



BLOSSOMS NGSS LESSON

Target Grade: High School	Lesson Title: Sea Level Rise: The Ocean's Uplifting Experience Developed by Tiffany Risch Coventry High School Coventry, Rhode Island	
Topic: Earth Science, Oceanography – Sea Level Rise		
State Standard – NGSS Performance Expectation(s) 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. <i>[Clarification Statement: Examples of evidence, for both data and climate model outputs, are for climate changes (such as precipitation and temperature) and their associated impacts (such as on sea level, glacial ice volumes, or atmosphere and ocean composition).] [Assessment Boundary: Assessment is limited to one example of a climate change and its associated impacts.]</i>		
Materials		
Handouts: <ul style="list-style-type: none"> ● Teacher Guide Sea Level Rise (PDF) ● Teacher Guide Sea Level Rise (MS Word) ● Sea Level Rise Data (PDF) ● Sea Level Rise Data (MS Excel) ● Suggested Assessment Sea Level Rise (PDF) ● Suggested Assessment Sea Level Rise (MS Word) ● Poster Paper ● Student Notebooks ● Graph paper (if computers are not available) 	Activity 2: <ul style="list-style-type: none"> ● permanent marker, ● 2 - unopened tuna cans ● 2 - identical medium sized bowls ● crushed ice ● water 	Activity 3: <ul style="list-style-type: none"> ● Rigid water bottle ● straw/graduated (or pipette) ● wax or putty ● #3 two-holed stopper or flip top water bottle ● adhesive thermometer or digital thermometer ● ruler ● food coloring ● permanent marker ● blow dryer or lamp
Phenomena <i>Sea level rises at different heights depending on location.</i>		

ACTIVITY 1

In the Classroom (Teacher):

This lesson has been designed to introduce students to the concept of sea level rise as it occurs through climate change. The students will examine three specific parameters: ice distribution, thermal expansion, and the use of data. While there isn't any required pre-required learning necessary to implement this lesson, a general understanding of sea level rise, glaciers, and climate would be beneficial to students. During classroom breaks, student groups will develop, discuss, and revise **models** and discuss potential explanations throughout the investigations. This lesson will take approximately 60 minutes to complete.

Teachers should “look for” evidence of the following when students are using the practice of **Asking Questions**.

Evidence Bullets (Look Fors):

- Ts should look for evidence of the following when Ss are engaged in the practice of **Asking Questions** such as:
 - Identify questions relevant to science phenomenon.
 - Distinguish between scientific and nonscientific questions.

Ask questions that arise from phenomena.

SUGGESTION: As the student groups share out their ideas for **causes** of sea level rise differential in the three cities, the teacher should record their ideas on poster paper or on the white board.

In the Classroom (Students):

- Students watch the first segment of the BLOSSOMS Video (**0:00 – 1:25**). In the video, the students are introduced to phenomenon that sea level rise does not occur equally on the East Coast of the United States. Specifically, students learn that sea level rise in Portland, ME is 0.5 ft, New York City, N.Y is 1 ft. and Cape Hatteras, N.C. is 1.5 ft. When the video is paused at the **1:25** mark, students are encouraged to:
 - Spend a few minutes to brainstorm possible explanations for these different measurements of sea level along the East Coast of the U.S.
- in groups of 4, students discuss possible **causes** for the sea level rise differential between the 3 cities. Student groups will record their initial **explanations** and **questions** (see evidence bullets in the teacher column) in their student notebooks.
- Groups share out their ideas and questions with the class.



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ACTIVITY 2

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In the Classroom (Teacher):

FOR THE INVESTIGATION SETUP AND PROCEDURE – See the Appendices - [Activity 2](#) in this document.

SUGGESTION: Setups for the activities in this lesson could be pre-distributed to group lab stations before the class to minimize down time.

The teacher pauses the video at the **2:18** mark and directs the student groups to make a prediction of what the water levels in each bowl will look like at the end of their investigation.

- Ask students to predict what will happen to the water levels in each bowl *during the duration of the class* and provide reasoning for their answer.
- Groups will record their ideas in their lab notebooks before they **develop their model**.

