



NASA/UCAR: Effects of Climate Change: Oceans and Ice

Presented by: Dr. Lisa Gardiner

Wednesday, April 14, 2010
6:30 p.m. - 8:00 p.m. Eastern time

Effects of Climate Change: Oceans and Ice

A web seminar for the NSTA community
By the UCAR Office of Education and Outreach,
with support from NASA.



Overview

- Melting snow and ice on land
 - *Glaciers Then and Now* activity
- Rising sea level
 - *Thermal expansion* activity
- Possible changes to ocean circulation
- Ocean acidification



Presenter:
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Educational Designer
UCAR
Office of Education
and Outreach



WINDOWS TO
THE UNIVERSE

Melting Snow and Ice on Land

(with an activity about glaciers)





Glaciers and Ice Sheets

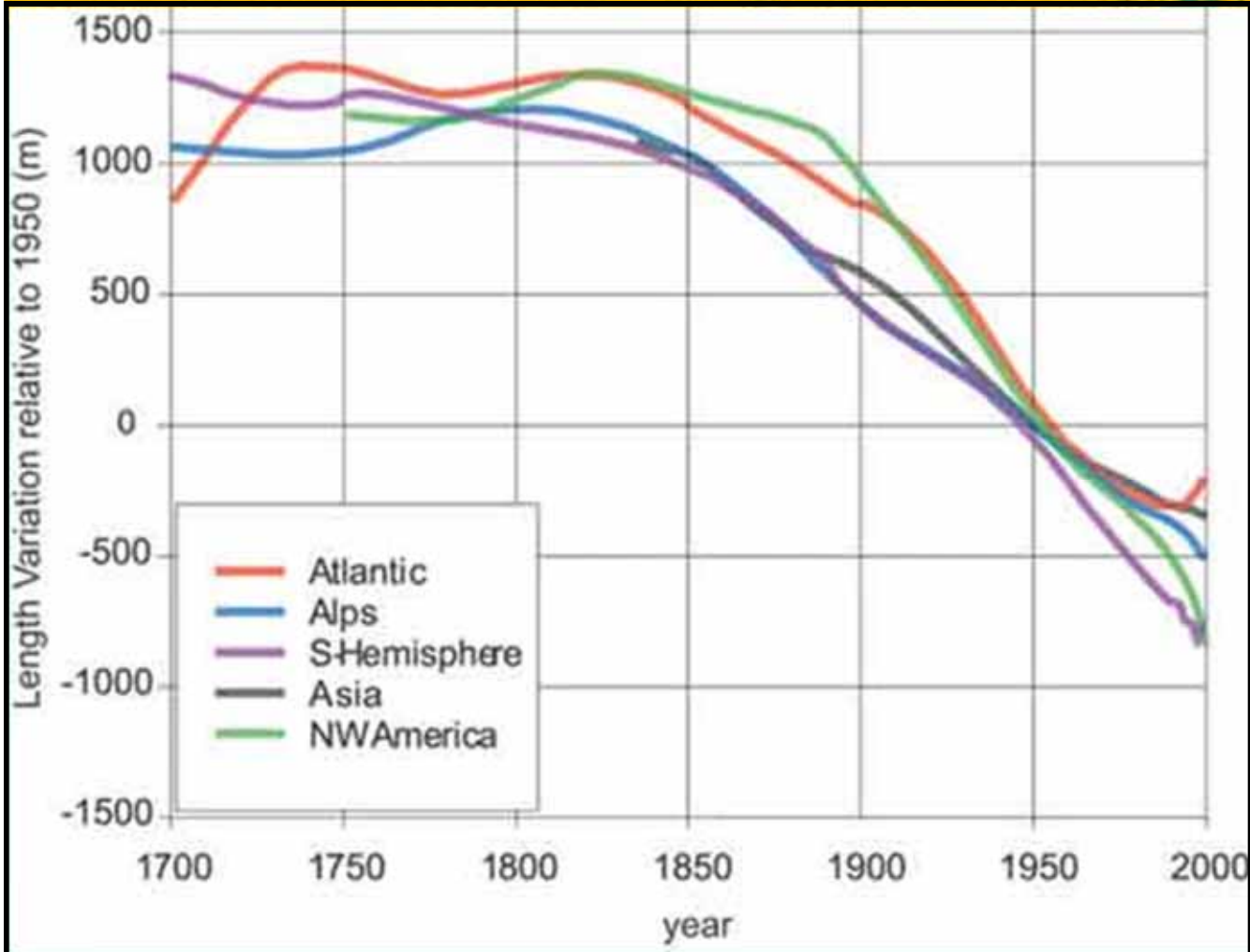


Matanuska Glacier, AK
Courtesy of N Gordon/UCAR

- Continental glaciers (also called ice sheets) cover large areas at high latitudes.
- Alpine glaciers (mountain glaciers) cover smaller, high altitude areas at all latitudes.
- To be considered a glacier, the ice must be moving.



Changes in Glacial Ice

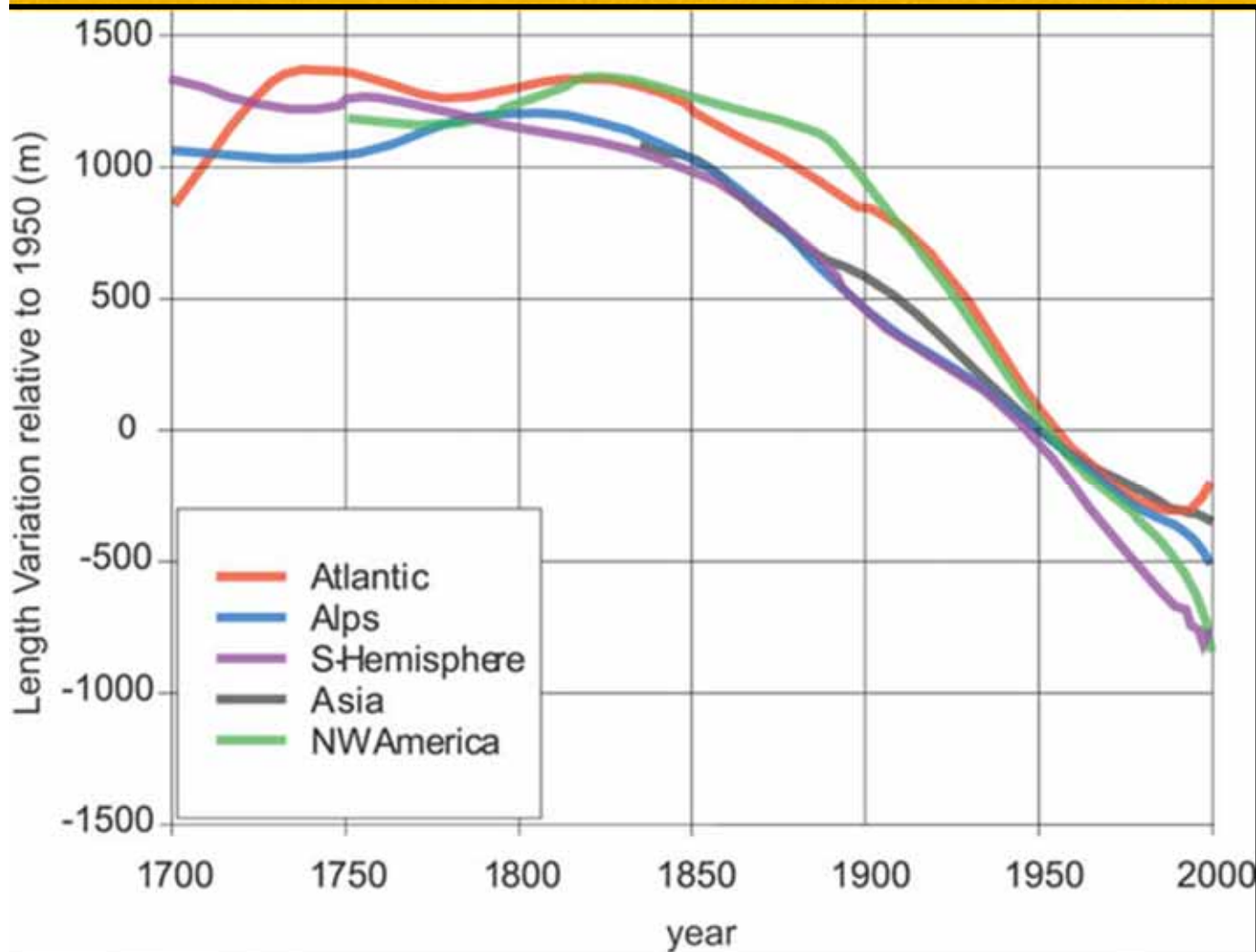


- What can we say about this graph?

[Type in the Chat]



“All glaciers are shrinking.”



