Today I Learned About Sea Level Rise, Part 1

Land Ice vs Sea Ice

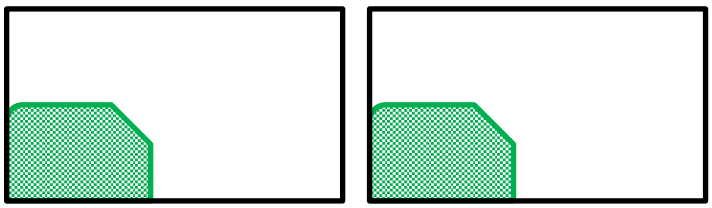
We know that melting ice adds to sea level rise – but which kind of ice? In this demonstration, we will measure the effects of modeled land ice and sea ice.

Materials

- ❑ Two equal-sized clear containers with flat bottoms
- ❑ Modeling clay or similar waterproof material
- ❑ Room-temperature water
- ❑ Ice cubes (smaller ice cubes will melt more quickly)
- ❑ Tape or a marker to mark the side of the clear containers
- ❑ Optional, to speed up heating: heat lamp

Setup

Use the modeling clay to make two same-size land areas, one in each plastic container (green areas below.)
This is a side view.



Extensions

- Measure the volume of water added to each container exactly.
- Measure the height of the water on the side of the container before adding ice.
- After the ice melts, measure the height of the water on the side of the container.
- Calculate the change in volume.

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Thermal Expansion

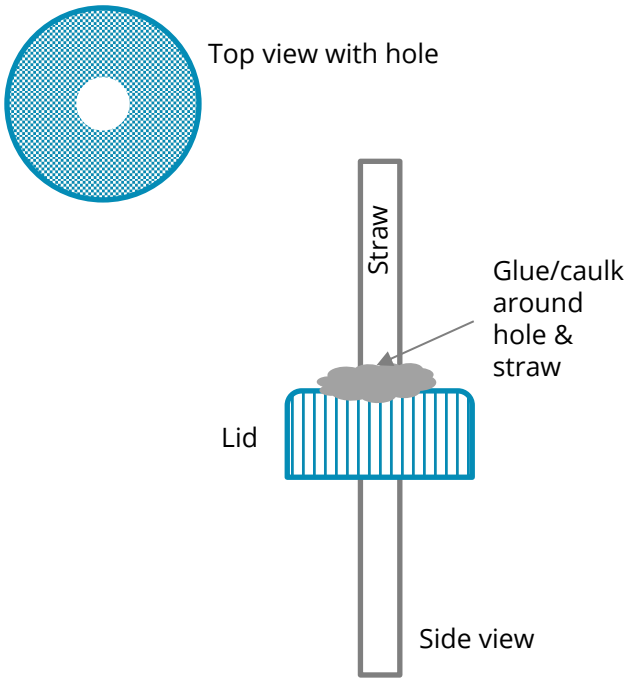
As water warms, the molecules move around more and take up more space. Warmer water has a larger volume than cooler water.

Materials

- ❑ A clear 12-20oz plastic bottle with a screw-on lid. (Such as a disposable water bottle, with either a screw top or flip-cap lid. Thicker, sturdier bottles work better than thinner, more flexible ones.)
- ❑ Food coloring or liquid watercolor
- ❑ A clear plastic straw
- ❑ Tape or a marker to mark the side of the straw
- ❑ Hot glue or waterproof caulk
- ❑ Cold water
- ❑ Optional, to speed up heating: heat lamp

Setup

1. Drill or cut a hole through the center of the top of the bottle cap. If you have a flip-top cap, you may not need this step.
2. Slide the plastic straw through the hole, leaving enough straw out the bottom to reach more than halfway into the bottle, and with 2-3 inches out the top of the cap.
3. Using hot glue or waterproof caulk, seal around the hole where the straw is.
4. Make sure that the lid can still be screwed on tightly.



Extensions

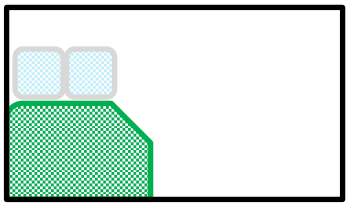
- Measure the change in volume exactly.
- Measure the change in temperature exactly.

