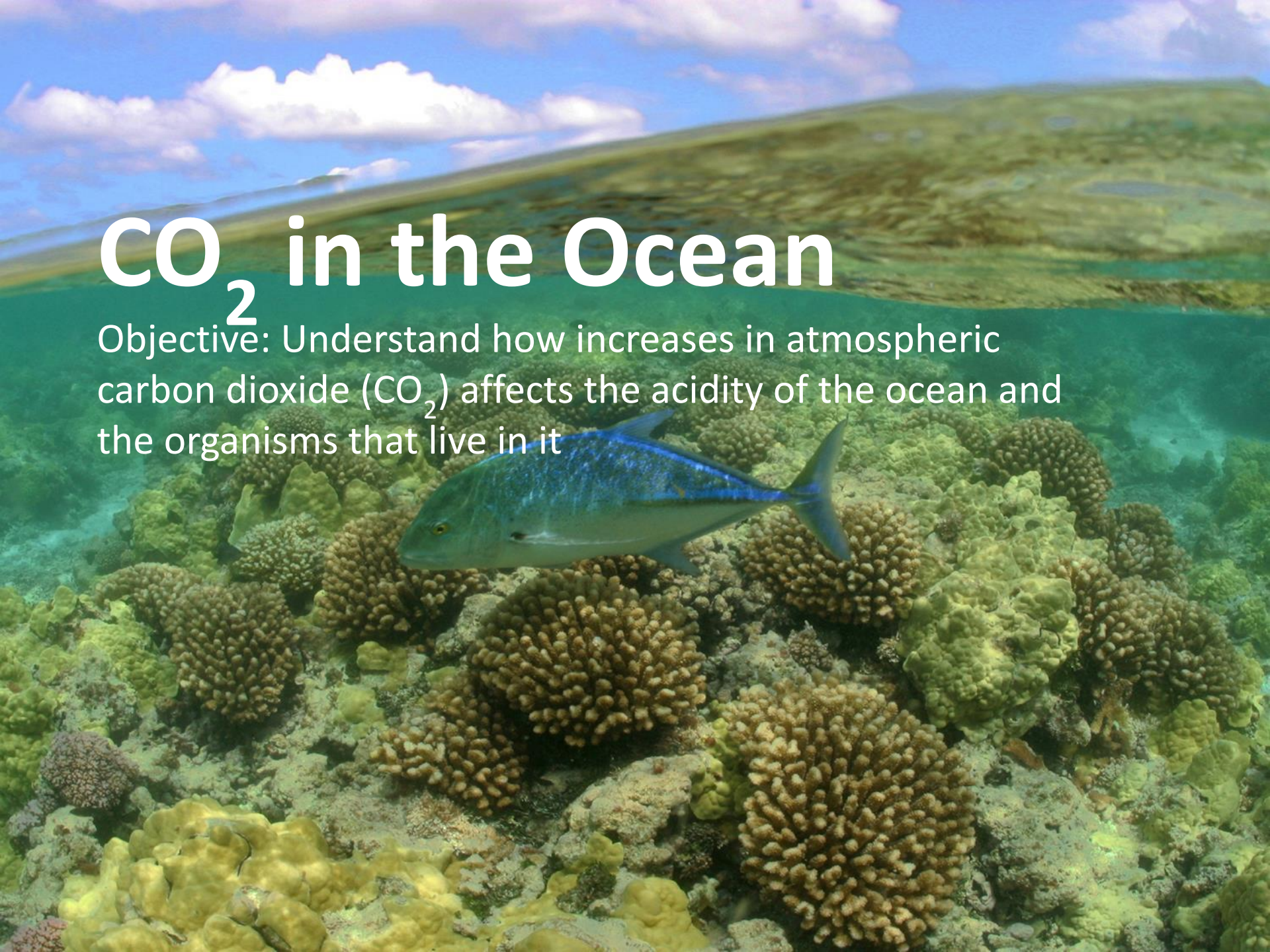


# CO<sub>2</sub> in the Ocean

Objective: Understand how increases in atmospheric carbon dioxide (CO<sub>2</sub>) affects the acidity of the ocean and the organisms that live in it

