Lesson Title: Predicting Climate Change

Grade Band: 10-12 Science Research

Length: 4- 42 minute lessons

Materials: Access to internet

NYSSLS Standards:

DCI:
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's systems.
HS-ESS2-5: Interactions of the Hydrologic and Rock Cycles: Plan and conduct an investigation of the properties of water and its effects on earth materials and surface processes. (Structure and Function)
HS-ESS3-6: Human Impacts on Earth Systems: Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity. (Systems and System Models)

Cross Cutting Concepts:
Patterns: Students observe patterns in systems at different scales and cite patterns as empirical evidence for causality in supporting their explanations of phenomena. They recognize classifications or explanations used at one scale may not be useful or need revision using a different scale; thus requiring improved investigations and experiments. They use mathematical representations to identify certain patterns and analyze patterns of performance in order to reengineer and improve a designed system.

Energy and matter:
Students learn that the total amount of energy and matter in closed systems is conserved. They can describe changes of energy and matter in a system in terms of energy and matter flows into, out of, and within that system. They also learn that energy cannot be created or destroyed. It only moves between one place and another place, between objects and/or fields, or between systems. Energy drives the cycling of matter within and between systems. In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.

Stability and change:
Students understand much of science deals with constructing explanations of how things change and how they remain stable. They quantify and model changes in systems over very short or very long periods of time. They see some changes are irreversible, and negative feedback can stabilize a system, while positive feedback can destabilize it. They recognize systems can be designed for greater or lesser stability.

SEP:
Analyzing and Interpreting Data:
• Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

Asking Questions:
Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.

Ask questions:
○ that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.

Engaging in Argument from Evidence:
• Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence, challenging ideas and conclusions, responding thoughtfully to diverse perspectives, and determining additional information required to resolve contradictions.

• Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.

• Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence.

Using Mathematics and Computational Thinking:

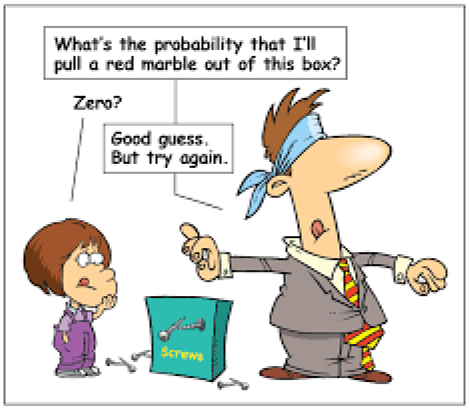
Using algebraic thinking and analysis for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

Math: Investigate chance processes and develop, use, and evaluate probability models.

Student Experience:

Engage:

Students will look at cartoon and discuss what “probability” means with a partner. Students will do a record their thoughts on post-its and put on front board. Student volunteers will help to sort similar responses.



Explore:

Students will visit the following site to individually read for understanding. They will record definitions that they develop (Likelihood, uncertainty, probability, confidence interval
http://cimss.ssec.wisc.edu/climatechange/globalCC/lesson9/concepts.html

Explain:

Students will come together as a class and teacher will check for student understanding by posing scenarios highlighting each term and asking students to raise fingers for their answers. Definitions for all terms will be projected for students to check their responses and modify as needed.

Teacher will introduce a 160 year dataset from Lake Mendota in Madison Wisconsin reflecting seasonal ice cover. Students will create a scientific question that the data set can be analyzed to answer.

Students will revisit the same site to answer the class question--something like: “Is ice off date on Lake Mendota in recent decades statistically different (earlier) than the first two decades of observed ice cover?”

Students will work through the activity online, first analyzing the data qualitatively, then quantitatively. Students will use reference scales/statistics (t-test, probability of occurrence and IPCC likelihood scale) to answer the class question. Students will report their findings on their lab station white board in the form of a CER chart. Students will then do a gallery walk to see classmate’s claims and the evidence they selected to support their claim. They can then modify/add to their original answers.

Elaborate:

Students will repeat the process using data from My NASA Data:
https://mynasadata.larc.nasa.gov/EarthSystemLAS/UI.vm

Students will work in pairs to explore the data that is available in My NASA Data.

Students will choose a "Featured Phenomenon" dataset within My NASA Data. They will explore the data and develop a scientific question that can be answered using the selected data set.

Once they're selected a question, they will check with teacher and explain their reasoning of how they think they will analyze the data to answer their question. Teacher will scaffold, as needed, to ensure each student group has a question that the selected data can answer using the statistical tools used during the Explore phase. Students will then run a t-test using an online stats tool (vassarstats.org)

Evaluate:

Partners will make a "mini-poster" to represent their findings. They will do a CER chart that will be posted around the room. Students will circulate, giving color coded feedback on each CER based on the rubric, below. Students will return to their work and evaluate if they need to make any changes prior to teacher review.
https://www.chemedx.org/blog/%E2%80%9Cscience-reasoning-rubric%E2%80%9D-support-argumentative-writing

Science Reasoning Rubric

		2 pts	1 pt	0 pt
Statement	**Claim** An assertion that something is true	Makes a claim that is sufficient to answer the question and is coherent.	Makes a claim that is sufficient to answer the question or is coherent.	Does not make a claim or makes an incoherent claim.
	or			
	Explanation Describes how and why a phenomenon occurs	Provides an explanation that addresses how and why a phenomenon occurs	Provides an explanation that addresses how or why a phenomenon occurs	Does not provide an explanation.
Argument	**Reasoning** Provides reasons the reader should accept your claim or explanation.	Includes all of the following: ❑ Cites sufficient and relevant evidence to support the claim/explanation. ❑ Describes how the cited evidence defends the claim/explanation. ❑ Reader feels compelled to accept your argument.	Includes two of the following: ❑ Cites sufficient and relevant evidence to support the claim/explanation. ❑ Describes how the cited evidence defends the claim/explanation. ❑ Reader feels compelled to accept your argument.	Includes one or none of the following: ❑ Cites sufficient and relevant evidence to support the claim/explanation. ❑ Describes how the cited evidence defends the claim/explanation. ❑ Reader feels compelled to accept your argument.