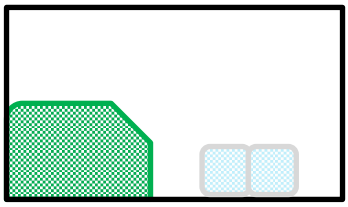
Today I Learned About Sea Level Rise, Part 1

"I mean, the oceans are pretty big. So you need to melt a lot of ice to really noticeably raise sea levels.

James Renwick, Victoria University of Wellington, New Zealand
TILclimate podcast: Today I learned about sea level rise, part 1

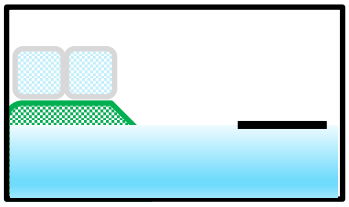
Land Ice vs Sea Ice Model

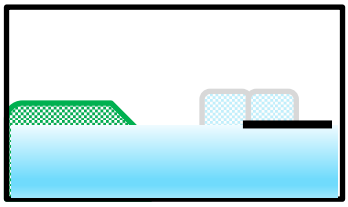




1: Add your ice to your model.

Put equal amounts of ice into your two models – on the "land" in one, and in the bottom of the other.





2: Add your ocean to your model.

Pour room temperature (or a little warmer) water into both models until the water level is about the same. Mark the water level on the side of each container.

Predict

Will the water level change in each of the models? Why or why not?

3: Warm up your model.

As we burn fossil fuels like coal, oil, and natural gas, we add carbon dioxide (CO_2) to the atmosphere. This carbon dioxide acts like a blanket surrounding Earth, trapping heat. Much of this heat is absorbed by the ocean.

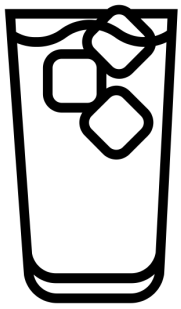
You can warm up your model quickly with a heat lamp, or more slowly by leaving it at room temperature and coming back to it the next day.

Observe

What do you notice? Did the same thing happen in each model? Why do you think this is?

Modeling the Real World

Where in the world is there ice floating in the ocean? Ice on land?



What does this glass of ice water have to do with this demonstration?

glass by Semmel Zenko from the Noun Project

Today I Learned About Sea Level Rise, Part 1

"The ocean's warming. And if you heat water it's going to expand. Of course, when ocean water expands, the only place it has to go is up."
James Renwick, Victoria University of Wellington, New Zealand
TILclimate podcast: Today I learned about sea level rise, part 1

Thermal Expansion Model

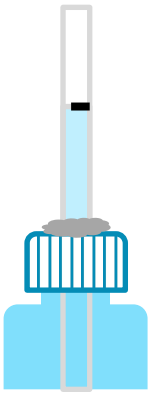
Please note that water will spill as part of this demonstration - protect your work surface.

1: Fill your bottle with cold water colored with food coloring or watercolors.

Fill the bottle all the way, to the absolute top. Water will probably spill out.

2: Screw the cap onto your bottle.

Carefully, so that no water spills out. Make sure the straw sits more than halfway into the bottle but does not touch the bottom, and that 2-3 inches of the straw is sticking out above the bottle cap.



3: Mark the water level on the straw.

Using a waterproof marker or lab pencil, mark how far up the straw the water comes. If there is no water in the straw above the cap, unscrew the cap and add more water to your bottle.

Predict

Will the water level change in the model? Why or why not?

Step 4: Warm up your model.

As we burn fossil fuels like coal, oil, and natural gas, we add carbon dioxide (CO_2) to the atmosphere. This carbon dioxide acts like a blanket surrounding Earth, trapping heat. Much of this heat is absorbed by the ocean.

You can warm up your model quickly with a heat lamp, or more slowly by leaving it in a sunny window and coming back to it the next day.

Observe

What do you notice? Why did this happen?

Modeling the Real World

As heat is being absorbed by the ocean, what would you expect to happen to sea levels, based on your observations?

