**Sea Level Rise The Ocean's Uplifting Experience\_1**

[00:00:00.00] [MUSIC PLAYING]

[00:00:17.78] Hello. My name is Tiffany Risch, and I am an oceanography teacher at Coventry High School in Coventry, Rhode Island. Maybe you have heard that sea level is rising across the Earth. Many scientists have been focusing on what is causing this sea level rise and have developed methods and models to predict the rate of sea level rise across the world's oceans.

[00:00:37.82] Did you know that the ocean apparently isn't rising at the same rate everywhere on Earth? In particular, on the ground-measured sea levels in some US East Coast regions, such as Cape Hatteras, North Carolina, have been measured to have risen about a foot-and-a-half during the 20th century as compared to New York City, which was measured as a one-foot increase, and Portland, Maine, which measured only a half-a-foot increase during the same time period. How can this be if the Earth is essentially a sphere?

[00:01:08.96] Let's think about this for a minute. It may be a bit complicated, but there is a key idea that relates to one of our experiments that we will examine today in this BLOSSOMS lesson.

[00:01:33.99] In this BLOSSOMS lesson, we will examine what could be contributing to sea level rise around the world as it relates to climate change. For our first activity, we will examine glacial ice melt. Your teacher will lead you through an investigation that simulates the different effects of global ice melting using the same setup as I have here.

[00:01:55.83] First, your teacher will ask you to make a prediction as to what will happen to the water level in each setup. Next, your teacher will ask you to develop a model to discuss what is causing the change in water level in each of the two setups. After you finish developing your model and making your predictions, I'll meet you back in the lab.

[00:02:33.23] Welcome back. Now that you have made your predictions and created your models, we will let the ice melt in your investigation over the course of the lesson and revisit this at the end. What do your models show? Are your models clearly labeled? Do they show the various components of the system you are modeling?

[00:02:53.45] As you think about what will happen in our investigation, it is important to understand that the earth experiences daily and monthly fluctuations in sea level due to short-term events, such as tidal cycles and storm surges. Short-term events occur daily and even monthly, or in the case of a storm, over several days. This is much different than long-term sea level rise, which is measured showing change over hundreds of years.

[00:03:21.44] In this next activity, you will examine the influence that heat has on water and record results in the lab setting. You will gather data and answer the question, is there a pattern related to temperature change and water level rise that can be measured? Make a prediction now before we get started.

[00:03:58.62] How did you do? Hopefully you had a chance to obtain some really good data to work with in the classroom. Did you notice any cause-and-effect relationships between the temperature and the height increase of the water? Look at your data tables. Can you pick out any specific patterns? Do those patterns have any connections to sea level rise?

[00:04:20.87] Scientists use data to look for cause-and-effect relationships and analyze patterns in the data to monitor sea level rise over time. They do this to tell the difference between sea level rise that happens daily due to daily ocean fluctuations versus more long-term variations. It is important to point out that the Earth continues to go through cycles of change. There have been periods of global warming and ice ages over the existence of the planet. We as humans have just never been around long enough to experience such changes.

[00:04:57.38] So how do we know this? Is the next activity, you will take a look at some data collected by NASA of actual sea level rise over time. Here are some parameters you should know about. The time column tells you the year and the portion of the year the data was collected. GMSL stands for Global Mean Sea Level in millimeters as compared to a 1990 reference set of data.

[00:05:25.27] Just by looking at the data, can you describe any patterns that you see? We will revisit this in the next activity.

[00:05:45.69] Welcome back. How did your graphs turn out? The Earth and its oceans are forever experiencing periods of change. The data from the last activity spanned a symptom from the 1800s to the early 2000s. While we may be experiencing a period of sea level rise now, the Earth~~?~~ has experienced sea level rise in the past.

[00:06:08.48] Just as an illustration of how things can change over thousands of years In. Contrast to 100 years, sea levels have risen approximately 120 meters or about 1 and 1/3 American football fields since the peak of the last ice age, with the melting starting about 19,000 years ago and ending about 6,000 years ago. You may think of this as planet Earth's massive ice melting out of water exercise.

[00:06:38.09] Before we end, let's go back to where we originally started and take a look at our glacial meltdown demo. As you can see, the model with the ice on top has led to an increase in water level in the bowl as compared to the model without ice on top. Did your models reflect this? Did the overall results surprise~~d~~ you? What have you learned about the potential causes for sea level rise and how would you revise your models to include those factors? Take a minute to reflect on your ideas and then to revise your model.

[00:07:25.10] Now it's time to revisit that apparent contradiction. Over the past 100 years, ocean levels have been measured to have risen differently in places like New York City, Maine, and North Carolina. How can this be? The massively heavy glaciers of the past ice age pressing down on the Earth's crust for thousands of years pushed the Earth's underglaciers crust downward. Areas just south of the glaciers, such as New York City and North Carolina, were simultaneously pushed upward by the downward displacement to the north.

[00:08:01.16] The Earth's crust was like a giant soft air balloon. Push it down one place and it pops up in another. Incredibly, even thousands of years after the ice age, the Earth's crust is readjusting to pre-glacial levels. It's like the Earth burping, upwards and downwards, reestablishing its previous levels. This is called post-glacial rebound. Can you now explain that previous contradiction?

[00:08:29.90] This was just discovered and explained by oceanographers in 2018. Science is wonderful. Science is never finished as there are always new things to learn. Through these activities today, I hope you have seen that distribution of ice, thermal expansion of water, and data interpretation are all important aspects of climate change as they relate to sea level rise. Scientists are also researching areas such as regenerative agriculture, bio energy with carbon capture and storage, also known as BECCS, direct air capture, sea water capture to further tackle climate change.

