

1 Global Warming

1.1 Hansen Article

Now that you've finished the quiz, let's discuss the article some more.

1.2 Melting Ice

Please think about how to design and carry out an experiment that will test what causes a greater increase in sea-level – when land-based or sea-based ice melts.

1.3 Coastlines

What will happen to coastlines as sea-levels rise? . . .

1.4 Expansion

What happens to substances when the temperature rises?

- Why did the marshmallows expand in the microwave.
- Why does the “mercury” rise when the temperature goes up.
- How do you expect the oceans to respond to increasing temperature?
Now, ignore the fact that when the temperature increases, ice melts. Again, how do you expect the oceans to respond to increasing temperature?
- The volume of a given mass of salt-water scales with temperature approximately as follows:

$$V_{\text{sea}}(T) \propto 1 + 1.42 \times 10^{-3} (T - 0.0124T^2) \quad (1)$$

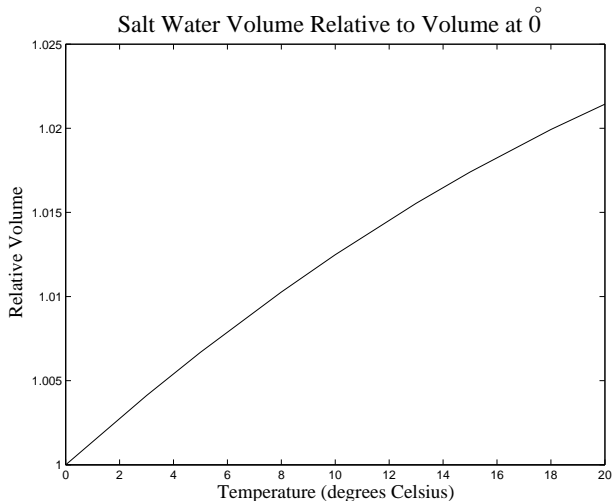
where T is measured in Celsius.

Make sure you understand what that \propto symbol means. It’s a way of summarizing ratio relationships. For a given temperature, equation (1) is meaningless. It is only useful for comparing the volume of a certain mass of salt-water at two different temperatures.

For example, let’s compare the volume of a given mass of salt-water at 3° C to the volume of that same mass at 6° C. Using equation (1) in ratio form, we may write

$$\frac{V_{\text{sea}}(6^\circ)}{V_{\text{sea}}(3^\circ)} = \frac{1 + 1.42 \times 10^{-3} (6 - 0.0124 \times 6^2)}{1 + 1.42 \times 10^{-3} (3 - 0.0124 \times 3^2)} = 1.0038,$$

which indicates that salt-water takes up 1.0038 times the volume dense (or, is 0.38% less dense) at 6° C than at 3° C. Below is a plot of relative volume as a function of temperature (relative to the volume of a given mass of salt-water at $T = 0$):



There is a mild division in the ocean. Below 1 km below sea-level, the ocean has a fairly different temperature and density than it has above that level. Let's call the level of that division L .

The average ocean temperature below L is about 4 degrees Celsius and above L is about 13 degrees Celsius.

- Use equation (1) to estimate the likely rise in sea-levels if the average ocean temperature above L increases by 5 degrees Celsius.
 - a) First, calculate the relative increase in volume in the region above 1 km:

 - b) In what direction(s) can the ocean expand?

 - c) Use your results from parts a) and b) to answer the question.