These presentation files have been put together to complement the ocean acidification resource:

The Ocean of Tomorrow

prepared by the NZ Marine Studies Centre.

Unless otherwise stated, graphs are taken from the Intergovernmental Panel on Climate Change (IPCC) reports, 2008 – 2014.

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Part 1

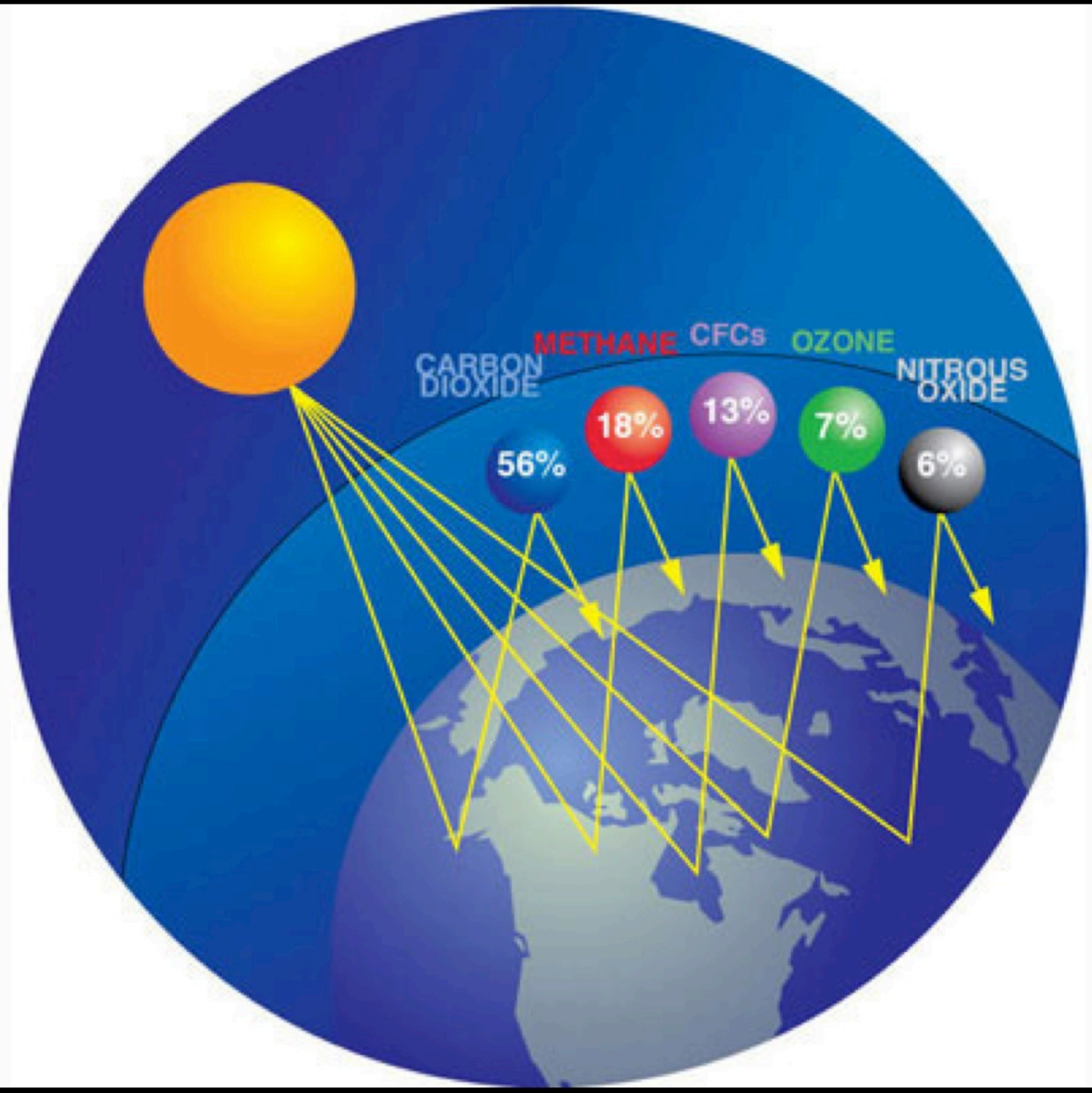
Introduction and background:
CO_2, climate change
and link to OA and pH.