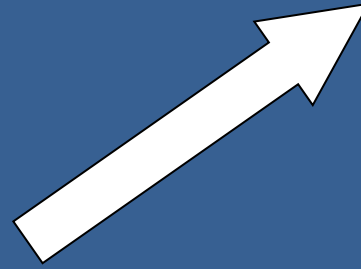




# Carbon Dioxide Sinks



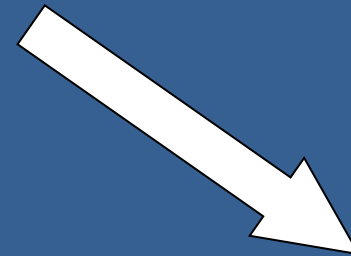
$8.8 \pm 0.5 \text{ Pg C yr}^{-1}$



~29%

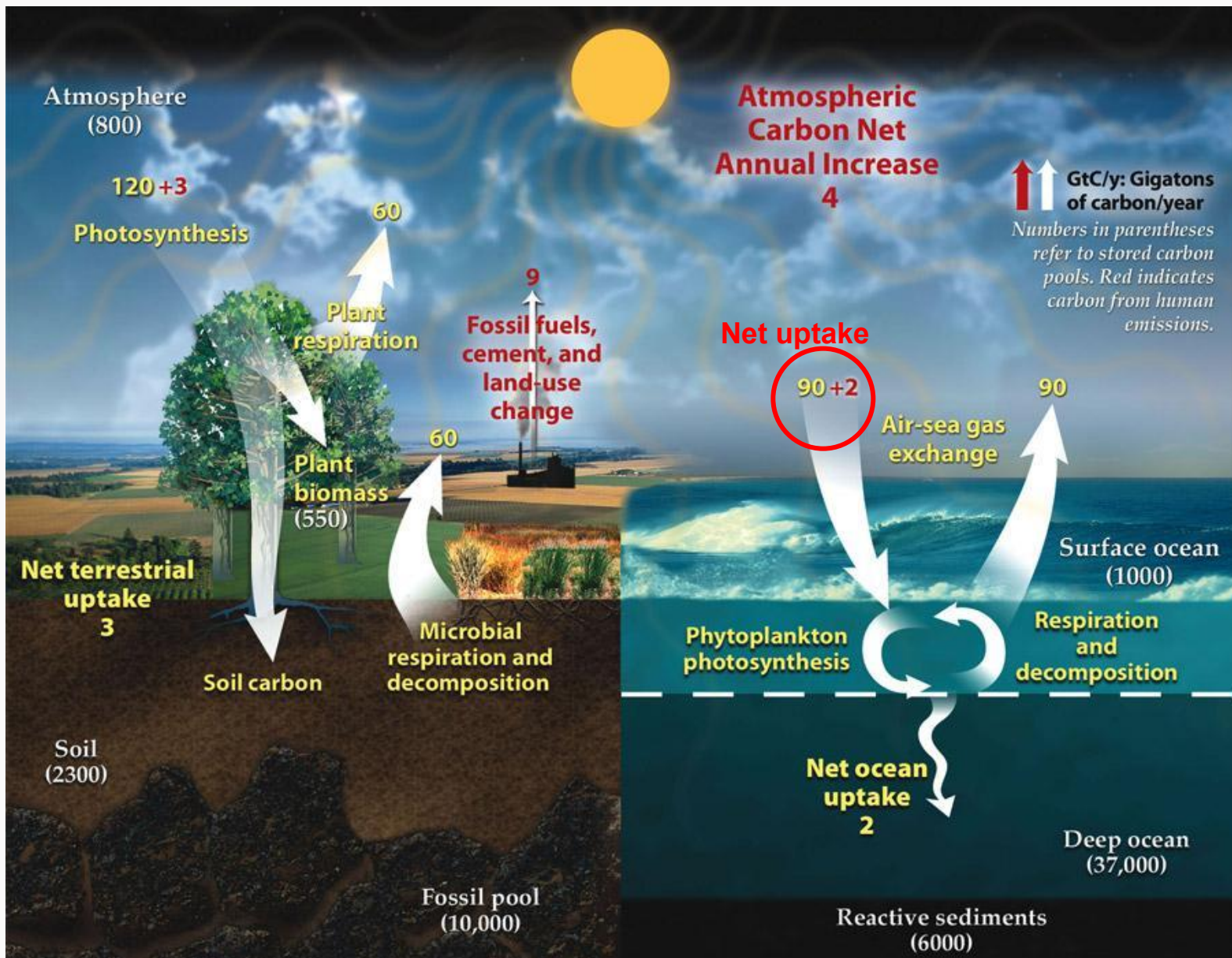


~43%



~28%

# Carbon Cycle

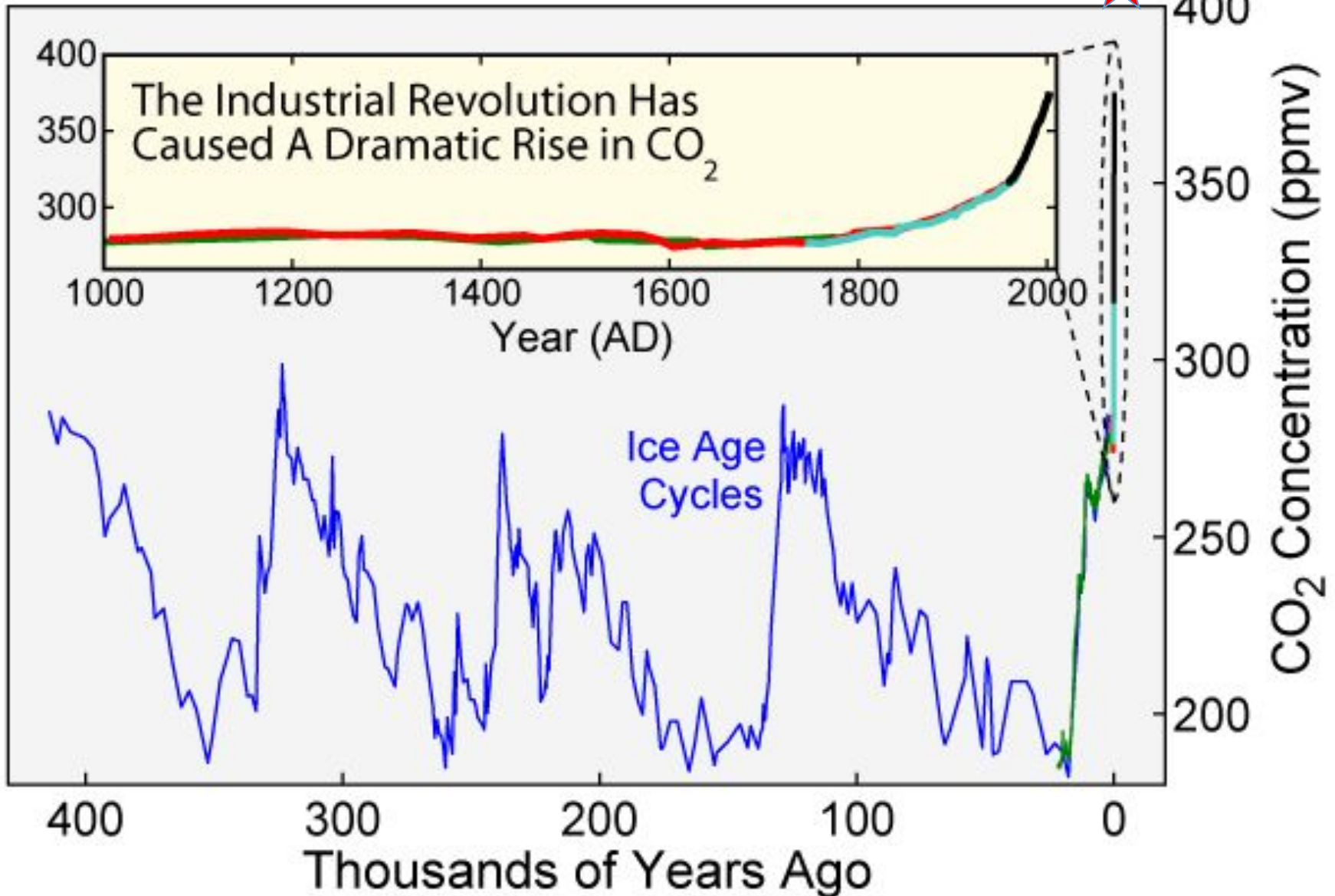