Teacher then directs the groups to **develop a model** that describes the **causes** of the water level change. (NOTE: An obvious prediction will be that “the ice will melt.” Have the students to consider that the water level in the two bowls will NOT be at equal levels.)

Teachers should “look for” evidence of the following when students are using the practice of **Developing and Using Models**.

Evidence Bullets (Look Fors):

- use and/or construct models to predict, explain, and/or collect data to test ideas about phenomena in natural or designed systems
- reflect on the components of models of simple systems with uncertain and less predictable factors.

SUGGESTION: Teacher may consider asking the students to suggest which of the polar regions each of the bowls represent? (*The first bowl with ice is to represent Antarctica, a continent covered with varying amounts ice depending on the season. The other bowl is to represent the Arctic, a general area in the northern hemisphere that is not marked by a true land-based continent, but still has varying amount of sea ice depending on the season.*)

SUGGESTION: As your students observe their investigation, have them think of some possible **causes** for the “sea level rise” observed in each bowl.

As the students are engaged in the activity the teacher should prompt the students with the following (crosscutting

In the Classroom (Students):

- The students watch the next segment of the BLOSSOMS video where the video teacher describes a lab investigation. The video is paused at the **2:18** mark. The video prompts the students to:
 - *Make a prediction of what you think will happen to the water level in each of your setups.*
 - *Develop a **model** of what is **causing** the water level to change in your setups.*
- One member from each group gathers the **materials** for Activity 2 (see **materials** section of this document) and brings the materials to the group’s lab station.
- Group members set up the materials in a similar manner as is shown in the video.
- Once the setup is complete, the group members collaborate to make a prediction of what will happen to the water level in each of the setups. The group will record their prediction in their student notebooks.
- Once each group has completed their predictions, groups will **develop a model** for each of the bowls (see evidence bullets in the teacher column) to reflect **causes** of the water level changes based upon their group’s prediction.
- Student groups will share their group’s **models** and cite evidence shown in their **models** to support their initial explanation.



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ACTIVITY 3

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In the Classroom (Teacher):

FOR THE INVESTIGATION SETUP AND PROCEDURE – See the Appendices - [Activity 3](#) in this document.

SUGGESTION: Setups for the activities in this lesson could be pre-distributed to group lab stations before the class to minimize down time.

The teacher pauses the video at the **3:43** mark and directs the student groups to make a prediction of the influence that heat has on water and for the prediction to be recorded in the student notebooks. Teacher also directs the groups **collect and record data** to answer the question “Are there observable **patterns** related to temperature change and sea-level rise?”

Teachers should “look for” evidence of the following when students are using the practice of **Planning and Carrying Out Investigations.**

Evidence Bullets (Look Fors): _

- make careful observations that generate evidence
- recognize patterns in observations and data

use tools, technologies and/or models (e.g. computational, mathematical) to generate and analyze data in order to make valid and reliable scientific claims

As the students are engaged in the activity the teacher should prompt the students with the following (crosscutting concept is in green) below.

Some teacher prompts using crosscutting concepts to structure student thinking about the phenomenon as they observe the setups:

- What **patterns** are observed in your group’s data?
- Are you observing any **cause** and **effect** relationships that might explain some of the **patterns**?
- Is your group’s prediction supported by your data? What is the evidence to support your claim?

In the Classroom (Students):

- The students watch the next segment of the BLOSSOMS video where the video teacher shares information about short-term events that effect fluctuations in sea-level and sets up discussion of the next investigation. The video is paused at the **3:43** mark. The video prompts the students to:
 - First, make a prediction about the influence that heat has on water.
 - **Collect and record data** to answer the question: “Is there a **pattern** related to temperature change and sea-level rise?”
- One member from each group gathers the [materials](#) for Activity 3 (see [materials](#) section of this document) and brings the materials to the group’s lab station.
- Group members create a **data table** (see evidence bullets in the teacher column) to record measurements in their student notebooks. (See the example of a data table in [Activity 3](#))
- Groups set up the investigation and begin heating the water bottle.
- Students consistently (every 30 seconds) record the amount of water that is visible in the straw in their group’s data table. (see steps 7 & 8 in the procedure for [Activity 3](#)).
- At the end of Activity 3 the group members collaborate to analyze the data to identify any **patterns** and **cause** and **effect** relationships’
- Groups use the data to support or refute their prediction. Each group will write a statement citing evidence of how their data supports or refutes their prediction in their notebooks.