To follow activity 1A. To lead into activity 1B and 3A.

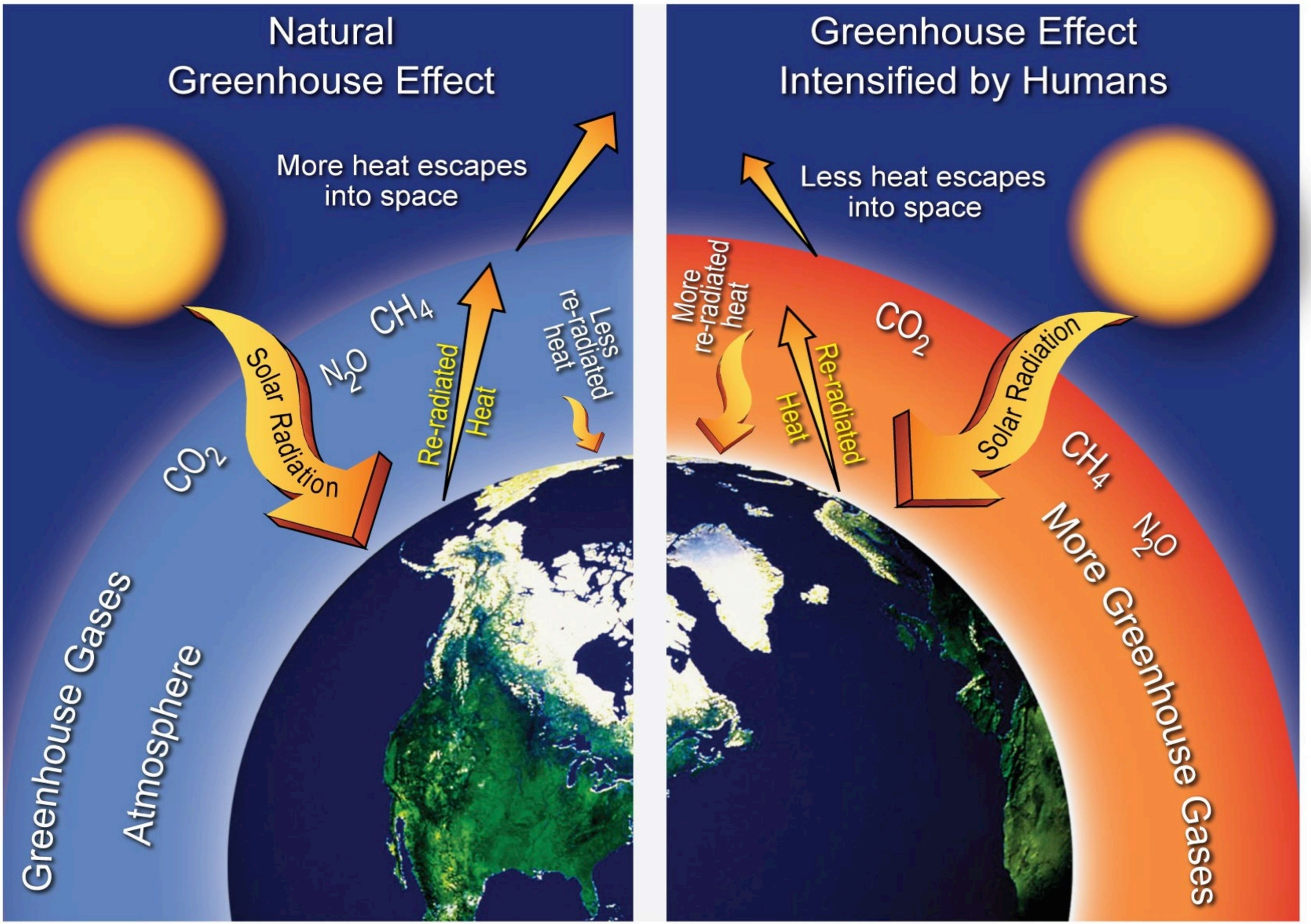
A complicated subject

- Air
- Water
- Skeletons
- Ecosystems
- Planet

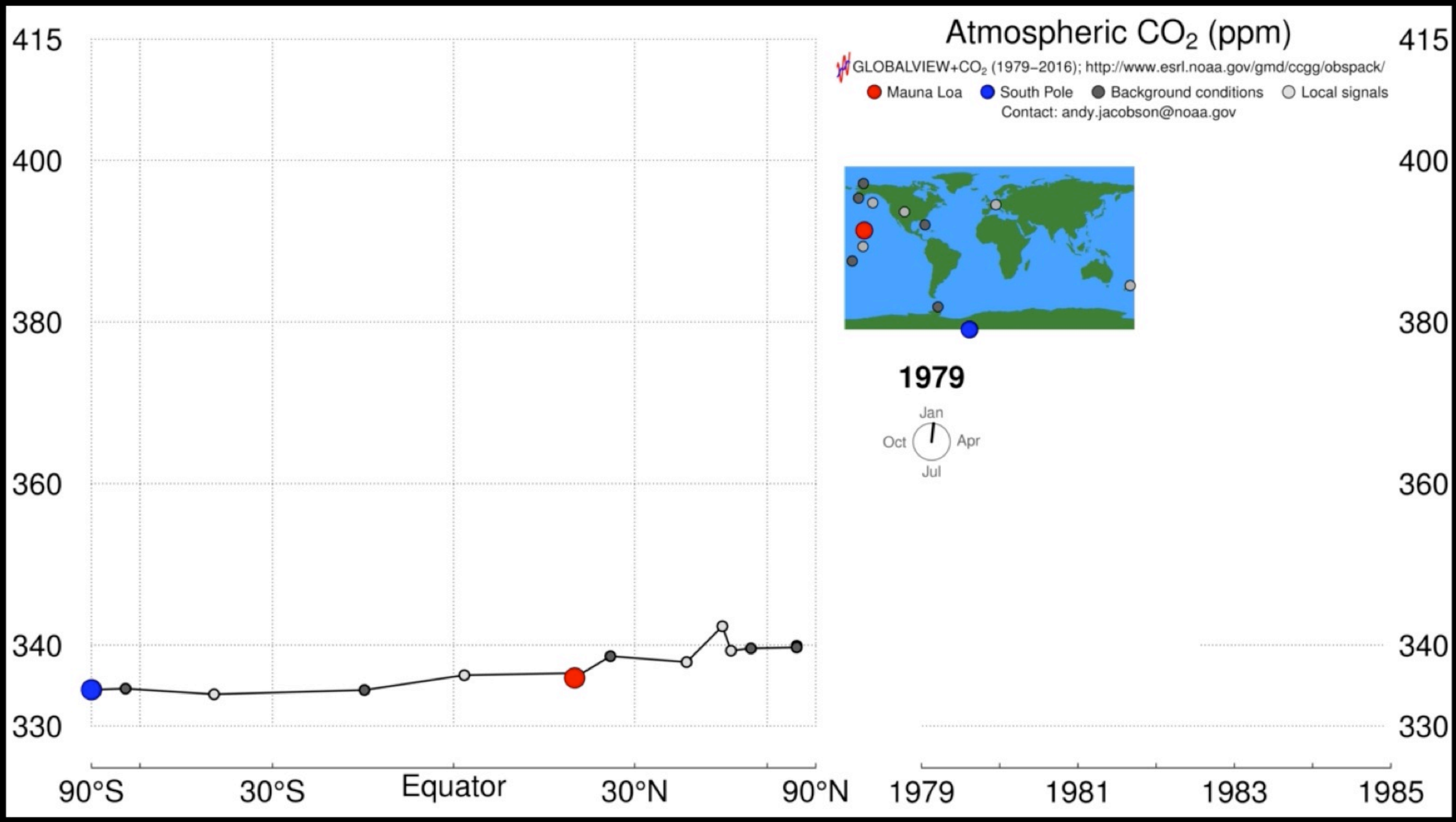
Greenhouse gases