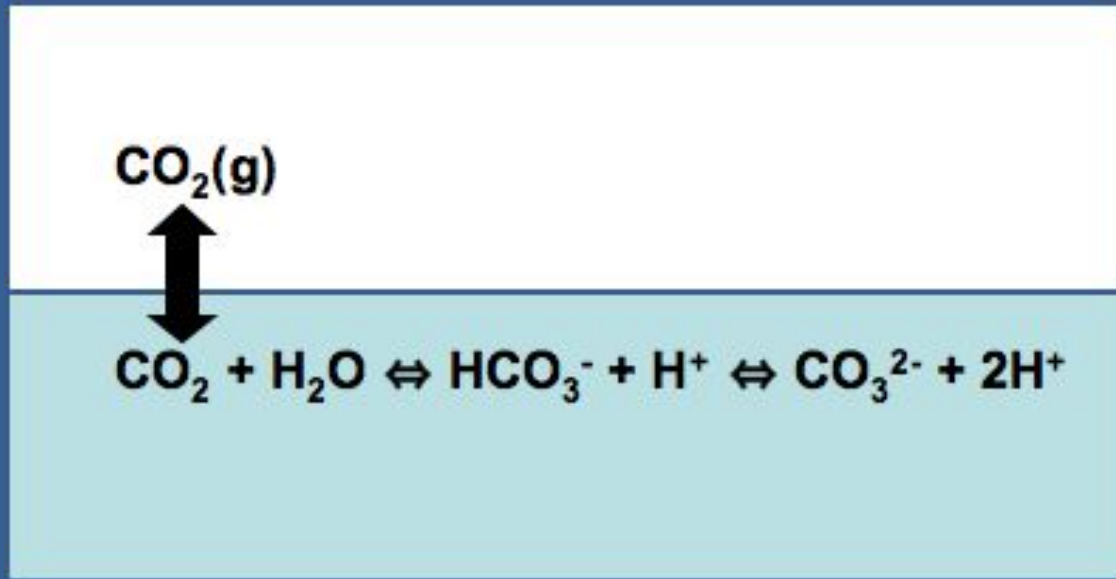
407ppmv – Mar. 2017

405ppmv – Mar. 2016

# Carbon Dioxide Variations

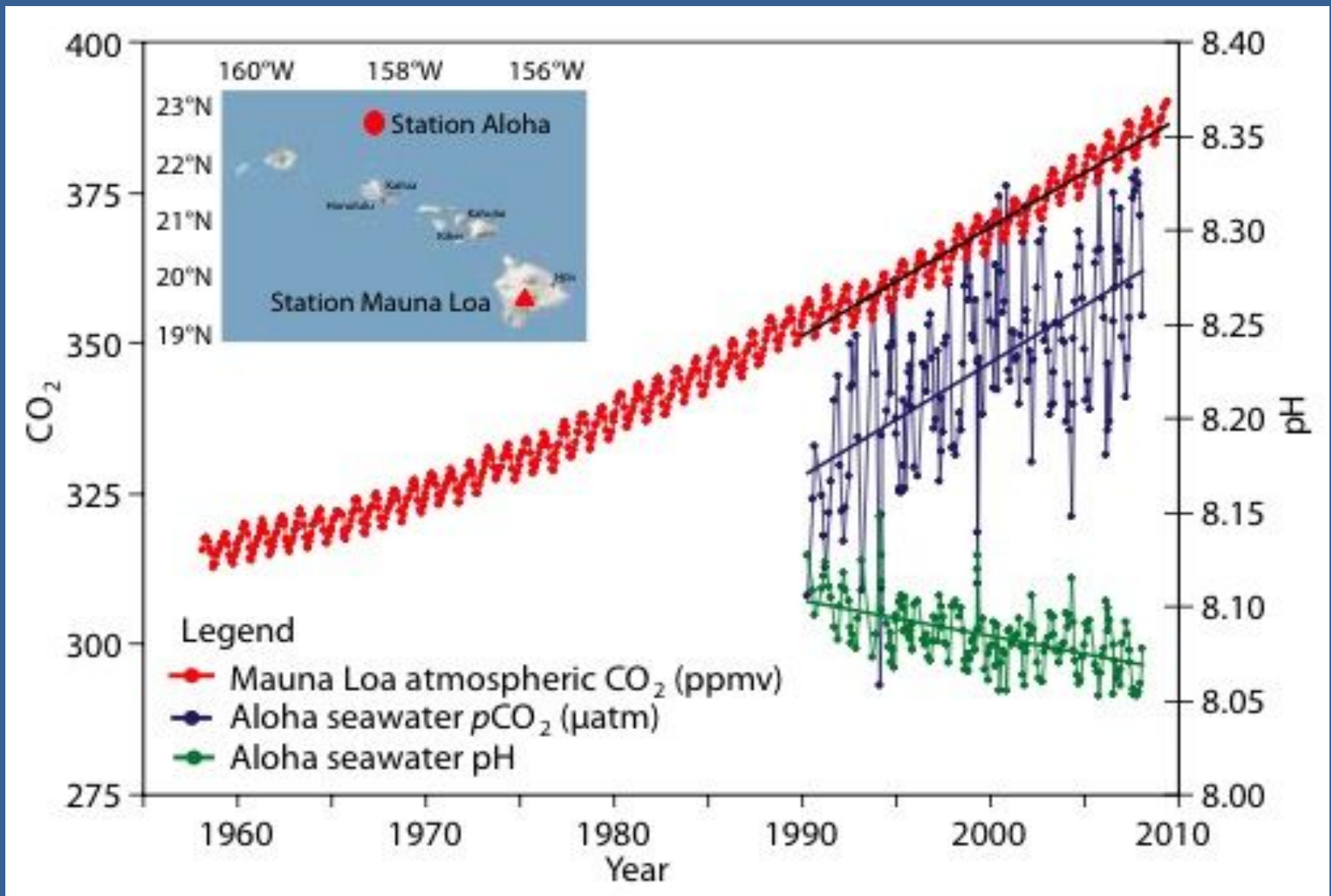


# Carbon Chemistry Overview



- $\text{pH} = -\log [\text{H}^+]$
- For every mole of  $\text{CO}_2$  taken up by the ocean, 2 moles of  $\text{H}^+$  are created