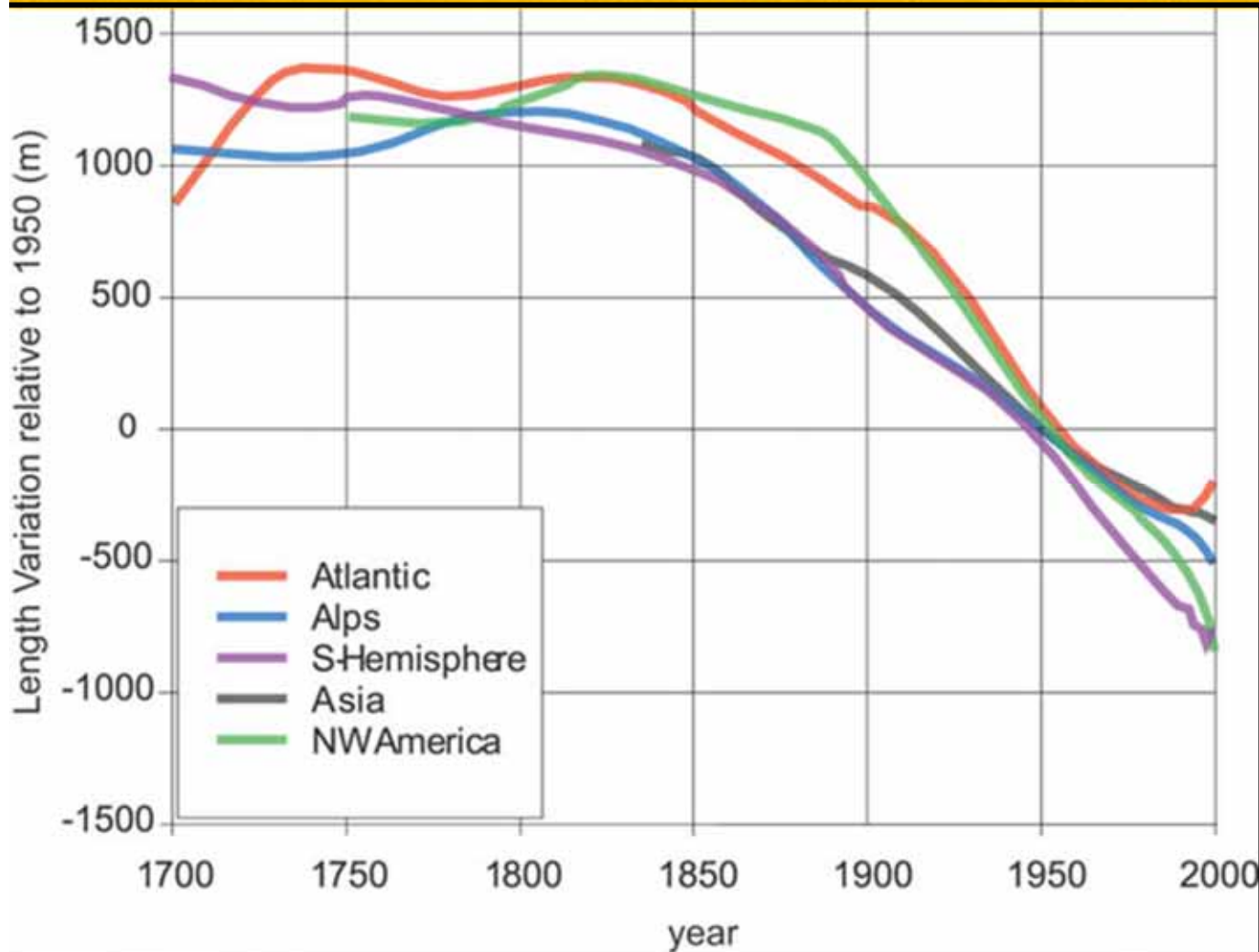
A. True

B. False

C. Can't tell from this graph



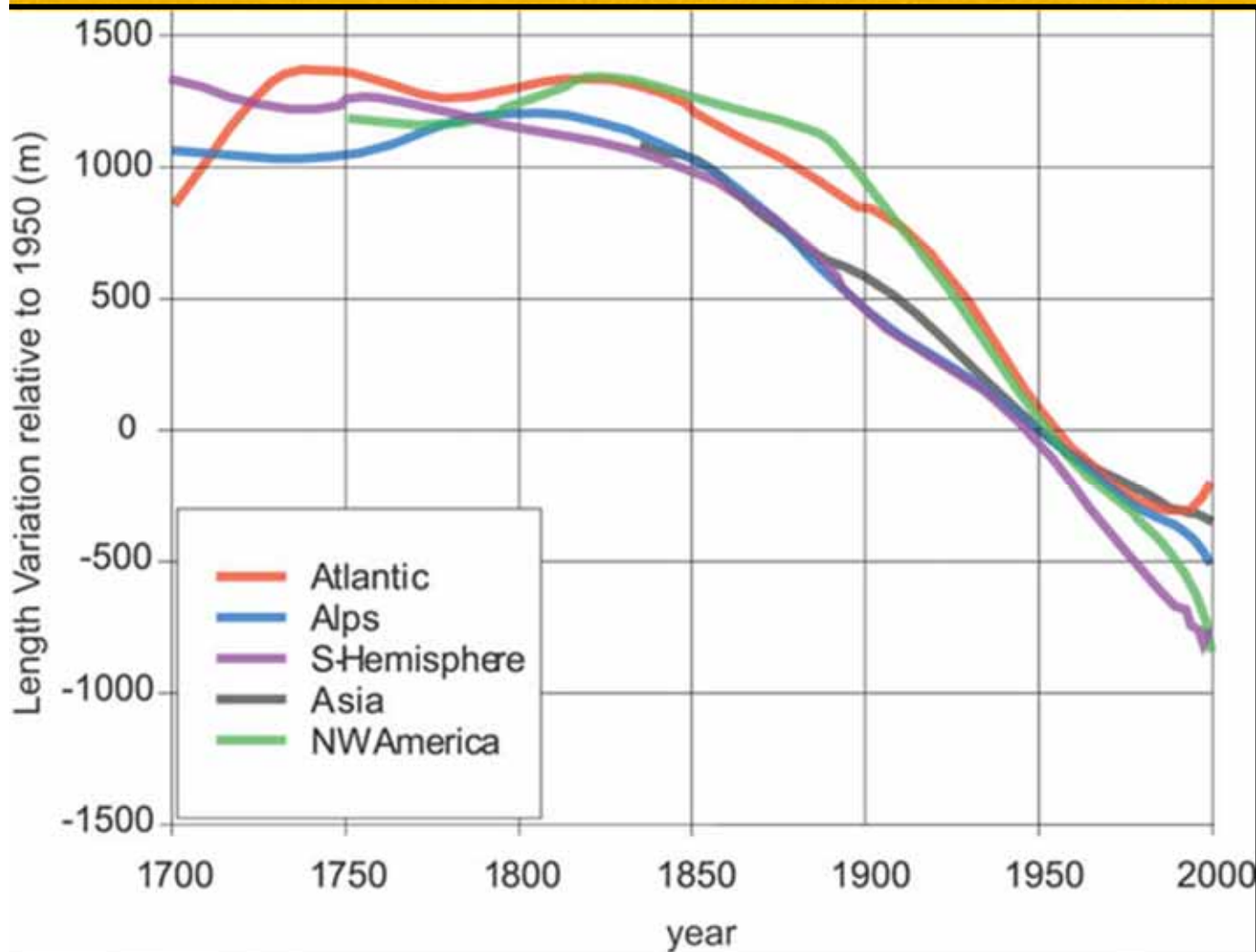
Answer: C



- We can't tell if all glaciers are melting because this graph is showing us averages for each region. (However, almost all glaciers are shrinking.)



“Starting around 1850, average glacier length declined.”