[00:09:11.21] It's been fun sharing this lesson with you. Thank you for your time and keep on learning.

[00:09:24.84] Thank you for choosing to use this BLOSSOMS lesson. The purpose of this lesson was to introduce students to the concept of sea level rise as it occurs through climate change by having them examine three specific parameters-- ice distribution, thermal expansion, and also analyzing and interpreting data.

[00:09:46.66] This lesson and the activities within it were designed using the three dimensions of the framework for K through 12 science education and the Next Generation Science Standards-- specifically, cross-cutting concepts, science and engineering practices, and disciplinary core ideas. The specific practices and cross-cutting concepts that students will be using throughout the lesson are-- cross-cutting concepts, systems and system models, cause and effect, stability and change, and also patterns; the Science and Engineering Practices, asking questions and defining problems, developing and using models, analyzing and interpreting data, and engaging in argument from evidence.

[00:10:38.21] The concept of sea level rise as it relates to climate change can be very challenging for students to understand, as there are many variables that can contribute to changing sea levels on a daily, monthly, and also yearly rate. It is important for students to understand that there are daily sea level changes that take place, such as tides. These short-term sea level rise events may also occur due to weather phenomenon, such as tropical storms or also hurricanes.

[00:11:11.15] Long-term sea level rise as related to climate change is what is being examined in this BLOSSOMS lesson. But even with that statement, we are talking over the course of a few hundred years as opposed to the length of time that the Earth has been in existence. Scientists know that Earth has gone through many periods of climate change over time, including times when sea level was much higher than what currently it is at today. As their teacher, your students should be made aware of this knowledge in advance and throughout this lesson.

[00:11:48.34] The use of Science and Engineering Practices and also the cross-cutting concepts allow for teacher-guided formative assessment throughout this entire lesson and helps structure student thinking. The SEPs allows students to make their thinking visible, and it also helps the practices to be tools to understand the phenomenon.

[00:12:09.61] As students use the practices, the teacher has the ability to also formatively assess their understanding and reveal their misconceptions. The cross-cutting concepts provide structure for the students as they try to explain the phenomenon. Providing students the opportunity to revise their thinking based upon new evidence that they discover or that they become aware of through discourse with their colleagues is essential for students as they figure out what is going on rather than simply just being provided with the facts.

[00:12:43.35] In segment 1, students are asked to observe an investigation that represents a model of how sea level rise may occur and to make a prediction with respect to what will happen in the two setups. Please see appendix 1, activity 1. A common misconception for students is that they may initially think that both bowls will experience the same amount of water level rise representing sea level as the ice melts in each bowl.

[00:13:12.60] Students may think that the ice on the top of the can will contribute to the volume of the water in the bowl once it melts, while the ice in the water will simply replace its own volume when it itself melts. This can be a very tricky concept when thinking about the source of the water that contributes to the sea level rise. Students are then asked to develop models of how their predictions occur, which will be revisited at the end of the lesson.

[00:13:42.85] You can assist your students with their predictions by circulating through the classroom and prompting their thinking for their models by developing their cross-cutting concepts embedded with their questions such as, what will happen to the water levels in each bowl over time? What could be some possible causes for their predictions? Develop models to explain what is causing the changes in their setups to make their predictions.

[00:14:10.29] In segment 2, students investigate the relationship between temperature and sea level rise. Again, students are asked to make predictions of the investigation outcome. These predictions will vary depending on how much background knowledge they have related to thermodynamics and also energy. The setup for the investigation itself may be a bit cumbersome. See appendix 1, activity 2.

[00:14:36.78] So it's best to be flexible with your materials. For example, if a straw is not working well, I found that a plastic pipette can actually do the trick. Also, if students cannot manage to make marks on the straw very easily, they can hold a ruler onto the top of the bottle and call off measurements at designated data point times.

[00:14:58.44] A ruler can also be used to measure a spot on the bottle at a specific distance away from the edge of the table to encourage consistent usage of the hairdryer or lamp in terms of the placement for the purposes of heating. Students may also need assistance with creating data tables or organizing their predictions, or even summarizing their findings as it relates to cause and effect relationships.

[00:15:22.38] As the students are engaged in the investigation, use the following cross-cutting concept embedded prompts. What cause and effect relationships did you notice between temperature and the height increase of the water? Look at your data tables. Can you pick out any specific patterns in your data? Do those patterns have any possible connections to sea level rise?

[00:15:46.60] These prompts are designed to structure your students' thinking toward the explanation of the phenomenon. From their data, the student should ultimately identify a pattern identifying a relationship between temperature and the height of the water. The major concept here is that the thermal expansion of water is one contributing factor to sea level rise.

[00:16:09.30] In segment 3, students are using data to identify patterns and trends and creating a model to explain their predictions. It may be the first time that students have actually seen a raw data set, and it may be overwhelming. Sometimes having them record their initial ideas is a good way to promote discussion in the classroom before diving into the actual activity Additionally, some students may not have worked with Microsoft Excel or Google Sheets. If this is an issue, you can always graph the data ahead of time for your students and present the pre-graphed data to them as a comparison tool after they've created their model graph.

[00:16:51.57] They of course should revisit their original model and revise if necessary and explain why they are making the specific revisions that are necessary. For an assessment, students could be presented with a sea level rise climate change scenario including specific data. They would have to use the information gathered from the BLOSSOMS lesson to form a claim, evidence, and reasoning response to the presented scenario.

[00:17:18.89] Thank you again for choosing this BLOSSOMS lesson. I'm confident that it will provide a foundation for your students as they explore the phenomenon of climate change.

[00:17:28.19] [MUSIC PLAYING]