- Acid!!!

# Ocean Acidification

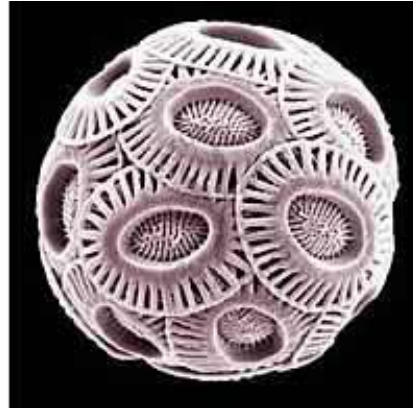


<https://www.youtube.com/watch?v=x1SgmFa0r04>



# CaCO<sub>3</sub> in the Ocean

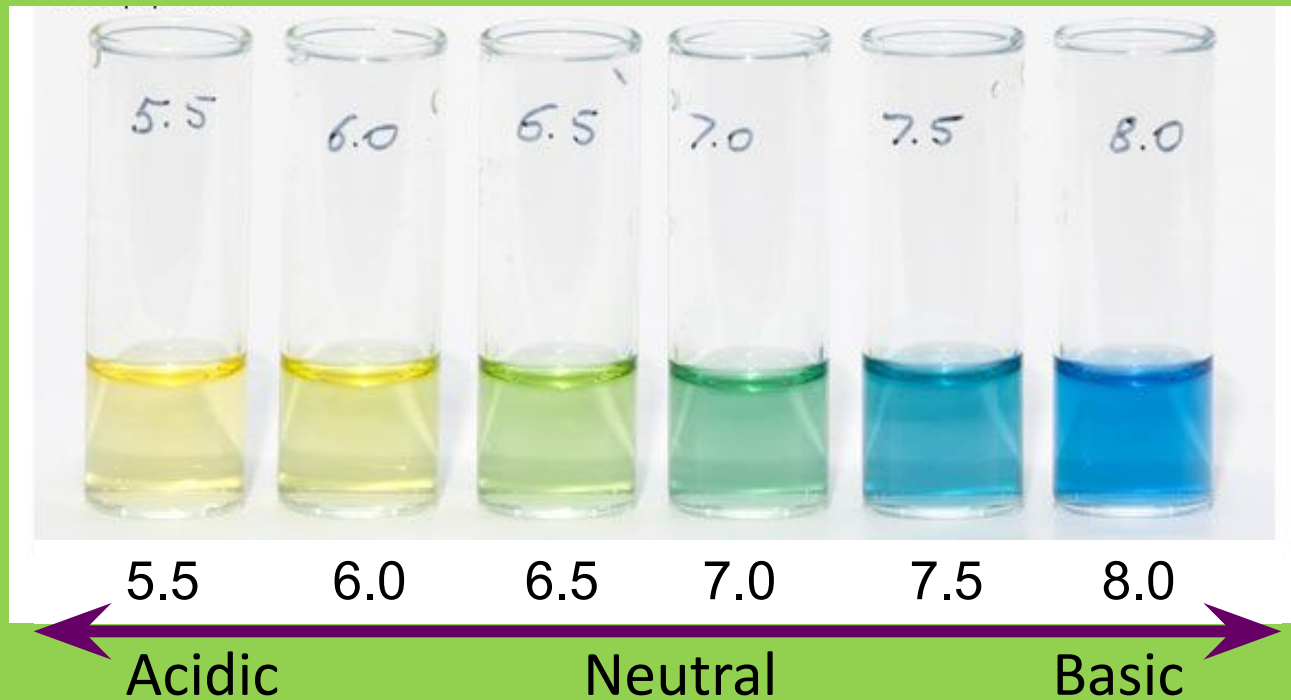
<https://www.youtube.com/watch?v=LF6rI-fZdas&feature=youtu.be>





