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 5

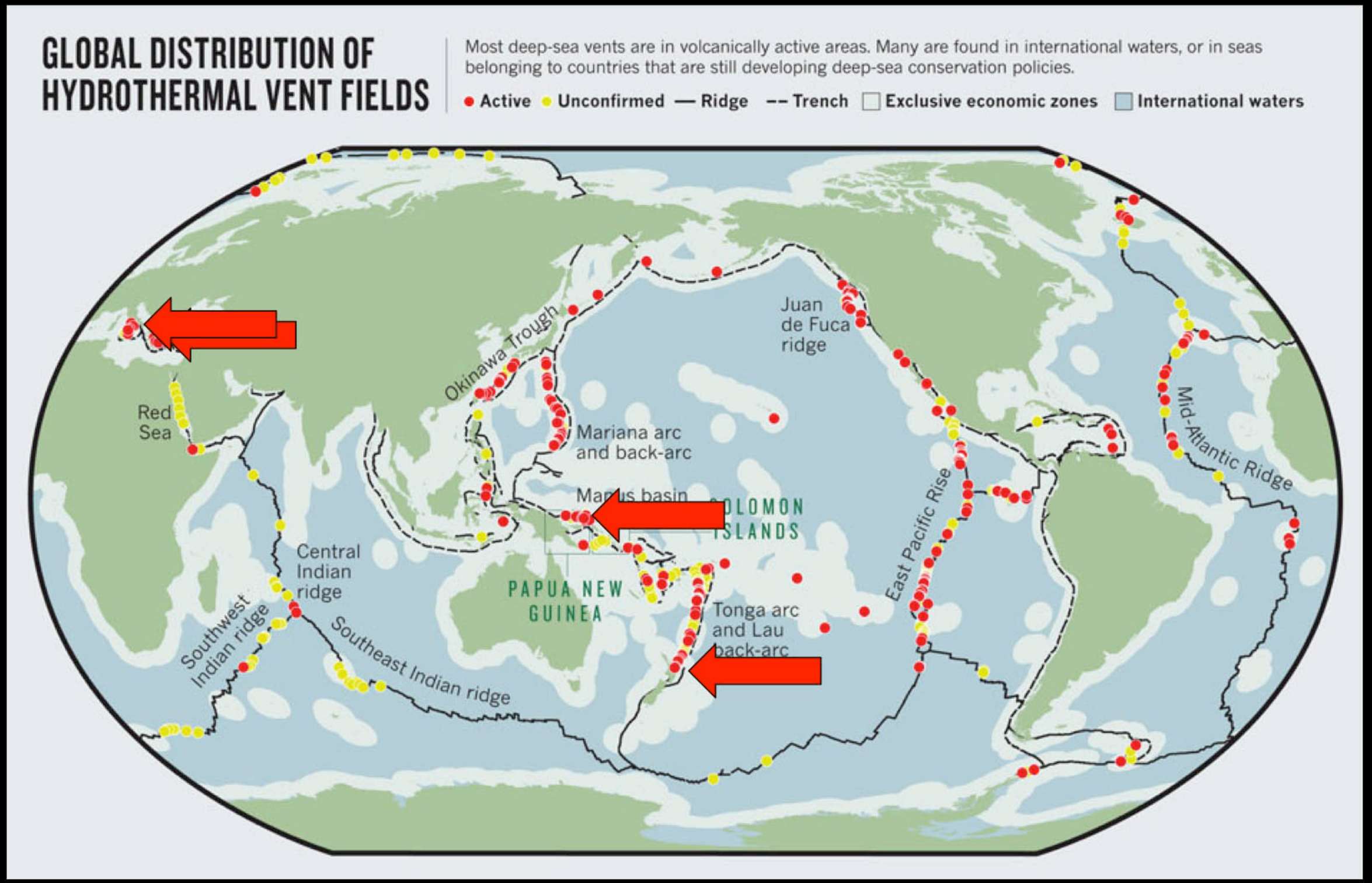
So what?