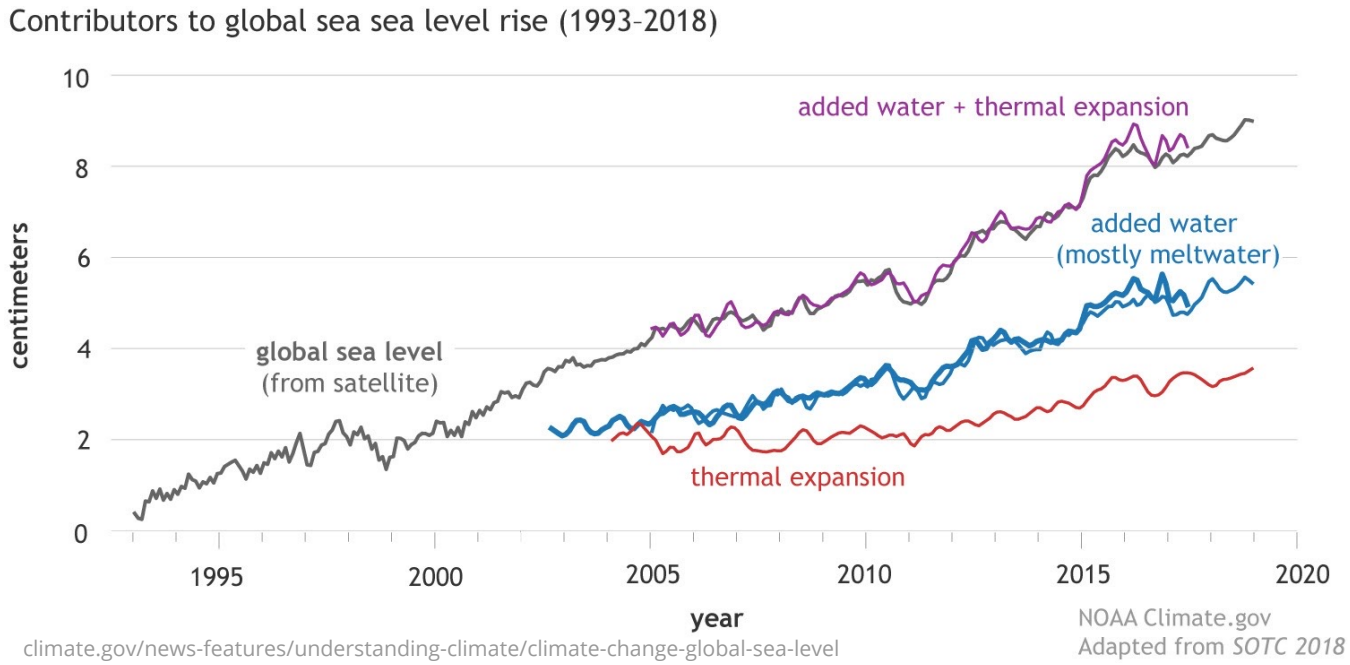
Today I Learned About Sea Level Rise, Part 1

A Warming Planet

When we burn fossil fuels like coal, oil, and natural gas, we release carbon dioxide (CO_2) into the atmosphere. Carbon dioxide and other gasses act like a blanket, trapping heat on Earth. A regular amount of carbon dioxide in the atmosphere is good – without it, Earth would lose heat to the cold of space, and there would be no life. Since the industrial revolution in the 1800s, we are seeing rampant carbon dioxide. It is out of control and causing too much warming. As we learned with the ice and water examples, warming has two effects on the level of the ocean – thermal expansion (warm water taking up more room) and melting land ice (adding more water to the ocean.)

The Seas Are Rising…

Due to a combination of thermal expansion and land ice melting, Earth has already seen eight to nine inches of sea level rise since 1880. The rate of rise is also changing – tide records from 1900-1990 showed four to five inches of rise, and then in the 25 years from 1990-2015, a further three inches.[1]



From the 1970s through the early 2000s, thermal expansion and ice melt added about equally to sea level rise. Since 2005, however, melting has been adding almost twice as much volume to the ocean as has thermal expansion. Worldwide glaciers, the Greenland Ice Sheet, and the Antarctic have all been melting at higher rates in the past twenty years than in the centuries before.[2]