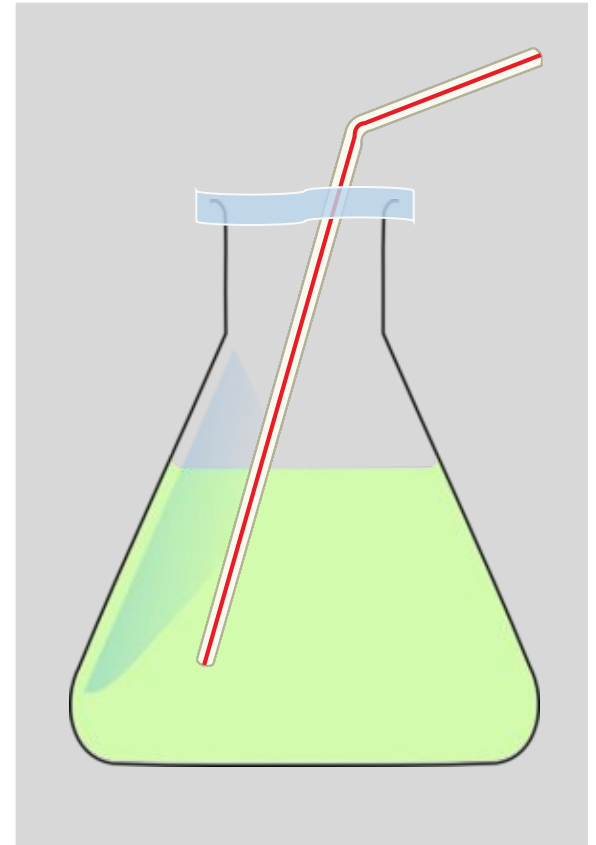
# Exercise 1: Determining a causal relationship between CO<sub>2</sub> and pH: Does a change in CO<sub>2</sub> cause a change in pH?

- We will be using a pH indicator known as **Bromothymol Blue**



# Exercise 1: Determining a causal relationship between CO<sub>2</sub> and pH: Does a change in CO<sub>2</sub> cause a change in pH?

- YOU will be adding CO<sub>2</sub> to water to see the pH change (you respire CO<sub>2</sub>!)
- Carefully add 50 mL of BTB into plastic Erlenmeyer flask, note color on form
- Stretch parafilm around flask/straw
- Exhale your CO<sub>2</sub> through straw into flask
- When color has changed, stop exhaling, and note color change on form

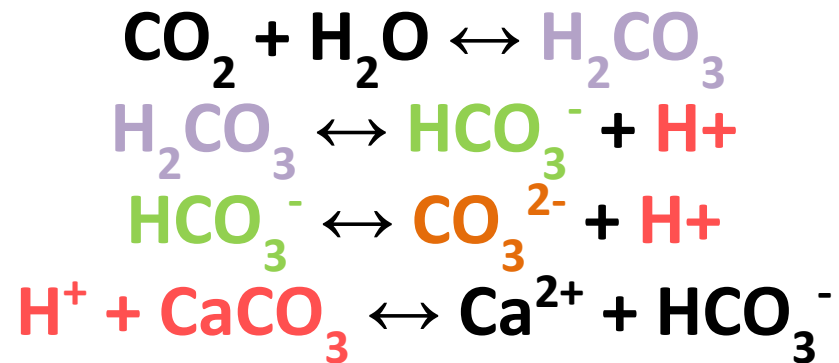




## Exercise 2: Seawater Buffer Capacity

= why the ocean is slightly basic

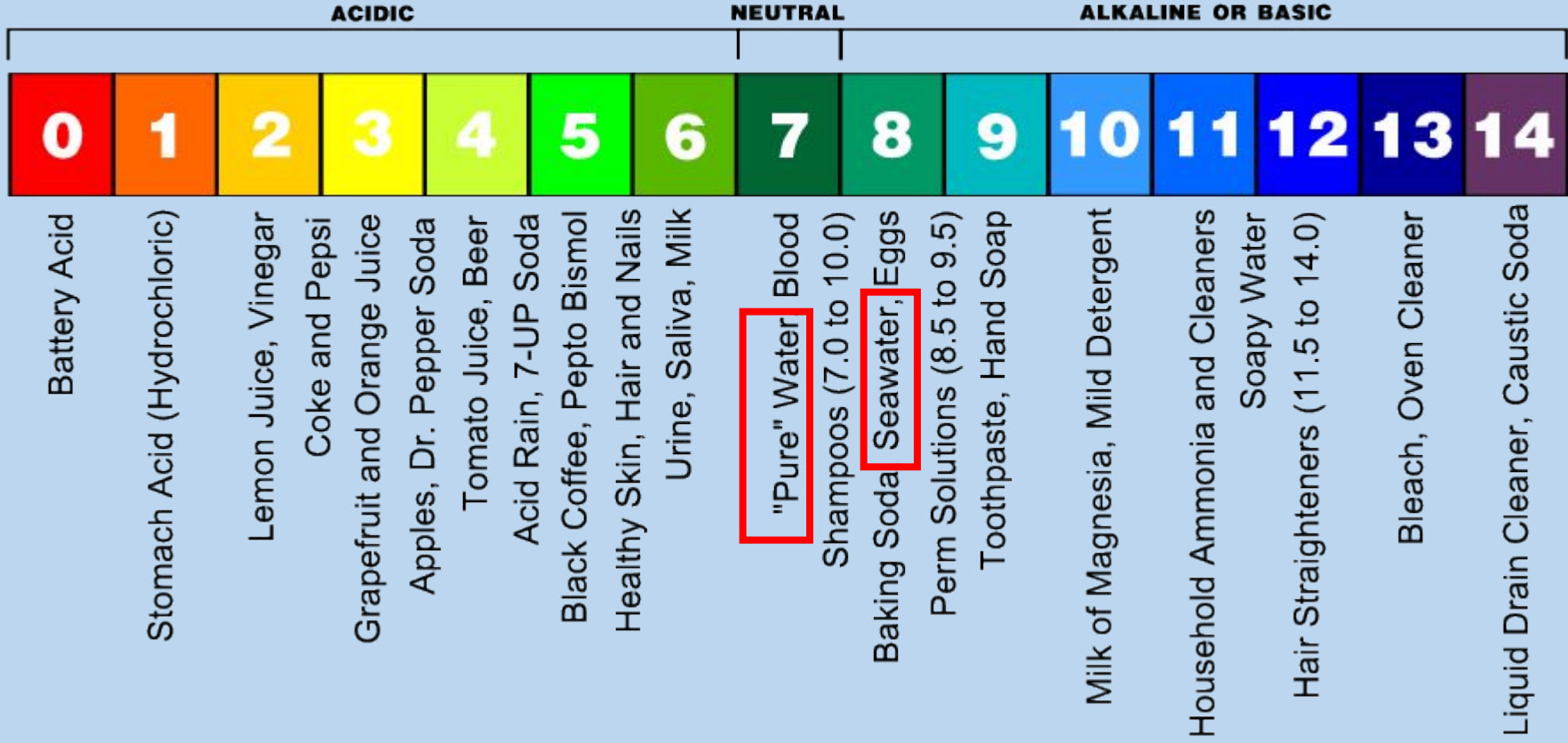
- Buffers resist change in pH when an acid is added.
- In the ocean, the following reactions occur:



- Compounds with negative charges can absorb  $\text{H}^+$



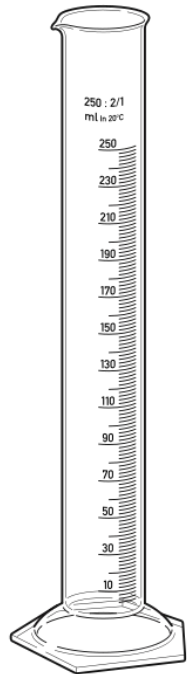
# pH of Common Substances



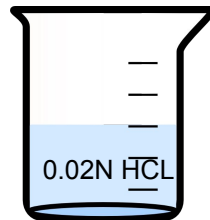
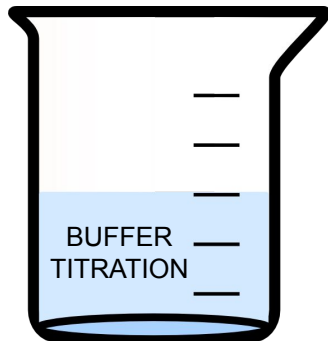


# Exercise 2: Assessing the Buffer Capacity of Seawater

2) Pour water into  
"Buffer Titration"  
beaker



1) Get 100 mL  
Deionized water



3) Get 20mL in  
"0.02N HCl"  
beaker



4) Measure  
starting pH  
with probe



5) Add 1mL  
HCl at a time,  
stir, measure  
pH with  
probe

# Exercise 2: Assessing the Buffer Capacity of Seawater

- You MUST wear gloves, goggles, and apron while completing Exercise 2 and 3

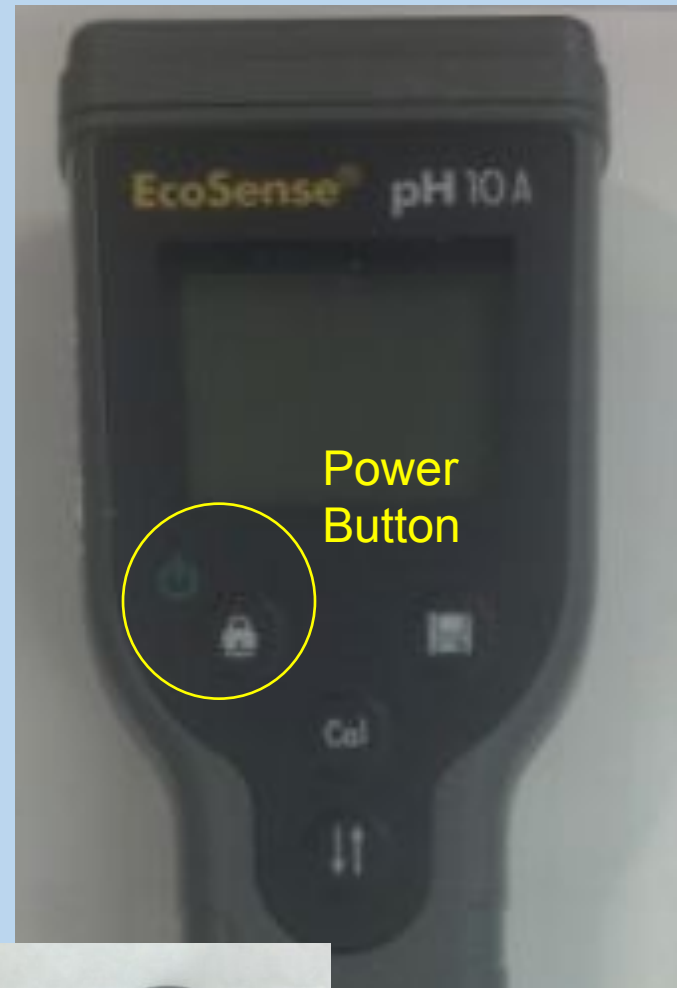


- For Table 1, use DEIONIZED water, stop at pH = 3, discard water in sink
- For Table 2, get 100 mL SEAWATER, complete entire table – DO NOT DISCARD
- For Table 3, add 0.25 grams  $\text{CaCO}_3$  to seawater mixture, stir vigorously for a few minutes before adding HCl, only add 5mL HCl – discard in sink when finished



# How to use the pH meters:

- Take off the cap that covers the probe.
  - Make sure the sponge stays in the cap when you take it off.
- Turn on pH meter
  - **ONLY USE THIS BUTTON!!!**
- Put probe in your solution, wait a few seconds, and the meter will tell you the pH.
- **Rinse the probe** between measurements and when you are finished.
- **Put cap back on when done.**