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ACTIVITY 4

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In the Classroom (Teacher):

FOR THE INVESTIGATION SETUP AND PROCEDURE – See the Appendices - [Activity 4](#) in this document.

Teacher distributes the [Sea Level Rise Data](#) set to the groups.

Teacher goes over the coding for the data with the students:

- The first column contains date information. The first four-digit number is the year. The following four decimal places represent a percentage of the year that has passed in days, falling approximately on the middle of each month. For example:
 - $1880.0417 = \text{Jan } 1880 (365 \text{ days} \times 0.0417 = 15.22 \text{ days} = \text{January } 15).$
- The second column is the Global Mean Sea Level (GMSL) in millimeters, compared with the average level in 1990.
-

Teacher should “look for” evidence of the following when students are engaged in the practice of **Analyzing and Interpreting Data** such as:

- Compare data to make sense of and explain phenomena.
- Compare data and use comparisons as evidence.
- Use graphical displays to analyze data in order to identify linear and nonlinear relationships.

Teacher should “look for” evidence of the following when students are engaged in the practice of **Using Mathematical and Computational Thinking** such as:

- Make and use measurements as evidence.
- Compare evidence from measurements.
- Organize and analyze simple data sets for patterns that suggest relationships.
- Use graphs to find patterns and/or relationships in data.

SUGGESTION: If time or resources are limited, teachers may graph the data ahead of time for students and provide copies of the graphs for students to interpret.

(OPTIONAL) Teachers may choose to have students insert a trendline and determine the equation of the linear trend to find the slope. The slope of the line will show the overall sea level rise over time.

In the Classroom (Students):

- The students watch the next segment of the BLOSSOMS video where the video teacher shares information about how the Earth has experienced many cycles of climate change with the last Ice Age occurring before mankind walked the Earth. The video is paused at the **5:34** mark. The video prompts the students with the following questions:
 - What **relationships** can you see in the data?
 - Do you notice any **patterns** in the NASA data set?
 - What are some possible **causes** for these **patterns** to occur?
- Each group is distributed a copy of the [Sea Level Rise Data](#) set.
- Each group will then create a **graph** (see evidence bullets in the teacher column) using the [Sea Level Rise Data](#) set.
- Once each groups graph is completed the students will **analyze and interpret data** (see evidence bullets in the teacher column) from their graph.
- Each group will use their data to respond to the questions on the video at the **5:34** mark. Their responses should be recorded in their student notebooks.
- **(OPTIONAL)** Students may be encouraged to insert a trendline and determine the equation of the linear trend to find the slope. The slope of the line will show the overall sea level rise over time.

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ACTIVITY 5

In the Classroom (Teacher):

This portion of the lesson is an opportunity for students to go back and observe their **Glacial Meltdown Demo** setups. The focus of this portion is for students to revise their predictions and their initial **models**.

Teachers should “look for” evidence of the following when students are using the practice of **Developing and Using Models**.

Evidence Bullets (Look Fors):

- use and/or construct models to predict, explain, and/or collect data to test ideas about phenomena in natural or designed systems
- reflect on the components of models of simple systems with uncertain and less predictable factors.

This would be an excellent opportunity for the teacher to reinforce that scientists and engineers are constantly revising their **models** as new data becomes available. Just like scientists the students have been exposed to data that they collected themselves as well as historical data that they **graphed and analyzed**.

In the Classroom (Students):

The teacher resumes the BLOSSOMS video and the video teacher summarizes the history of sea level rise over time. The video teacher also revisits the **Glacial Meltdown Demo** and shares the results. The BLOSSOMS video is paused at the **7:15** mark and the students are directed to:

- *Revise your original prediction and discuss how it is reflected in your **model** (see evidence bullets in the teacher column).*
- Student groups revise their prediction and their initial **models** of the two bowls. The students should use what they learned in the lesson

CONCLUSION

- The teacher resumes the video where the video teacher explains the concept that the **Glacial Meltdown Demo** was designed to model.
- For an assessment the teacher may consider using the [Suggested Assessment Sea Level Rise](#) found in the Materials section of this document.