Leading into Activity 5A and 5B.

How will ecosystems react?

- We can't replicate a whole ecosystem in the lab
- We need someplace where the sea is warmed and acidified by CO_2
- Someplace like… a volcano!

Volcanic vents have been studied in some places



Whakaari White Island: Does it tick the boxes?

- Preliminary studies suggest it might:
  - Have CO_2 vents, about the right levels of temperature and pH
  - Be accessible and diveable
  - Provide non-vent areas nearby for comparison

That's why scientists are studying at White Island

- CO_2 => Warming and Ocean Acidification
- Seawater will be different some day
- Affects marine critters and communities
- You cannot study whole ecosystems in the lab
- Scientists have been collecting data from Whakaari White Island in order to see if it can be a living lab, providing "seawater of the future"

Some final words about Climate Change,
Global Warming and Ocean Acidification

The Southern Ocean dominates exchange between the deep ocean and atmosphere because ~ 80 % of deep water resurfaces in the Southern Ocean (Lumpkin and Speer, 2007), as westerly cir-cumpolar winds and surface flow draw up deep water (Talley, 2013).

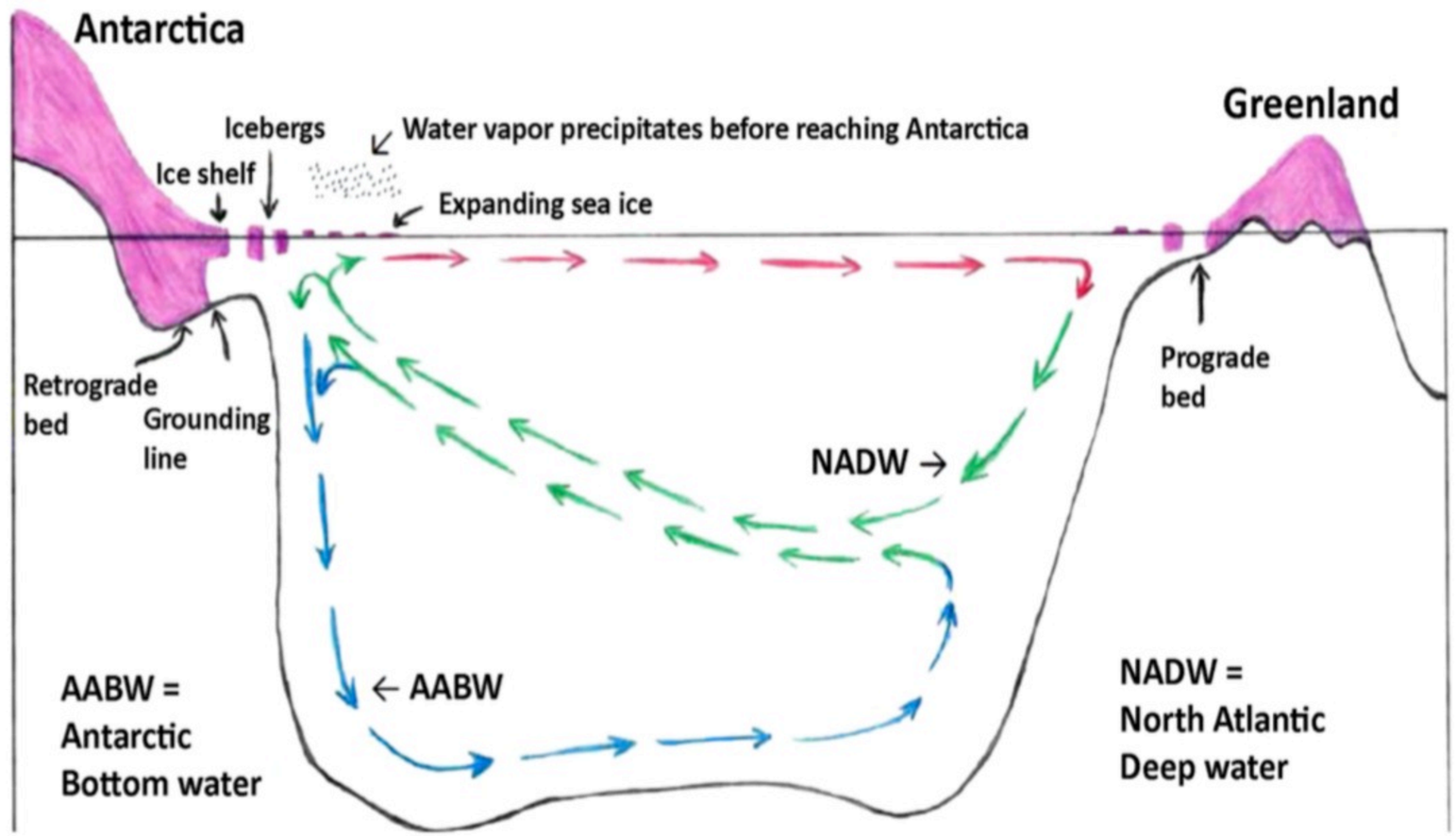
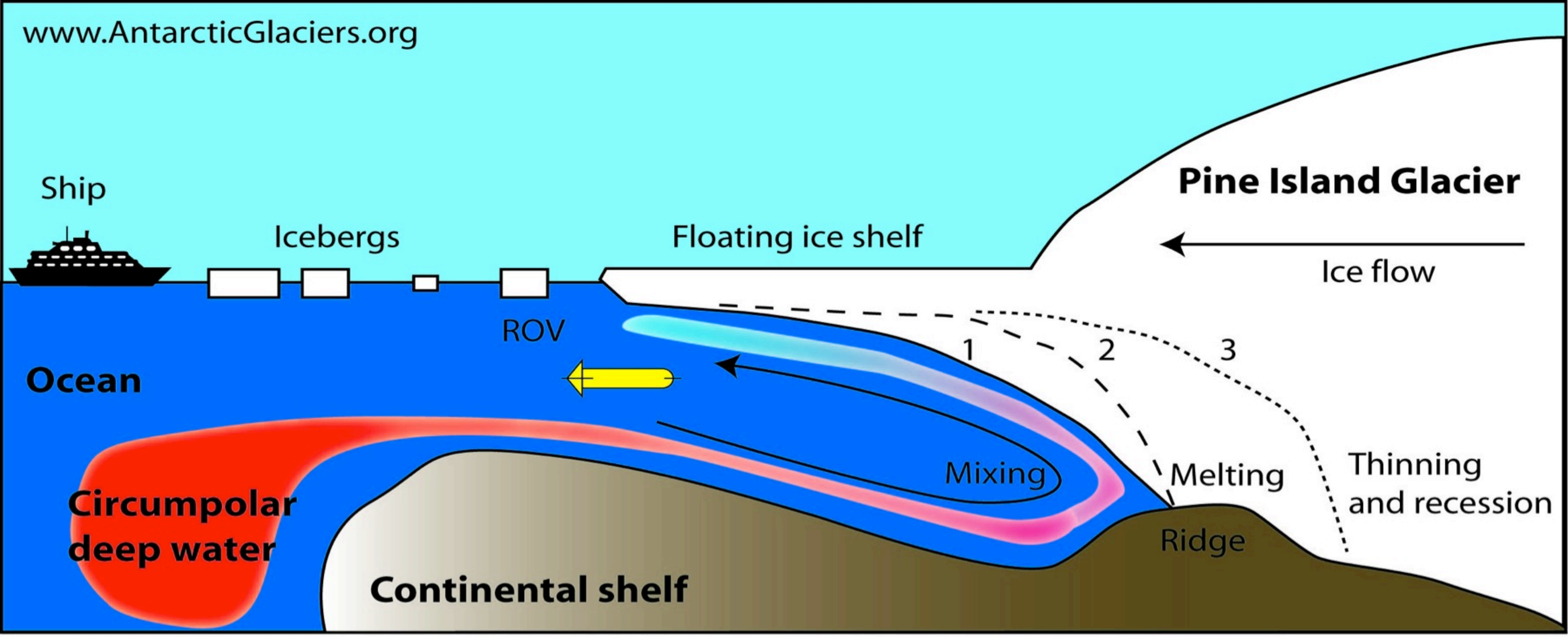