Cap

Probe

Sponge

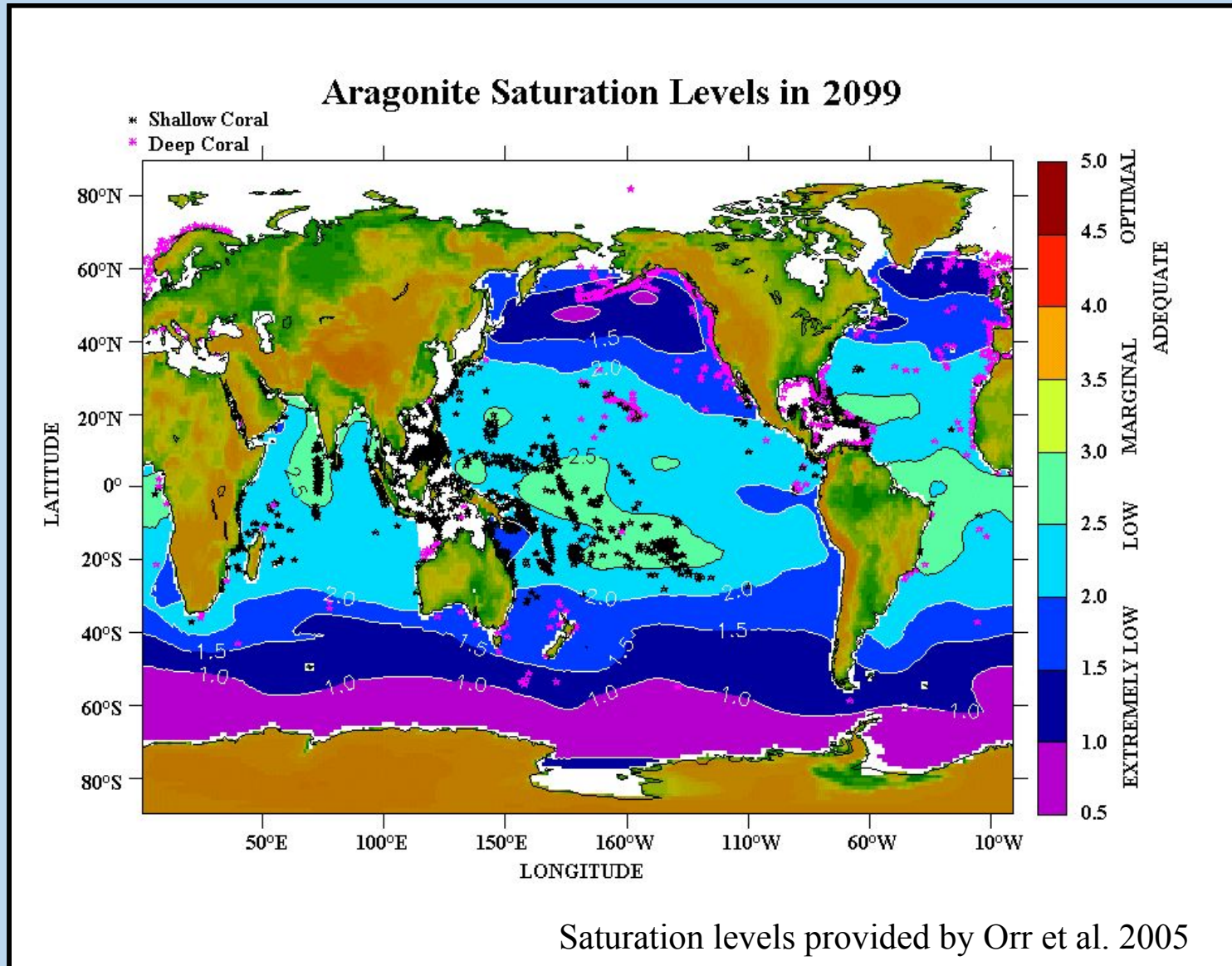
# Exercise 3: Effects of Acid on Biology in Ocean

- Remember:  $\text{Ca}^{2+} + \text{CO}_3^{2-} \rightleftharpoons \text{CaCO}_3$
- BUT, ocean acidification decreases the availability of  $\text{CO}_3^{2-}$
- If  $\text{CO}_2$  in the ocean increases, organisms with  $\text{CaCO}_3$  shells:
  - Will suffer because more  $\text{CO}_2$  in seawater causes ocean pH to decrease, which dissolves shells
  - And because more  $\text{CO}_2$  in seawater causes ocean pH to decrease, which makes new shell formation difficult by juvenile organisms

<https://www.youtube.com/watch?v=6SMWGV-DBnk>

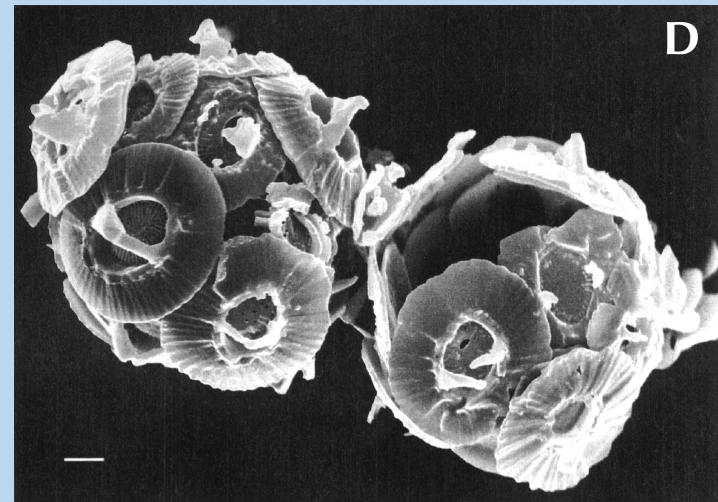
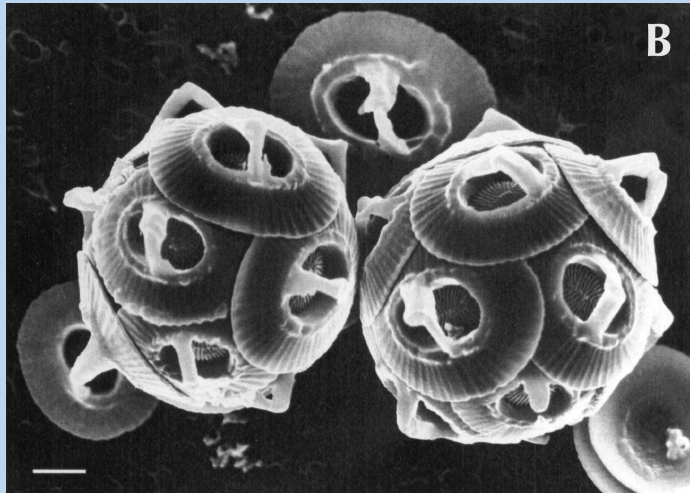