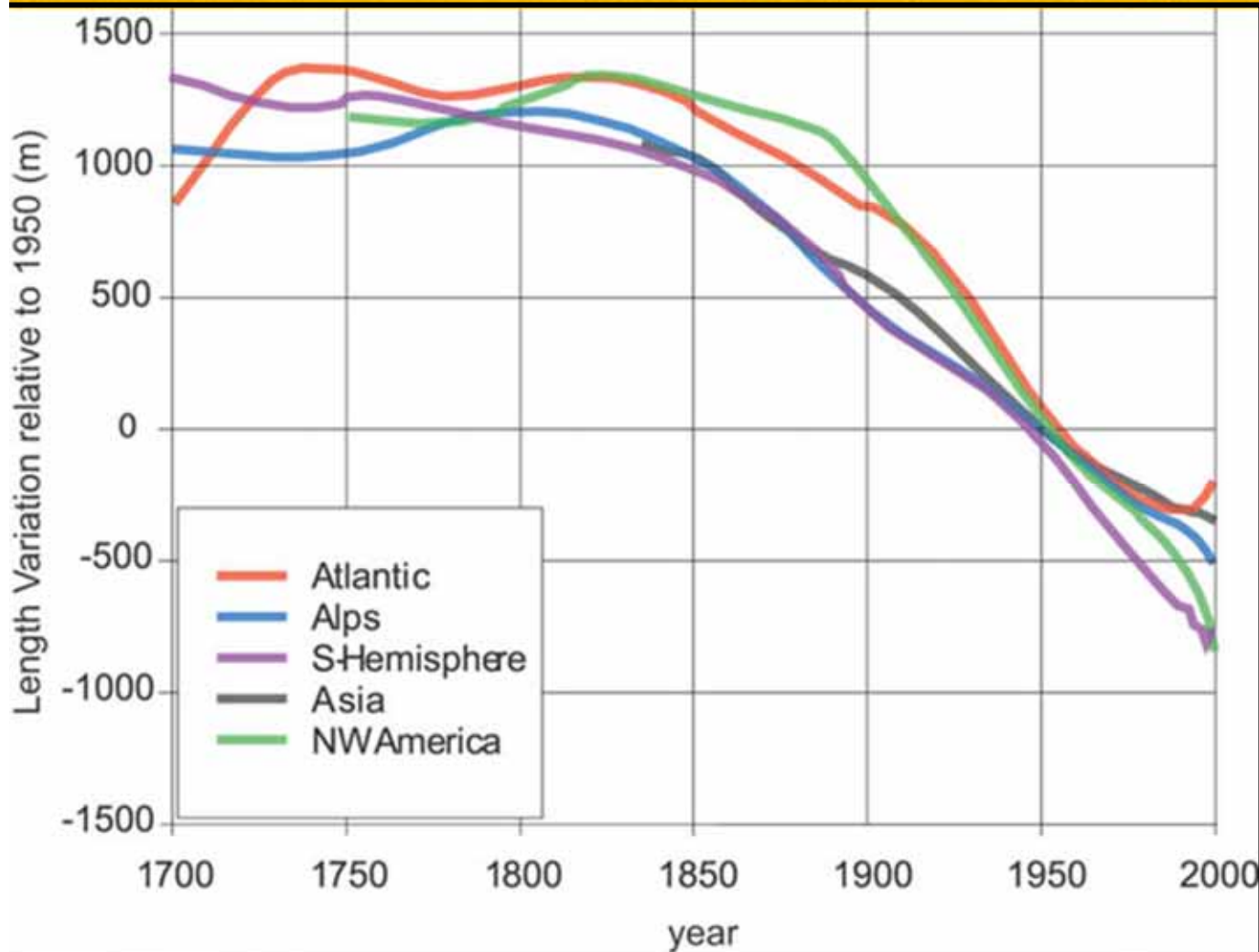
A. True

B. False

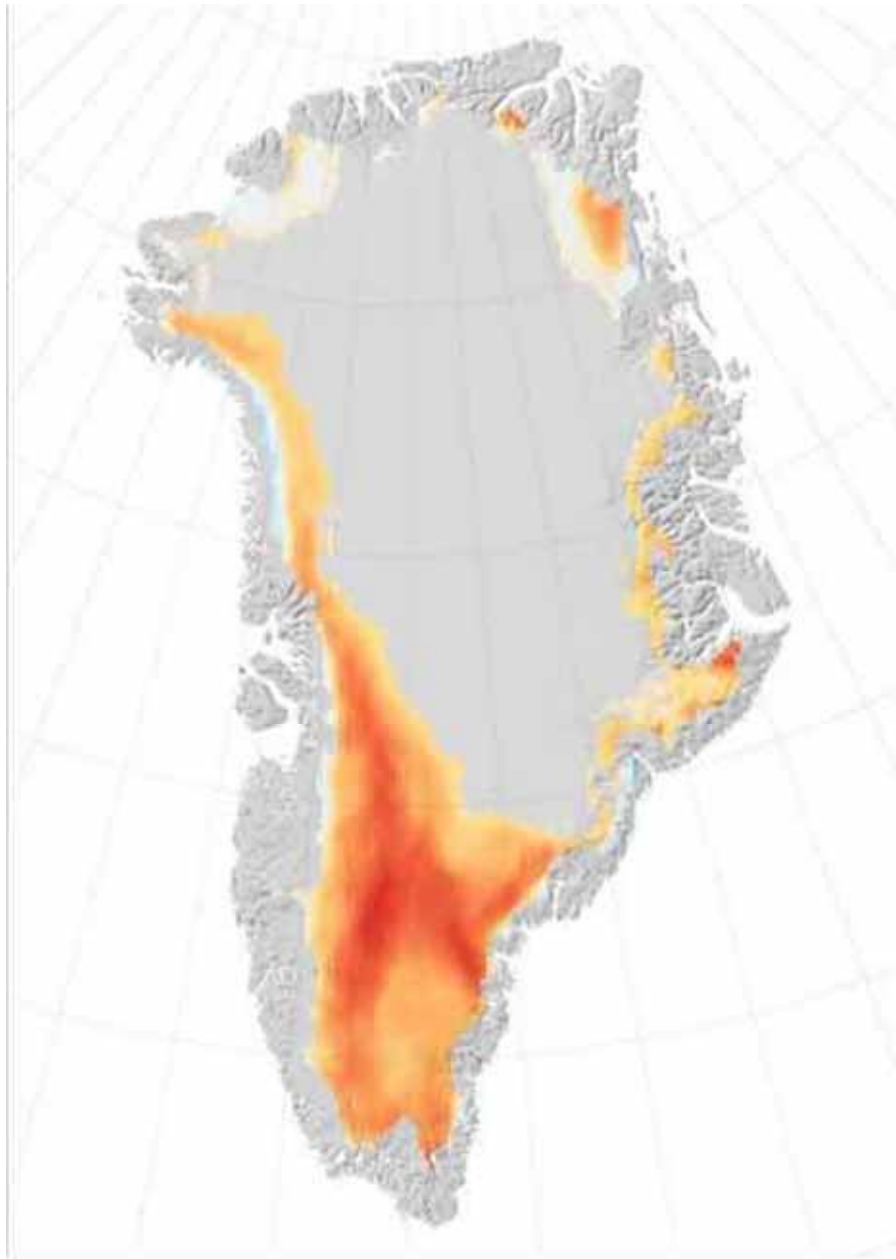
C. Can't tell from this graph



Answer: A

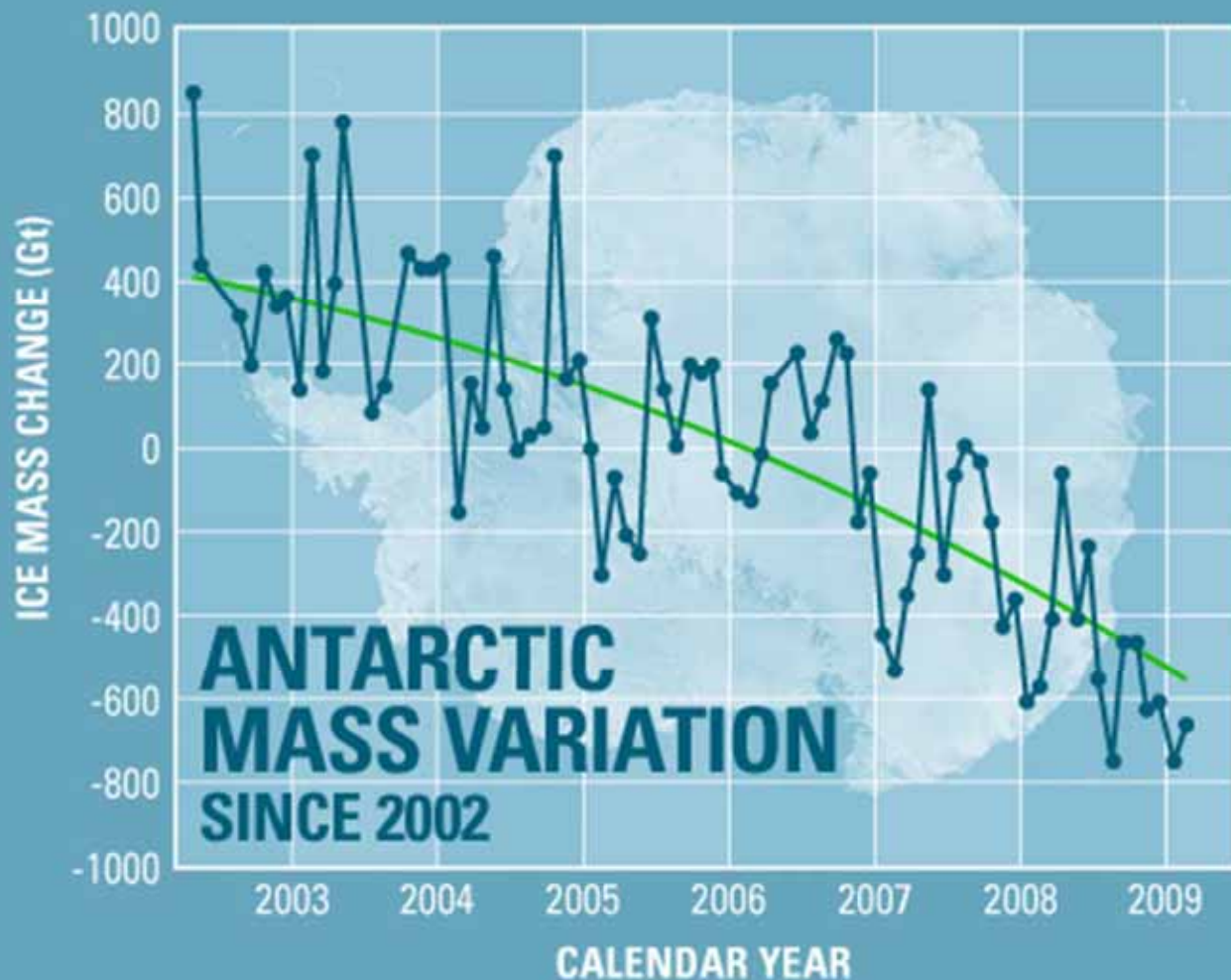


- This statement is true and can be deduced from this graph. Glaciers in all regions have been getting smaller since the mid-19th Century.



Greenland

- The map at left shows in orange/red areas where there were higher than average number of melt days in 2007.
- There is evidence that both the rate of ice melt and area of ice melt are increasing.
- There is evidence that melt water under the ice is increasing glacier movement towards ocean (basal slip).



- Antarctica has been losing more than 100 cubic kilometers (24 cubic miles) of ice per year since 2002.

http://www.nasa.gov/topics/earth/features/20100108_Is_Antarctica_Melting.html

Mountain Glaciers



PERU VIEW

Qori Kalis Glacier in Peru. Left: July 1978. Right: July 2004.