Human Influence on the Greenhouse Effect



Higher than it's been for a long time

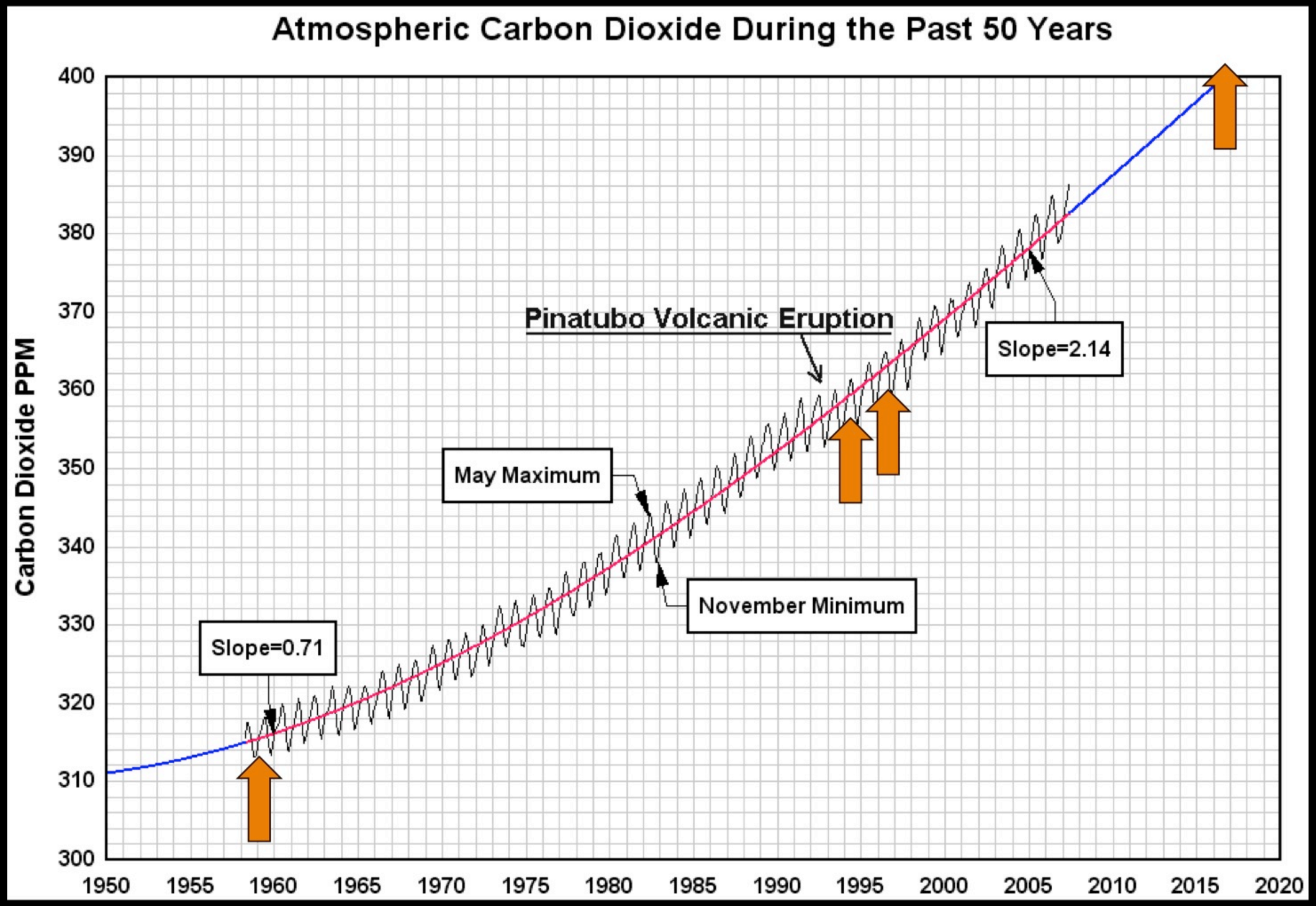


For the animated history of atmospheric carbon dioxide from 800,000 years ago until January 2016 see: https://www.esrl.noaa.gov/gmd/ccgg/trends/history.html

Up in the air

- Pre-industrial levels of atmospheric CO_2 were about 280 ppm
- They have climbed to over 400 ppm today
- Could reach 1000 ppm by 2100
- We know a lot about this because CO_2 is an important greenhouse gas