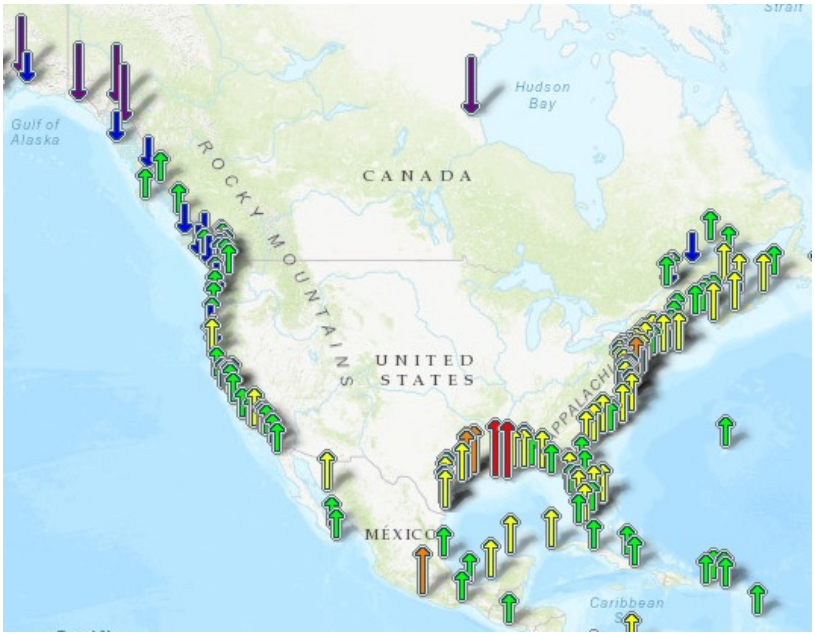
[1] National Oceanic and Atmospheric Administration "Tracking sea level rise… and fall" published August 2017
https://www.noaa.gov/explainers/tracking-sea-level-rise-and-fall

[2] National Oceanic and Atmospheric Administration " Climate Change: Global Sea Level" published January 2021
https://www.climate.gov/news-features/understanding-climate/climate-change-global-sea-level

Today I Learned About Sea Level Rise, Part 1

… But Not Equally

Sea level is also affected by plate tectonics, ocean currents and winds, pumping water and oil out of the ground, and even the gravity of ice sheets. This means that the amount and rate of sea level rise around the world is not even.[3] In some places (especially Alaska and Northern Europe) sea level is falling because of plate tectonics. Most of the world is experiencing between 3 and 9mm of rise per year. That is a range of under a foot to over three feet in 100 years.



https://tidesandcurrents.noaa.gov/sltrends/

What's Going to Happen?

Climate impacts are already being seen and felt around the world. Since heat-trapping gases remain in the atmosphere for tens to thousands of years, some climate impacts will continue even if we dramatically reduce fossil fuel use in the coming years.

Gas	Lifetime in the Atmosphere
CO^2 Carbon Dioxide	>1,000 years
N^2O Nitrous Oxide	>100 years
CH^4 Methane	>10 years

Slowing It Down

Communities and leaders all over the world are taking practical, common-sense steps to switch away from fossil fuels and toward greener, cleaner forms of energy such as wind and solar. These changes will be pivotal in creating the future we want.

Share

Talking about major changes like sea level rise can feel overwhelming. Communities all over the world are taking action to protect people and places from harm. How would you explain what you observed and learned to a family member or friend?

[3]National Oceanic and Atmospheric Administration Tides and Currents: Sea Level Trends, https://tidesandcurrents.noaa.gov/sltrends/

Today I Learned About Sea Level Rise: Solutions

"If we get to more than two degrees C of warming, a lot of the coastal cities and all the infrastructure that's there now would have to be abandoned or go under water. We're going to see people looking to be re-homed on a scale that just hasn't been seen before. Personally, I think we all have a moral responsibility to help others, so I'd be up for it, but I don't run the world."

James Renwick, Victoria University of Wellington, New Zealand

TILclimate podcast: today I learned about sea level rise, part 2

What Do We Do Now?

Sea level rise is a direct consequence of the burning of fossil fuels like coal, oil, and natural gas. Leaders around the world are working to dramatically reduce our use of fossil fuels. You may have seen some of these solutions around your community or in media. Solutions tend to fall into these four categories:

Energy Shift
Americans are innovators. What are some innovations you have seen that are shifting our energy systems away from producing carbon dioxide?

Energy Efficiency
Reducing our energy use overall reduces the demand for fossil fuels and makes the transition to renewable energy easier. What are some solutions that you have seen that are helping communities use less electricity, gas, and oil?

Talk About It
72% of American adults agree that climate change is happening, but only 35% talk about it even occasionally*. How can you share what you learned about sea level rise with your friends, family, or larger community?

Adaptation
Cities and towns all over the world are changing coastlines, roads, buildings, and infrastructure to handle a warming world. What are some solutions that you have seen that are helping communities protect people and places from climate impacts?

*https://climatecommunication.yale.edu/visualizations-data/ycom-us/