Photographed by Lonnie G. Thompson. Credit: the Glacier Photograph Collection of the National Snow and Ice Data Center/World Data Center for Glaciology

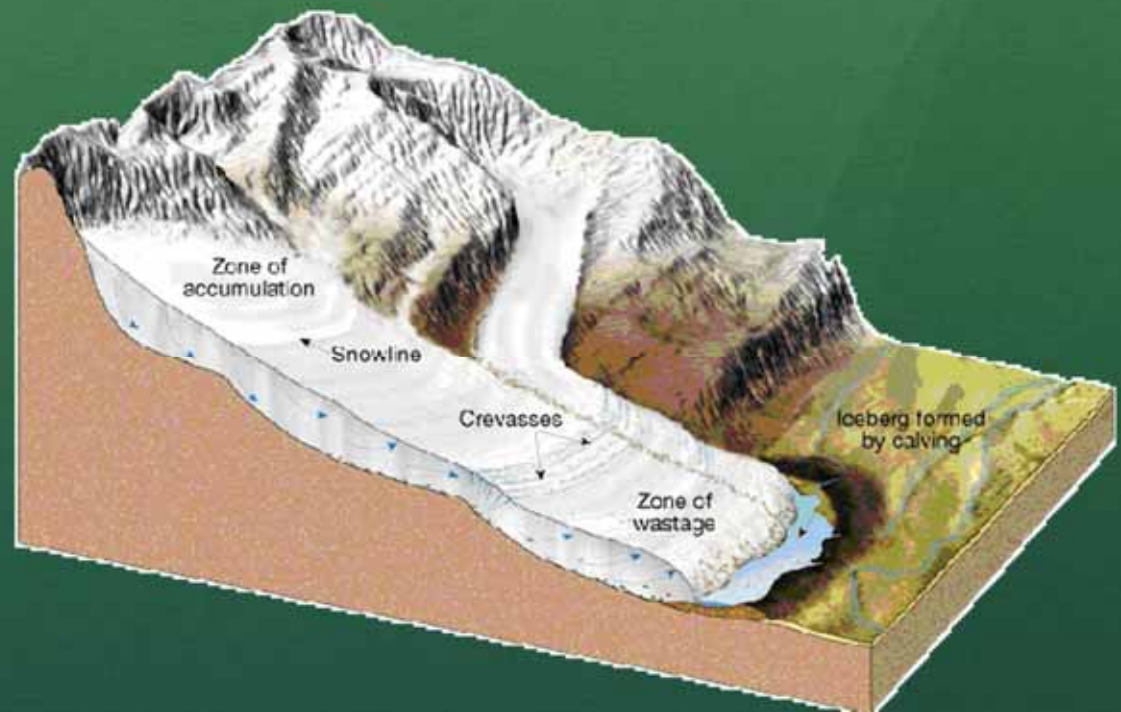
Part of a special section of the NASA's Global Climate Change Web Site called "State of Flux, Images of Change"

<http://climate.nasa.gov/stateOfFlux/>

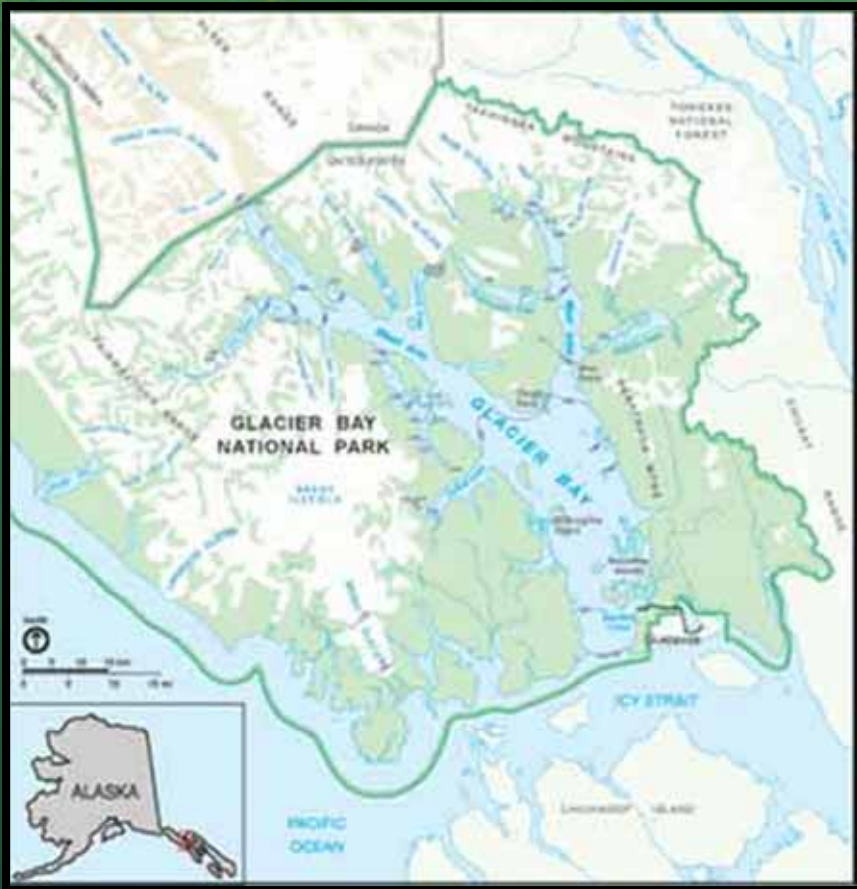


How Glaciers Change

- **Glacial advance:**
Glaciers become larger when more snow falls than melts.
- **Glacial retreat:**
Glaciers become smaller when more snow melts than falls.



Activity: Glaciers Then and Now



- Students compare photographs of glaciers to observe how Alaskan glaciers have changed over the last century

http://www.windows2universe.org/teacher_resources/teach_glacier.html



Muir Glacier

Glacier Bay National Park, Alaska



Photos courtesy of NSIDC



Muir Glacier

Glacier Bay National Park, Alaska



Photos courtesy of NSIDC



Carroll Glacier

Glacier Bay National Park, Alaska



1906

Photos courtesy of USGS



Carroll Glacier

Glacier Bay National Park, Alaska



Photos courtesy of USGS



**Let's Pause
Two
Minutes for
Questions?**



Rising Sea Level

(with an activity about thermal expansion)

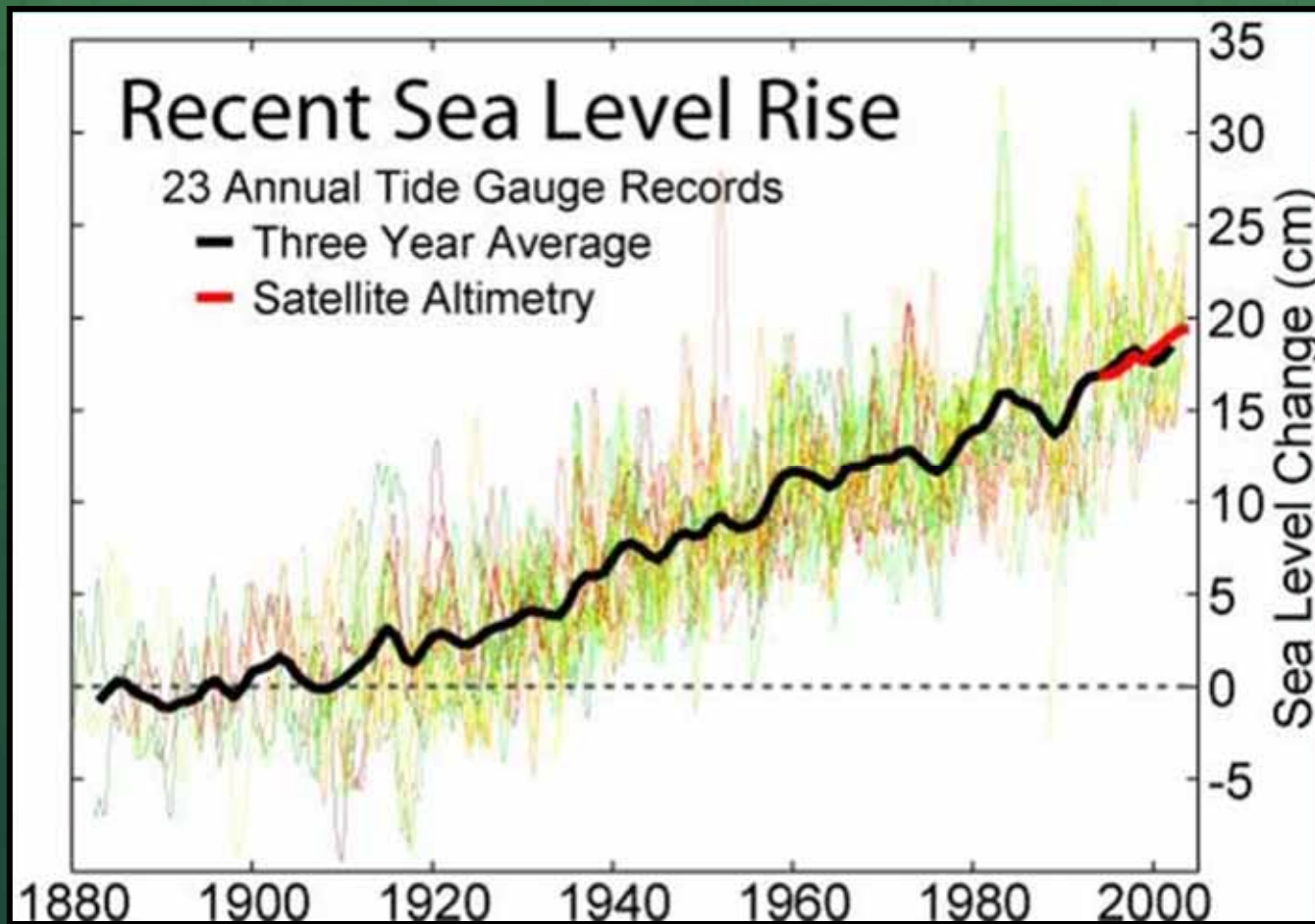




How much is sea level rising?