Figure 18. Schematic of stratification and precipitation amplifying feedbacks. Stratification: increased freshwater flux reduces surface water density, thus reducing AABW formation, trapping NADW heat, and increasing ice shelf melt. Precipitation: increased freshwater flux cools ocean mixed layer, increases sea ice area, causing precipitation to fall before it reaches Antarctica, reducing ice sheet growth and increasing ocean surface freshening. Ice in West Antarctica and the Wilkes Basin, East Antarctica, is most vulnerable because of the instability of retrograde beds.

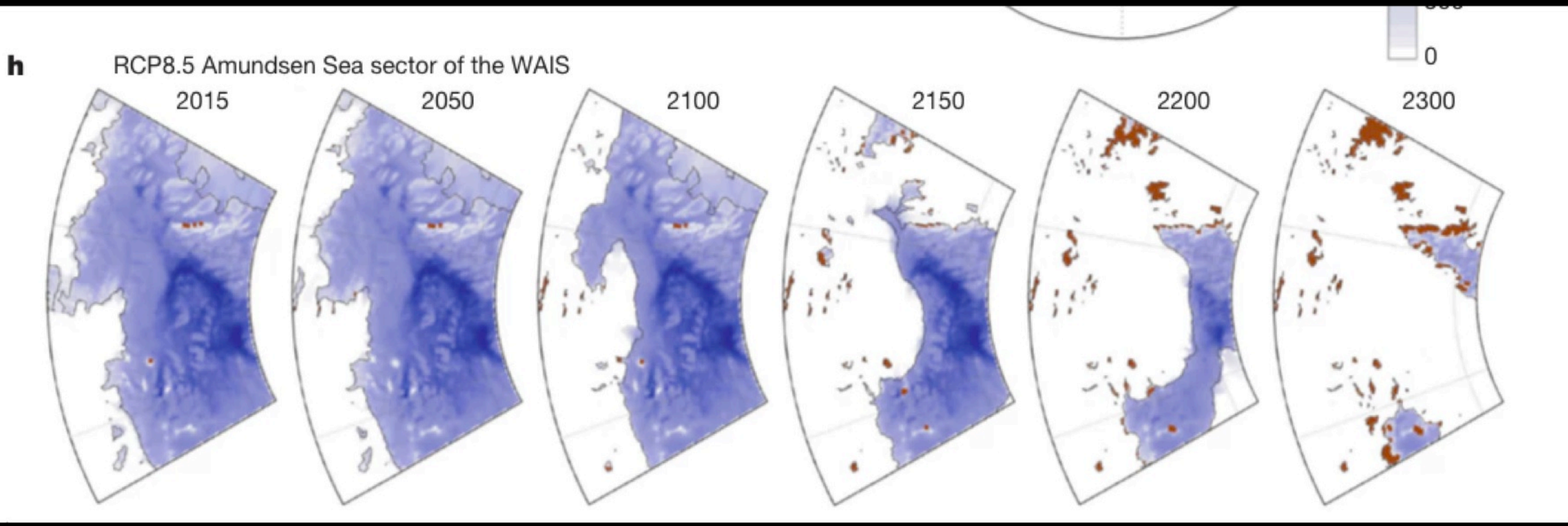
Hansen et al . (2016) Ice melt , sea level rise and superstorms.
Atmos. Chem. Phys., 16, 3761–3812, 2016



1. Early 1970s. Pine Island Glacier is grounded at a bedrock ridge.
2. Warm, inflowing Circumpolar Deep Water melts the base of the glacier. The glacier steepens and accelerates.
3. Present day, observed by a remotely operated vehicle (ROV). Glacier is thinning and receding.