Atmospheric CO_2 is increasing

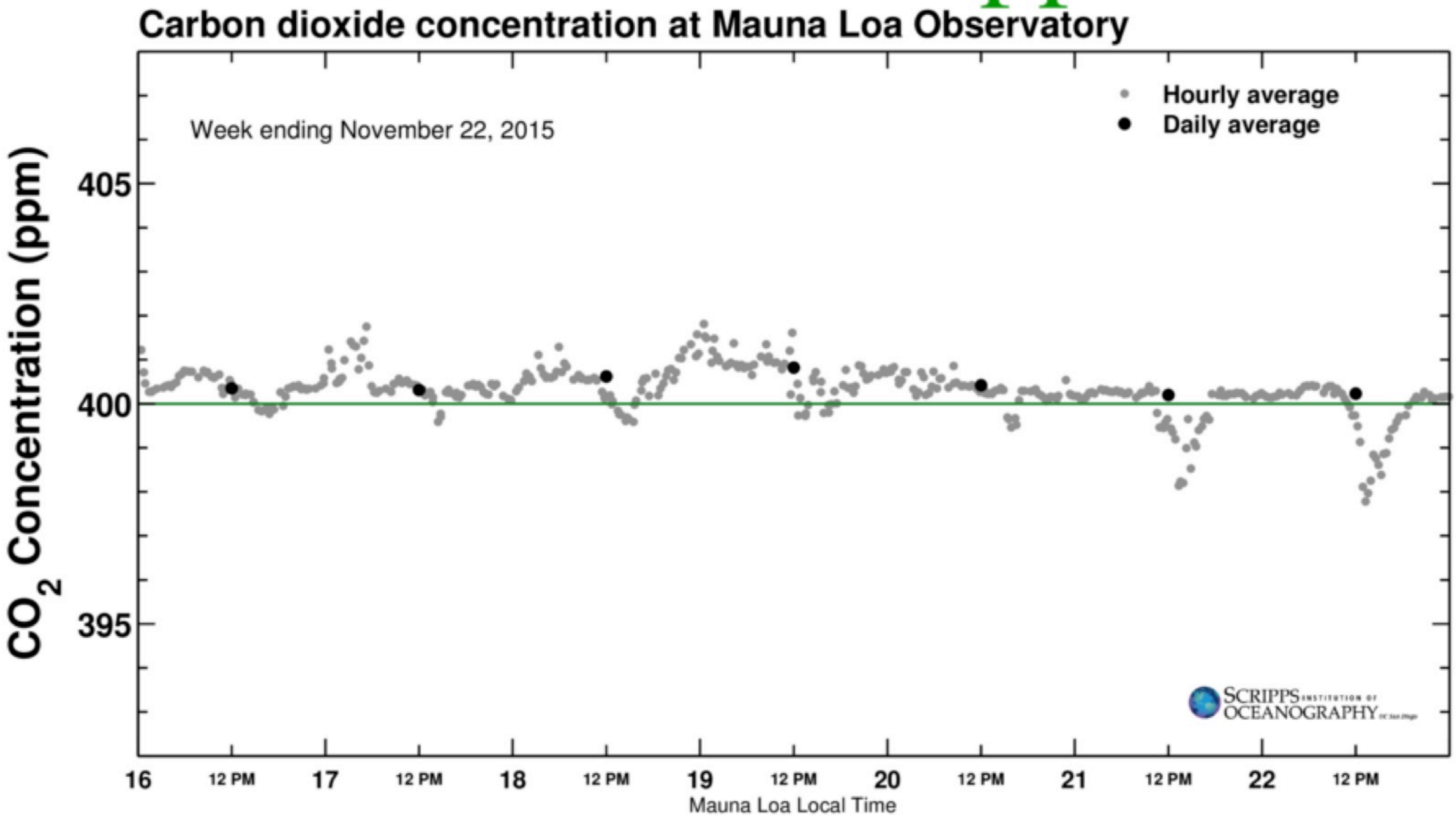


At Mauna Loa, Hawaii (www.planetforlife.com)