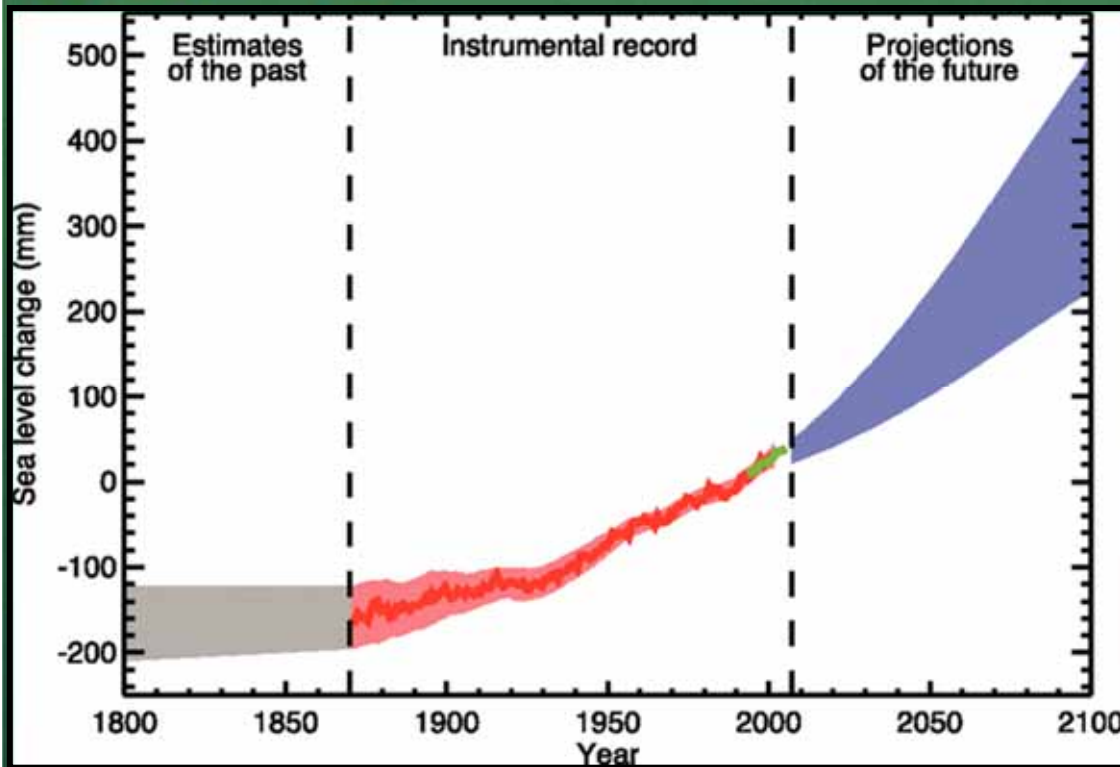
Since 1900 sea level has risen 10-20 cm.

(During the previous 3000 years, sea level stayed essentially the same.)



Robert A. Rohde/Global Warming Art Project

How much sea level rise is predicted?



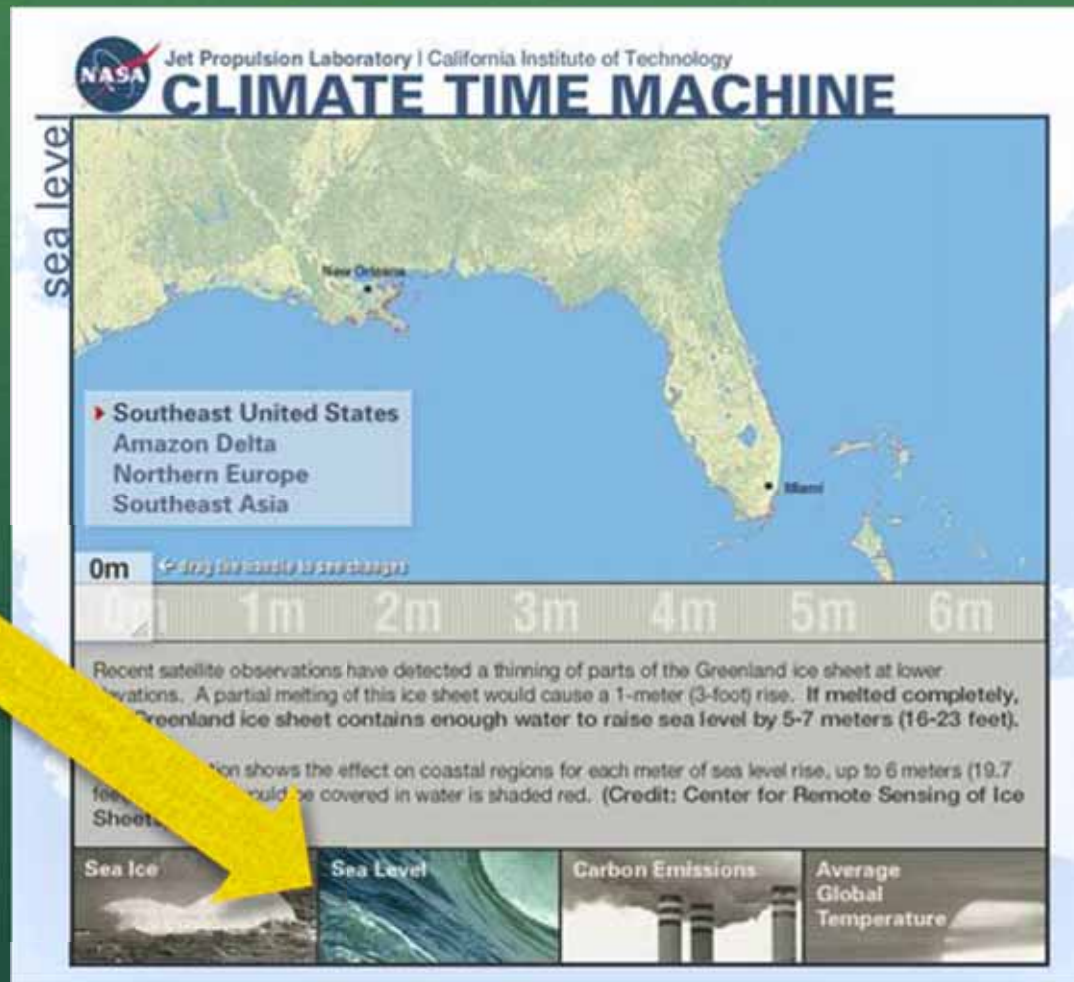
- Currently, global sea level is rising about 3mm per year.
- Sea level is expected to rise 18-59 cm over the 21st Century.

Why is there a range in estimates?
Post your thoughts in the chat.



Web Tour: Exploring the NASA Climate Time Machine!

Click
on
Sea
Level



<http://climate.nasa.gov/ClimateTimeMachine/climateTimeMachine.cfm>



What did you discover?

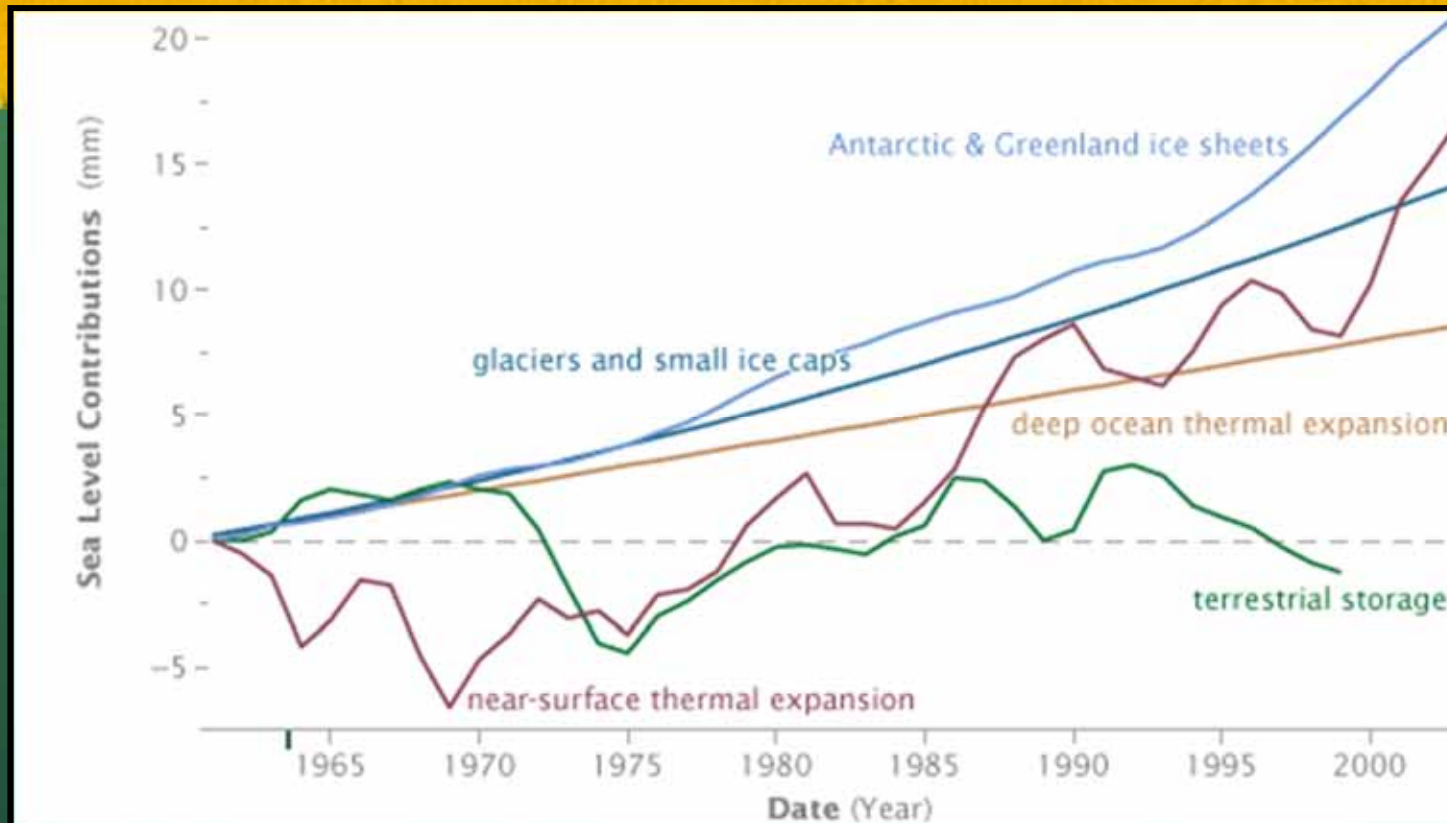


If the Greenland Ice Sheet melted completely, raising sea level 6 meters, which cities labeled in the “Climate Time Machine” would be underwater?