APPENDICES:

Activity 2: Glacial Meltdown Demo:

Procedure:

BLOSSOMS LESSON Sea Level Rise: The Ocean’s Uplifting Experience

Coaching Template ©Next Gen Education LLC

NOTE: Science and Engineering Practices are written in **bold blue font**. Crosscutting Concepts are written in **bold green font**.



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1. Make a mark approximately half-way up both tuna can labels. Try to make the mark at the same distance from the bottom for both cans.
2. With the bowls side by side on a level surface, place a marked can, lid side up, in each of the bowls.
3. In the first bowl, pile as much crushed ice as possible on the lid of the can. Be careful not to let any of the ice spill off.
4. In the second bowl, distribute the ice in the bowl around the can so that it comes about halfway up to the marked line.
5. Pour water into both bowls, stopping when you reach the half-way mark on each can label.
6. Give the ice time to melt completely, then recheck the water levels.

Some Tips to Set Up Demo

In the first bowl, place as much ice as possible on top of the container, whereas in the second bowl, no ice was placed on top of the can, but ice is distributed in the water.

Additional Teacher Notes:

Summarize concepts students may have expressed. Many students will believe that as the ice melts, both bowls will experience a sea level rise. The difference has to do with ice on land melting & contributing to sea level rise vs. ice in water in both containers melting and replacing its own volume. Ice on top of Antarctica melts and contributes to sea level rise. Ice that is part of the Arctic melts, but replaces its own volume, therefore it does not change the water level.

Prepare students for the next dual activity using questions related to factors that cause sea level rise such as:

- Is there a **pattern** related to temperature change and water level rise that can be measured? What and how **causes** this occur?

As this is a lab activity, students may be placed in lab groups ahead of time and all set ups should be ready to go beforehand

Activity 3: Is There a Relationship Between Temperature and Water Level Rise?

Procedure:

1. Unscrew flip top from water bottle & insert straw (If using water bottle & stopper, insert thermometer & pipette into stopper).
2. Ensure straw is vertical and inserted so that 2-3 inches of the straw are down into the bottle when the cap is on, and seal flip top with putty.
3. Adhere thermometer to side of bottle (A digital thermometer may be added with the straw through the bottle for true data collection & analysis).
4. Add water to the bottle and 2 drops of food coloring (easier to see water against ruler).
5. Continue to fill the bottle with water until it is completely full to the top. Screw top on bottle, being careful to watch for the overflow.



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6. Make a line using the permanent marker to represent where the present water line is on the straw.
 - a. A ruler can also be taped or held to the top of the bottle for easier measurements
7. From a uniform distance, direct a heat source at the bottle (blow dryer, lamp)
8. Take measurements consistently over time (every 30 seconds, or every 1 minute) how much the water level rises in centimeters (cm). Record measurements in the data table. Temperature may also be recorded as an additional data set.

SUGGESTION: Be cautious of air bubbles in set up, and to ensure the initial glacial melt down demo from activity 1 is safely far enough away from this activity as a blow dryer and lamp will be used.

Sample data table (NOTE: The data table could be reproduced in the students' notebooks or the teacher may elect to make copies for distribution to student groups:

Observation Number	Temperature (°C)	Height (cm)
1		
2		
3		
4		
5		

Activity 4: What are Some Possible Causes of Sea Level Rise?

Data file: <https://docs.google.com/spreadsheets/d/1RVZCz9DfzMVMEunDJOu1mYCGybzZIS0HNTC2piHRILo/edit?usp=sharing>

Students will examine data sets of global sea level rise measured over time in groups. Data is contained in two columns.



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The first column contains date information. The first four-digit number is the year. The following four decimal places represent a percentage of the year that has passed in days, falling approximately on the middle of each month. For example:

$$1880.0417 = \text{Jan } 1880 \text{ (} 365 \text{ days} \times 0.0417 = 15.22 \text{ days} = \text{January } 15\text{)}.$$

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