CO_2 in atmosphere now

Latest CO_2 reading
November 22, 2015

400.23 ppm



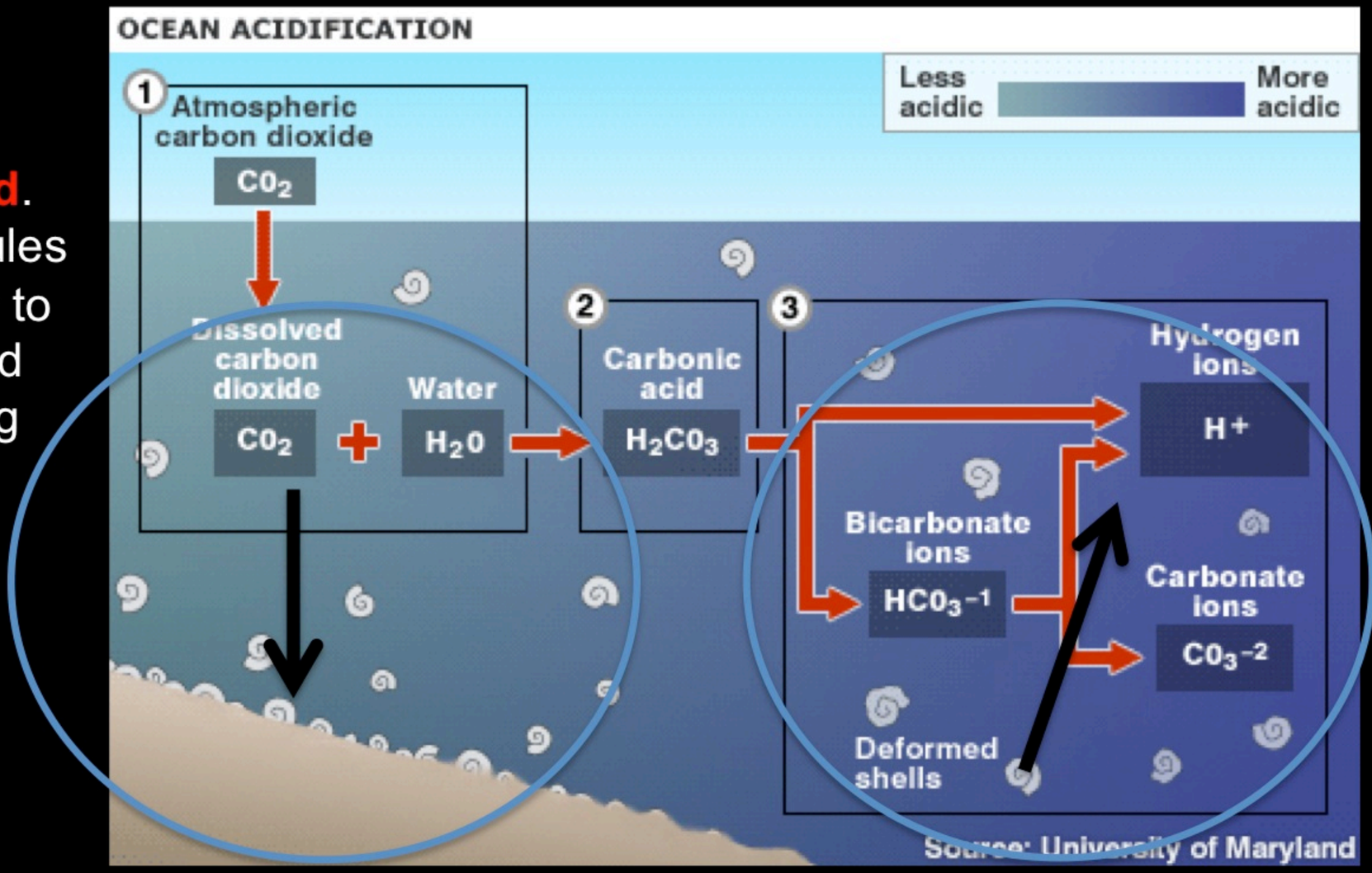
Jump into the water

- Oceans absorb CO_2 from atmosphere — about 1/3 of what we produce
- CO_2 (gas) + H_2O <--> HCO_3^- + H^+ (bicarbonate)
- HCO_3^- <--> $CO_3^=$ + H^+
- More atmospheric CO_2 means more H^+ ions in sea water.

Human emissions of CO_2 are causing our oceans to become more acidic!

A pH unit is a measure of acidity ranging from 0-14. The lower the value, the more acidic the environment.