Write your answer above with the text tool.

Why is sea level rising?

NASA Earth Observatory

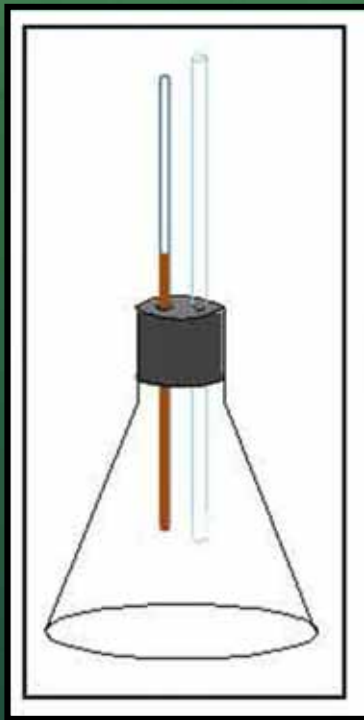


- Melting glaciers and ice sheets add water to ocean.
- Sea water expands as it warms.

<http://earthobservatory.nasa.gov/Features/OceanCooling/page5.php>

Activity:

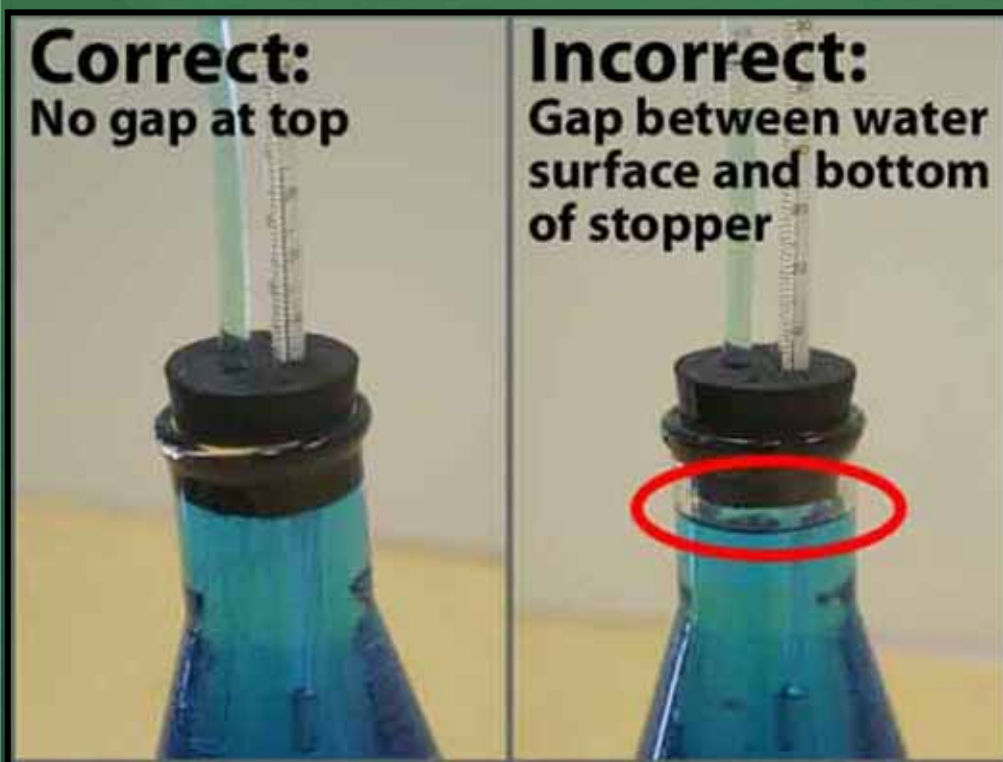
Thermal Expansion and Sea Level Rise



- With a simple model, students investigate how thermal expansion of water can affect sea level.
- Students will be able to describe the change in water level when the water is exposed to heat.



Setting up the model



1. Completely fill the flask with very cold water
2. Place thermometer and glass tube into the cork and place cork into the mouth of the flask. The water should rise a short way up the glass tube.
3. Have a student report the temperature of the water and mark the water level in the glass tube.

Testing what happens as water warms:



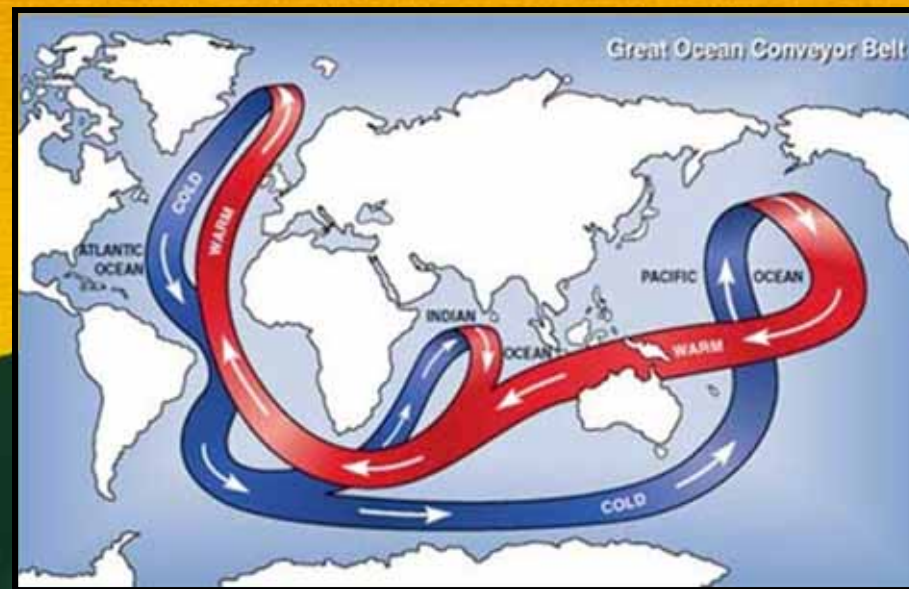
1. Ask students to predict what will happen to the water level when exposed to heat. Form a hypothesis or multiple hypotheses.
2. Place the flask under a lamp to warm the water. Within 5-10 minutes the water level in the glass tube will have risen.



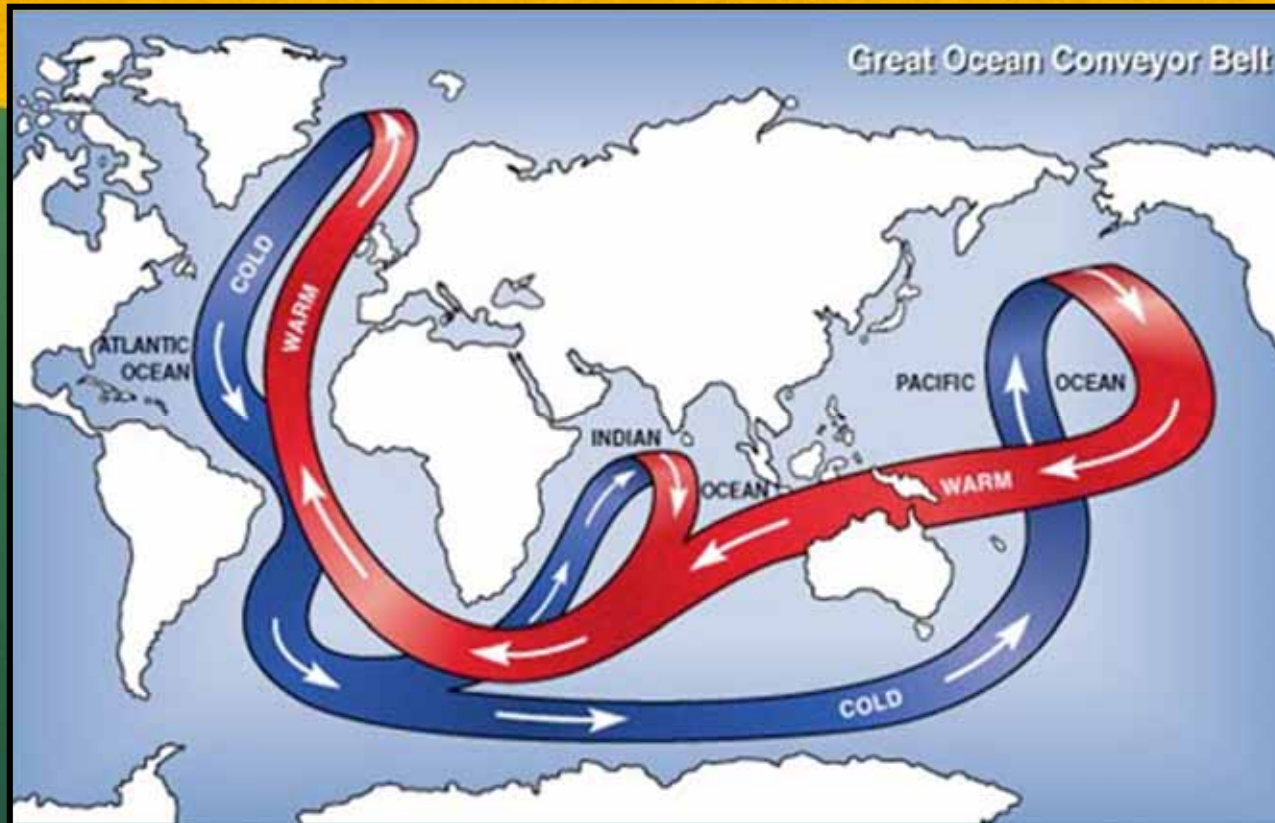
Questions about sea level rise?



