deal." *Science News For Kids* 3. *Middle Search Plus*, EBSCO*host* (accessed November 17, 2012). Through this

article during the United Nations Climate Change Conference, it details the framework of a climate treaty and how the international community works together to change greenhouse gas emissions.

David, LaurieGordon, Cambria. 2007. "CO₂: THE BIG KAHUNA." *Scholastic Math* 28, no. 3: 6. *Primary Search*, EBSCO*host* (accessed November 17, 2012). This article utilizes a prepared line graph detailing carbon dioxide levels measured by a scientist. It makes a connection to seasonal change levels and can be used to hypothesize and predict annual levels.

Cutraro, Jennifer. 2008. "FOR KIDS: Farms Sprout In Cities." *Science News For Kids* 1. *Middle Search Plus*, EBSCO*host* (accessed November 17, 2012). This article gives information on farming in urban environments. This can be used as a point of discussion or use as a variable of change to test effects on air quality.

Ornes, Stephen. 2009. "FOR KIDS: Greener Diet." *Science News For Kids* 1. *Primary Search*, EBSCO*host* (accessed November 17, 2012). This easy to interpret article summarizes scientific study of the effects of diet choices on the climate and environment.

McCollum, Sean. 2005. "GLOBAL WARMING. (cover story)." *Junior Scholastic* 107, no. 13: 5. *Primary Search*, EBSCO*host* (accessed November 17, 2012). This article is great to assign to students for climate change background information as well as introduce the Kyoto Protocol.

Hansen-Harding, Alexandra. 2002. "GLOBAL WARMING. (cover story)." *Junior Scholastic* 104, no. 16: 8. *Middle Search Plus*, EBSCO*host* (accessed November 17, 2012).This article breaks down the contributions to climate change along with energy security, conservation, and visual representations of global temperature trends.

Hanson-Harding, Alexandra. 1997. "Global warming: How big a threat?." *Junior Scholastic* 100, no. 9: 2. *Middle Search Plus*, EBSCO*host* (accessed November 17, 2012). This article introduces the Intergovernmental Panel on Climate Change through the United Nations based on a Kyoto, Japan meeting. Global warming details are included, prevention strategies, as well as the introduction of the policy side of global warming.

McCollum, Sean. 1995. "Is earth losing its cool?." *Junior Scholastic* 98, no. 7: 8. *Middle Search Plus*, EBSCO*host* (accessed November 17, 2012). This source on the greenhouse effect offers scientist disagreements in point of view on various elements and impacts.

2002. "The Greenhouse Effect." *Kids Discover* 12, no. 2: 9. *Primary Search*, EBSCO*host* (accessed November 17, 2012). This article is an additional resource to the mechanics of the greenhouse effect and can be utilized to compare and contrast with additional sources.

2006. "Trouble Earth." *Kids Discover* 16, no. 5: 12. *Primary Search*, EBSCO*host* (accessed November 17, 2012). This article introduces the greenhouse effect and the impact on nature. Causes of climate change are presented through the unbalance of oxygen and carbon dioxide into the atmosphere.

COSTELLO, EMILY. 2012. "WILD WEATHER." *Scholastic Math* 32, no. 8: 14. *Primary Search*, EBSCO*host* (accessed November 17, 2012). This article connects the greenhouse gases emitted through various human activities to changes in weather.

List of Materials for Classroom Use

http://www.epa.gov/climatechange/kids/This video used as an overview for students and introduction to the Greenhouse Effect in which it breaks down specific causes and offers great background information.

http://www.epa.gov/cleanenergy/energy-resources/refs.htmlThis site provides calculation formulas for converting various source of energy to carbon dioxide emissions. Some formulas may require to be simplified for accommodating to various grade levels.

http://ghgdata.epa.gov/ghgp/main.doThis site includes carbon emissions data reported by U.S.refineries/companies.

http://co2now.org/This site displays current global CO2 emissions ppm on a monthly basis.

Coordinate Grids (Link(s): http://themathworksheetsite.com/cgi-bin/coordinate_plane.pl

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[i] Winston of Churchill: One Bear's Battle Against Global Warming by: Jean Davies Okimoto, 2007, Sasquatch Books, Seattle, WA.
[ii] http://www.ucar.edu/learn/1_3_1.htm
[iii] http://earthobservatory.nasa.gov/Features/SORCE/sorce_02.php
[iv] www.epa.gov/climatechange
[v] http://www.esrl.noaa.gov/gsd/outreach/education/climgraph/docs/cg_23.pdf
[vi] http://www.stewartmarion.com/carbon-footprint/html/carbon-footprint-kilowatt-hour.html
[vii] http://www.eia.gov/tools/faqs/faq.cfm?id=74&t=11
[viii] ftp://ftp.eia.doe.gov/environment/co2emiss00.pdf

[ix] http://www.stewartmarion.com/carbon-footprint/html/carbon-footprint-car.html
[x] http://data.worldbank.org/indicator/EN.ATM.CO2E.PC
[xi] www.epa.gov
[xii] http://www.mathsisfun.com/temperature-conversion.html
[xiii] http://teachertech.rice.edu/Participants/sboone/Lessons/Greenhouse/
[xiv] www.projectgreenbag.com/plastic-bags-and-co2-emissions