Warm water corals have primarily formed in aragonite saturation levels  $> 4$  (higher pH) and generally **stop growing  $< 3$**  (lower pH)

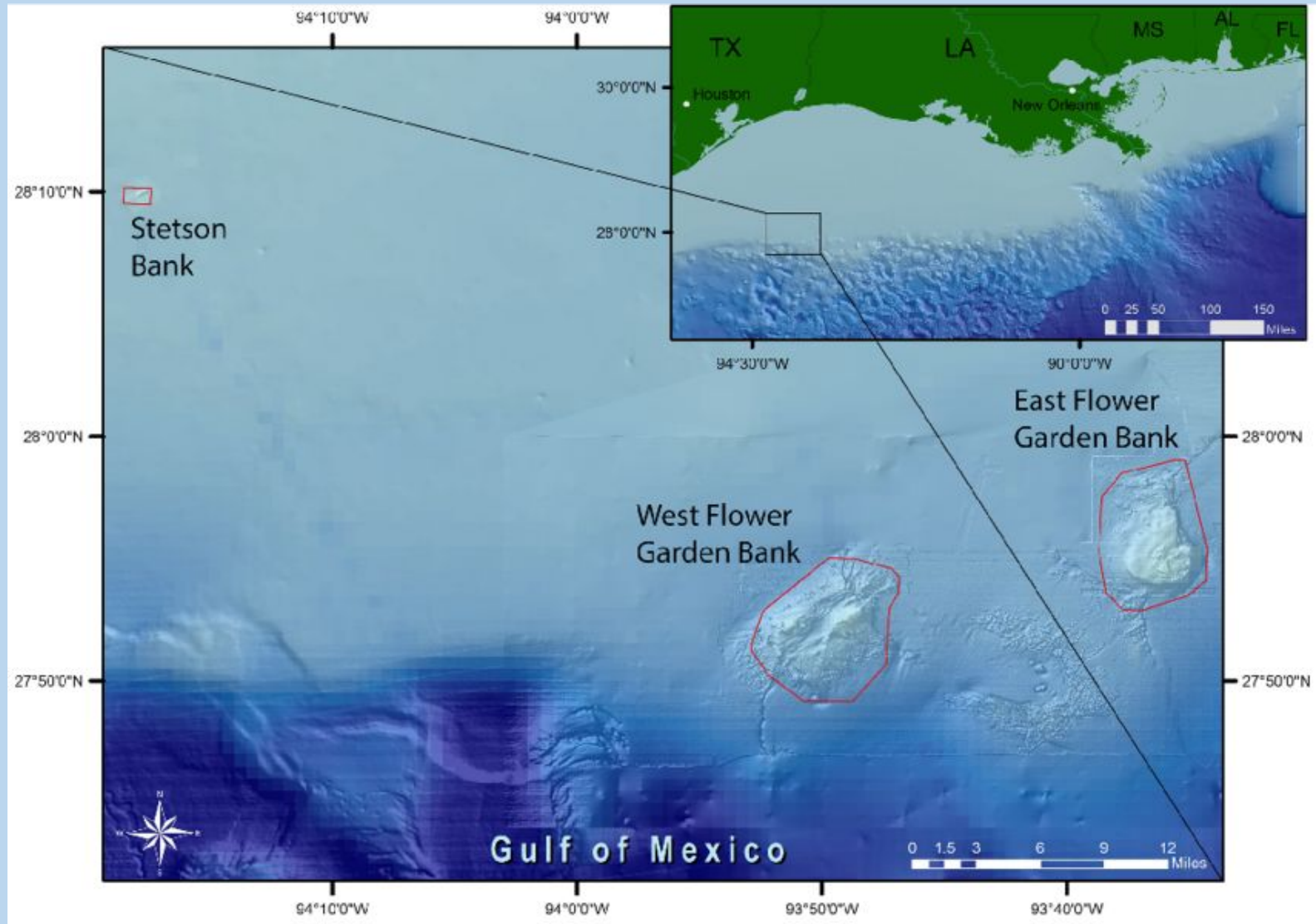


# Exercise 3: Effects of Acid on Biology in Ocean

- You are comparing a BEFORE and AFTER, so be sure to examine the coral sample before adding the acid and record your observations.
- Sandpaper is available so you can make a small 'fresh' surface to test.



# Exercise 4: Explore The Flower Garden Banks



Visit <https://sanctuaries.noaa.gov/vr/flower-garden-banks/> for a virtual tour and to answer questions



## Clean Up

- All solutions can go down sink, flush with water
- Please discard your used straws.
- Make sure your area is cleaned up nicely.

# Reminders

- BE CAREFUL WITH ACIDS
- Wear gloves, goggles, and aprons
- Next week is the last lab: Ocean Pollution
- Complete Ocean Acidification forms and do post-lab on eCampus
- Check grades on eCampus for errors!