Possible Changes to Ocean Circulation



What is thermohaline circulation?



Large scale pattern of water movement through the world's ocean basins due to changes in water temperature and salinity, which lead to differences in density.



How likely is this?

YouTube [Browse](#) [Upload](#)

The Thermohaline Circulation - The Great Ocean Conveyor Belt (NASA)

[djxatlanta](#) 896 videos




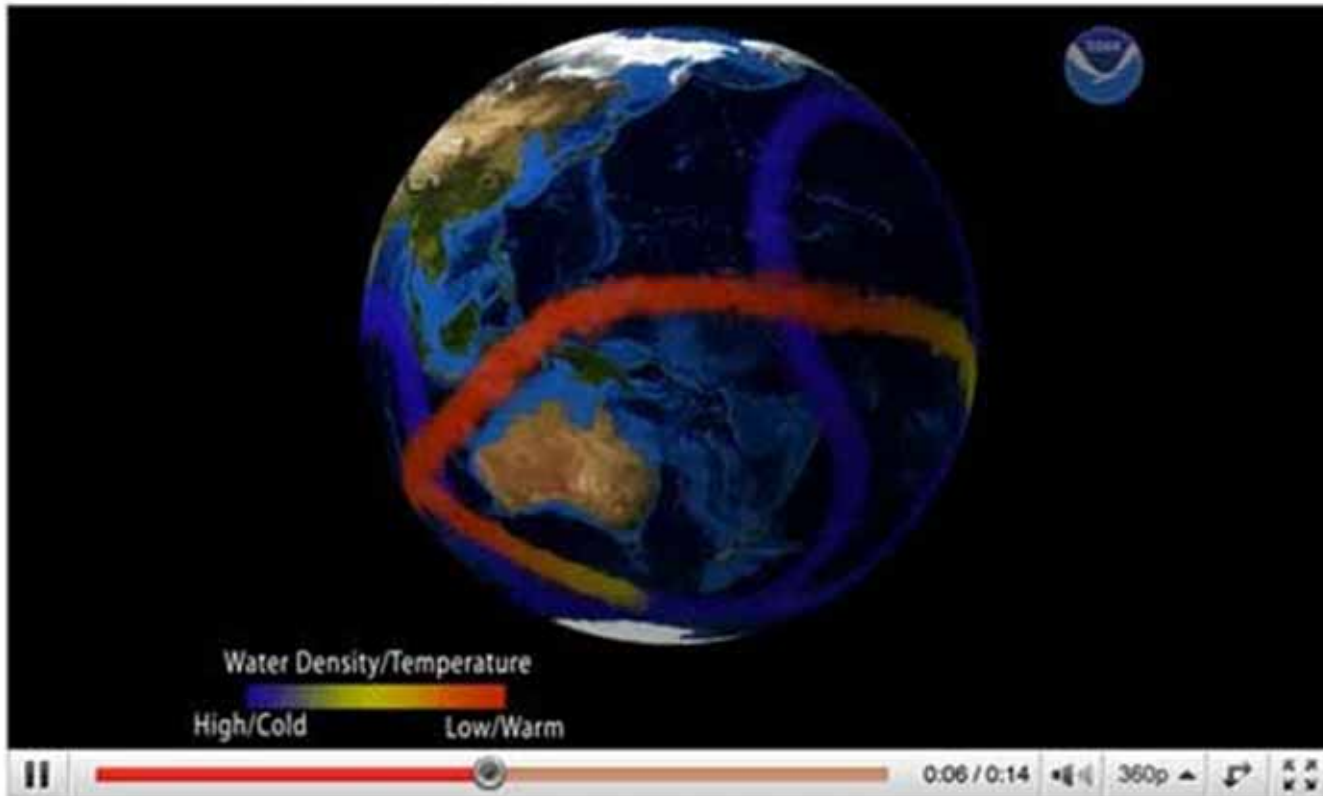
0:12 / 1:24 360p

[djxatlanta](#) — October 15, 2009 — The oceans are mostly composed of warm salty water near the surface over cold, less salty water in the ocean dep... **18,395** views

http://www.youtube.com/watch?v=3niR_-Kv4SM

Thermohaline Circulation


NOAAVisualizations 36 videos  [Subscribe](#)



NOAAVisualizations — April 16, 2008 — The word "thermohaline" is a conjunction of terms referring to "heat" and "salinity." The movement of most mid ...

 **10,874** 
views



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http://www.youtube.com/watch?v=lazg1F9hE_c&



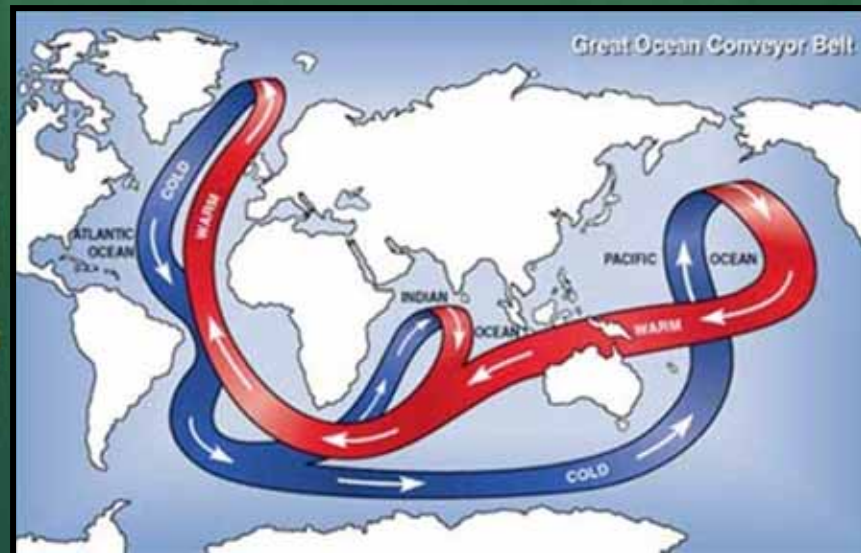
Arctic sea ice decline may impact ocean circulation.

- Decline in Arctic ice cover 1980 to 2003
- Influx of fresh water from melting ice is making Arctic Ocean water less dense.
- Less dense water may not sink as much as it does today, disrupting ocean circulation.





Questions about ocean circulation?