Some CO_2 reacts with the water to form **carbonic acid**. Some carbonic acid molecules react with a water molecule to give a **bicarbonate ion** and a **hydrogen ion**, increasing the ocean's "***ACIDITY***"



$$pH = -\log [H_3O^+]$$

pH is a log scale

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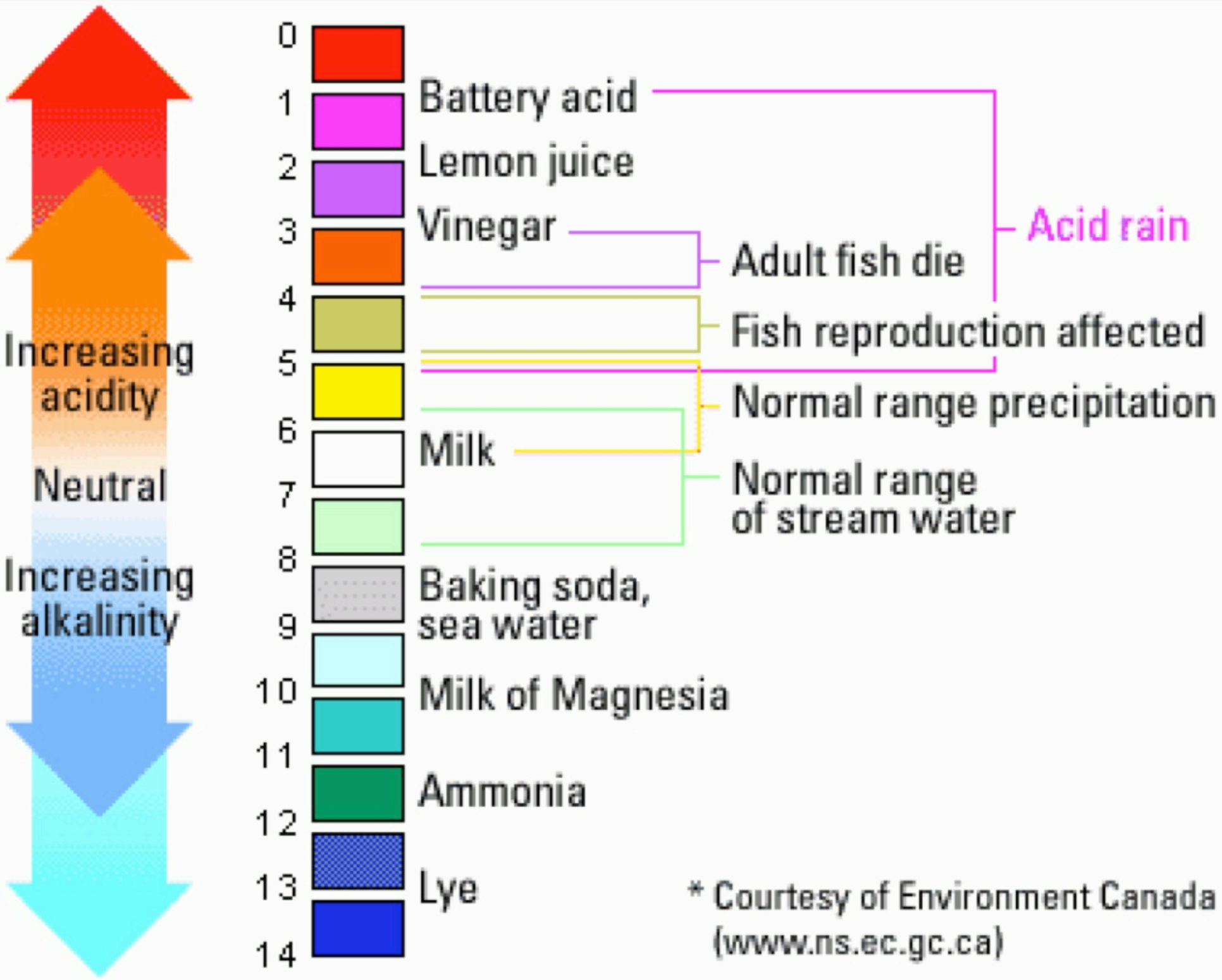
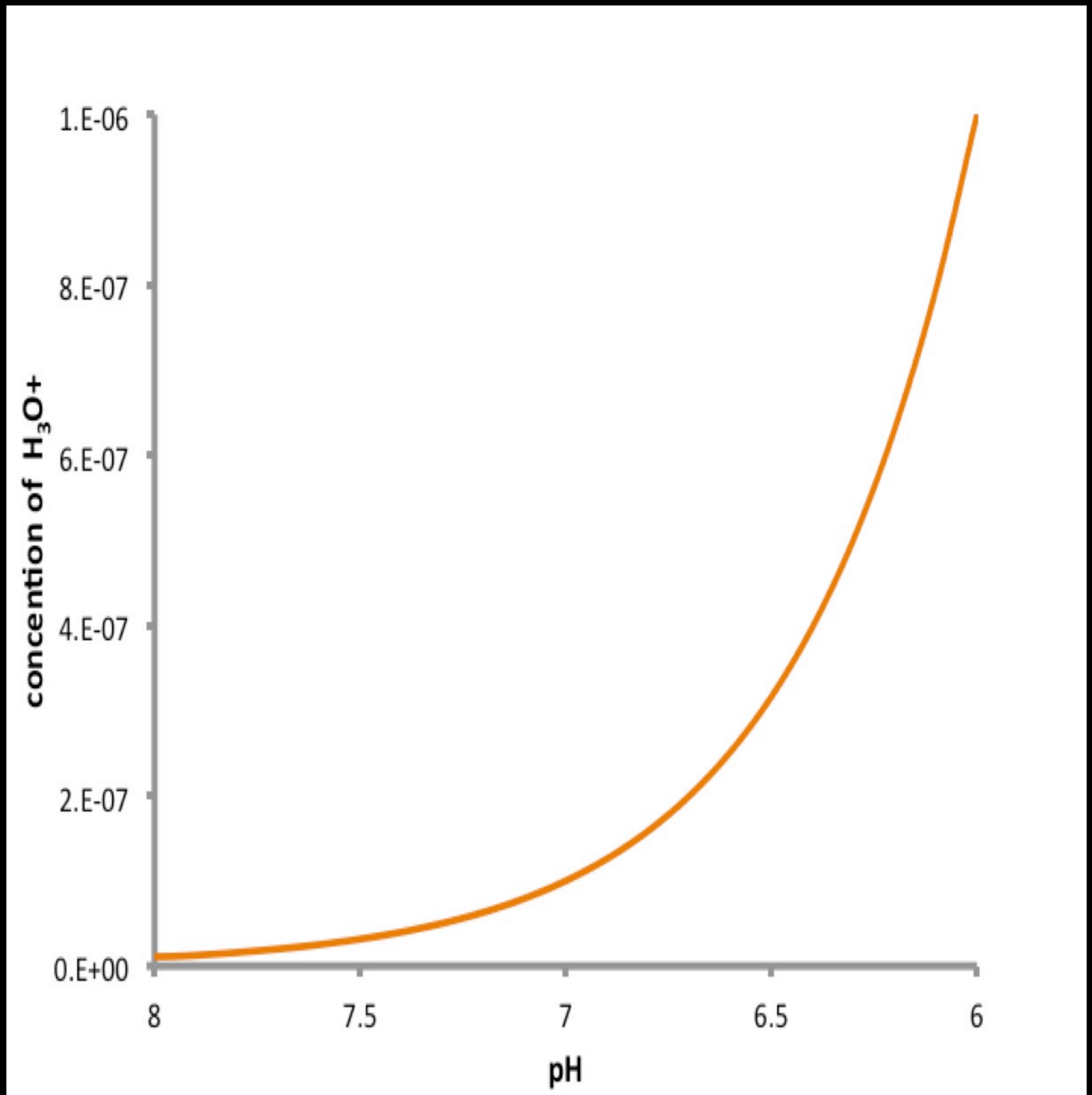
All about pH

- Name comes from "potential hydrogen"
- Negative logarithm of concentration of hydrogen ions (H+) in a solution
  - Higher pH means fewer H+ ions
  - A change of 1 pH unit is 10x the amount
- Water at 25° C is neutral: pH = 7.0 units
- Less than 7 is acid, greater is alkaline
- Arbitrary scale goes from 0 to 14

The pH Scale



* Courtesy of Environment Canada (www.ns.ec.gc.ca)



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$pH = -\log [H_3O^+]$

pH difference 1 means concentration of H_3O^+ ions differs by factor of 10.

A change of ocean pH from 8.1 to 7.6 is a 120% change in concentration of H_3O^+.

The current value of 8.14 is itself about 0.1 less than the preindustrial value (about 30% change) so by 2100 the H_3O^+ concentration will have changed by about 150% since the start of the industrial revolution.

Activity 1B and 3A: Exploring Ph

- What is pH?
- How do we measure pH?
- What is the pH of different solutions?
- How does carbon dioxide change the pH of seawater?