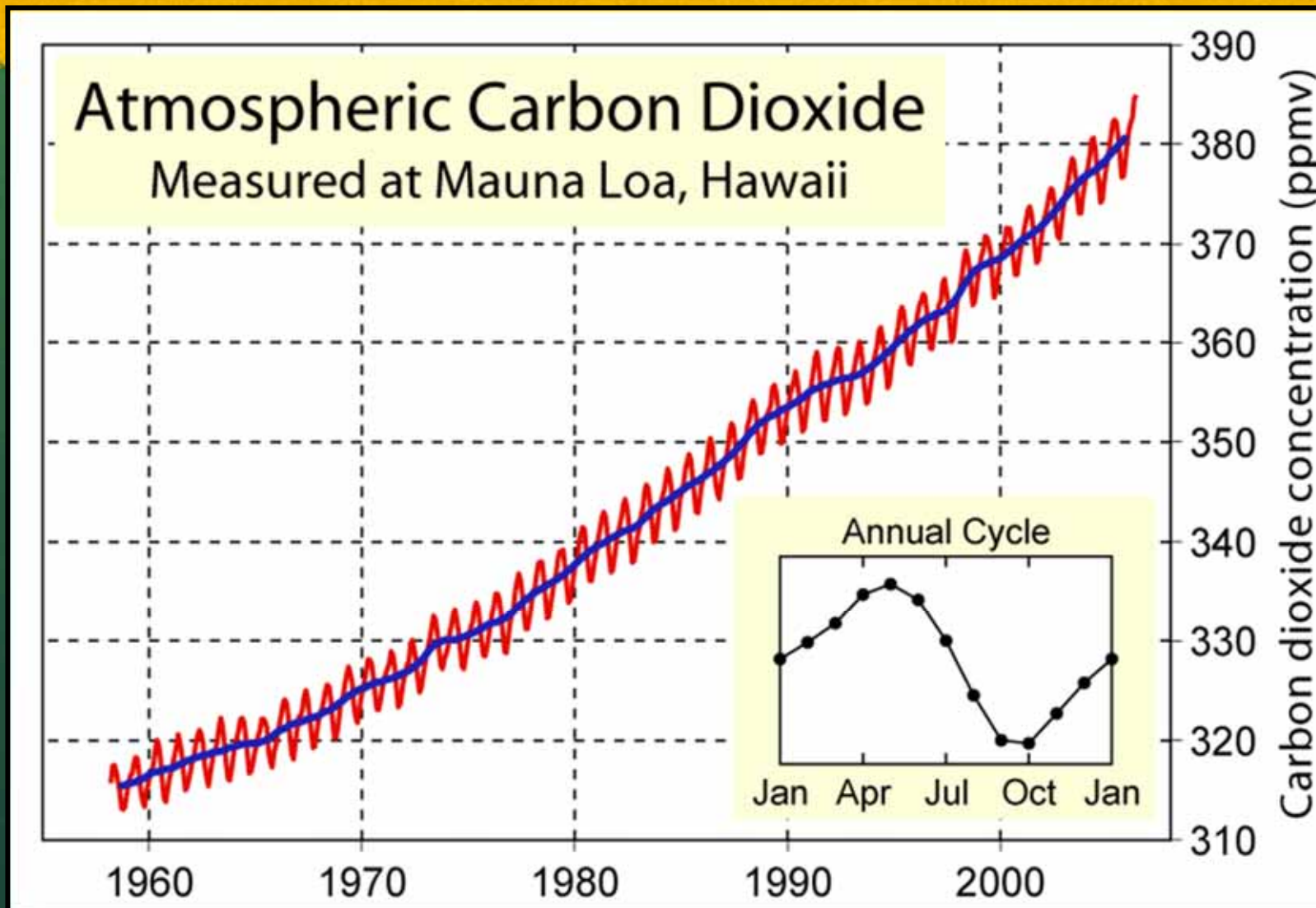
Ocean Acidification



Measurements of atmospheric CO₂ (Keeling Curve)

5/2009

386.11



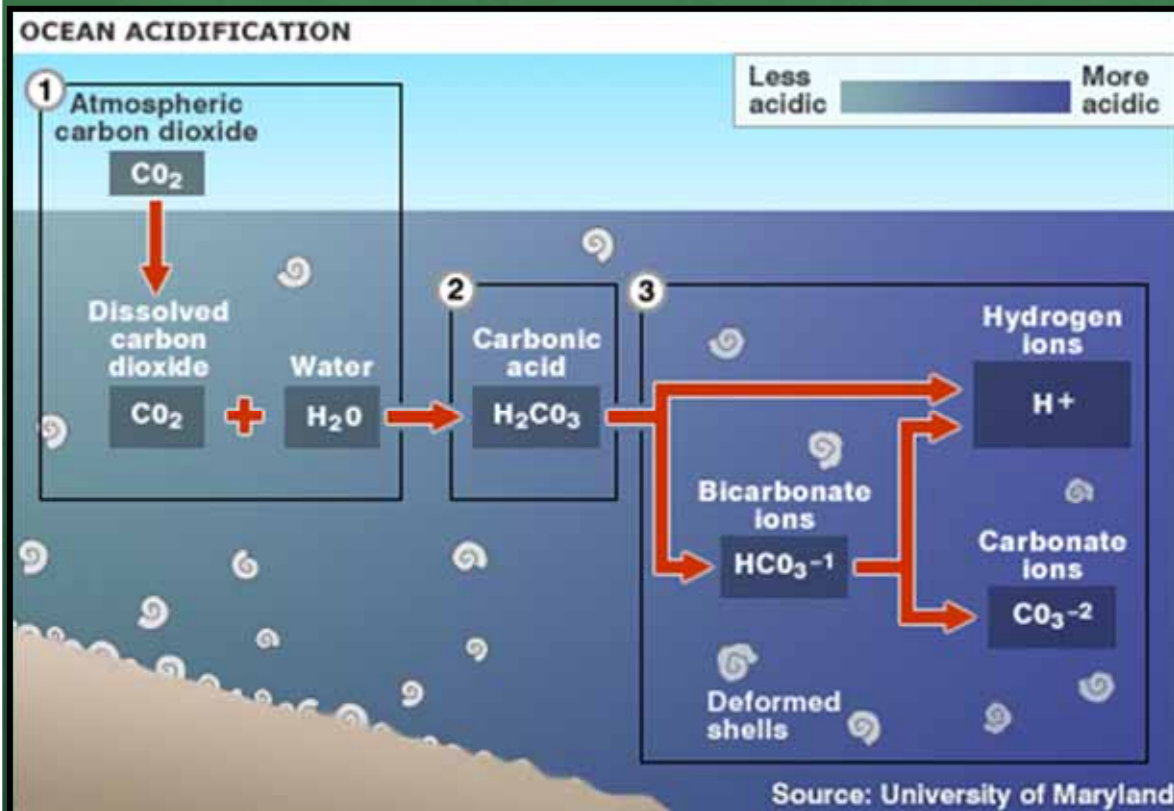
3/1958

315.71

Image courtesy: www.globalwarmingart.com, See also: www.esrl.noaa.gov/gmd/ccgg/trends/



Carbon dioxide gets dissolved in the ocean.



- Up to half the carbon dioxide released from burning of fossil fuels gets into the ocean.
- In ocean water, CO_2 forms carbonic acid which makes it difficult for animals to form CaCO_3 (limestone) shells.



How will ocean acidification affect marine life?



- In experiments, doubling amount of CO₂ dissolved in seawater decreased calcification rates in corals an average of 30%.
- Note that the rate at which corals build their skeletons is affected by many other factors too (such as temperature, light, and nutrients).



Experiment!

Vinegar + Shell = ?

- Vinegar is acidic.
- The shell is made of calcium carbonate.
- What will happen to a shell left in vinegar?
- Write your hypothesis in the chat.



The shell in the picture is the clam *Codakia obicularis*, but any clam or snail shell will work. (Shell only! Not alive!)



Results...



Shell in vinegar (left), control shell (right)



After 3 hrs –
shell in vinegar fragile, color
gone, edges crumbling



After 4 hrs –
shell in vinegar broken,
very thin, crumbling

The ocean is not vinegar.

(but a little change in pH can make a big difference)

- Vinegar has a pH of about 3
- The pH of seawater varies between 7 and 8
- Since the start of the Industrial Revolution, pH of seawater has dropped about 0.1.
- In the next century, it is expected to drop another 0.1-0.35.



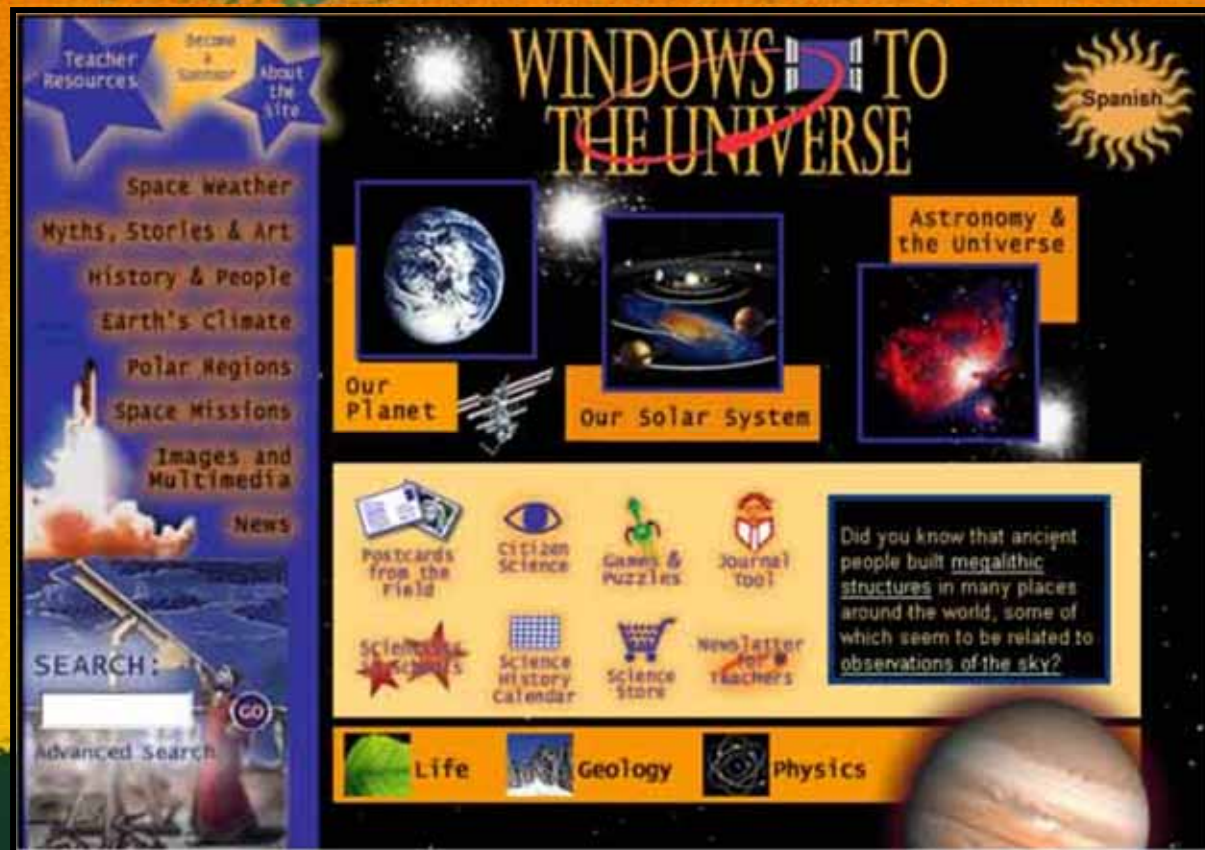
Great Barrier Reef
Courtesy of NASA



Questions about ocean acidification?



Climate and Global Change on Windows to the Universe



<http://www.windows2universe.org>



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<http://ecourses.ncar.ucar.edu>

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Web Seminar: Predicting Future Climate and Considering Solutions
Time: 5:30PM Wednesday, April 28th
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