Almost counter-intuitively, regional cooling from ice melt produces an amplifying feedback that accelerates ice melt by placing a lid on the polar ocean that limits heat loss to the atmosphere and space, warming the ocean at the depth of ice shelves. The regional surface cooling increases Earth's energy imbalance, thus pumping into the ocean energy required for ice melt.

If the ocean continues to accumulate heat and increase melting of marine-terminating ice shelves of Antarctica and Greenland, a point will be reached at which it is impossible to avoid large-scale ice sheet disintegration with sea level rise of at least several meters. The economic and social cost of losing functionality of all coastal cities is practically incalculable



DeConto and Pollard (2016) Contribution of Antarctica to past and future sea-level rise
Nature 531 , 591-597 doi:10.1038/nature17145

See also: https://robertscribbler.com/2016/12/06/one-by-one-the-flood-gates-of-antarctica-are-breaking-open/

Way, way into the future?

— Higher, warmer and more acidic (a 10m sea level rise)

http://www.musther.net/nzslr/Maps/National/10mSLR-Landscape-NZ-SI+2014Coast.jpg

Fisheries damage

- Over a billion people rely on fish for most of their protein
- Worldwide, the fishing industry employs around 200 million people, generating $80 billion a year

Planetary damage

- 50% of the oxygen in the atmosphere is produced by marine phytoplankton
- That means, every second breath is courtesy of a healthy sea

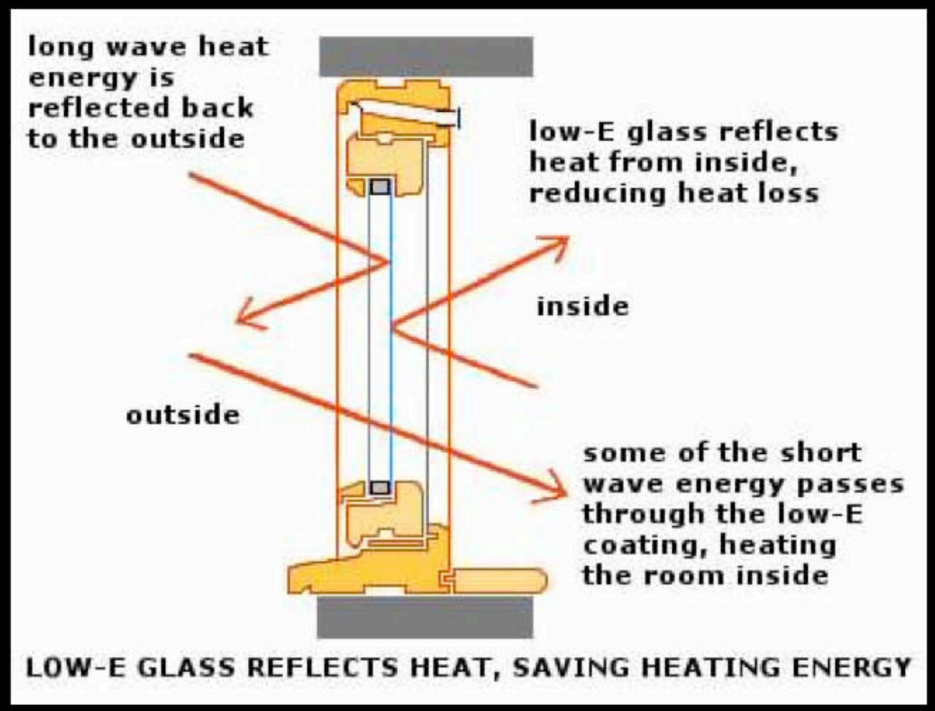
Is it fixable?

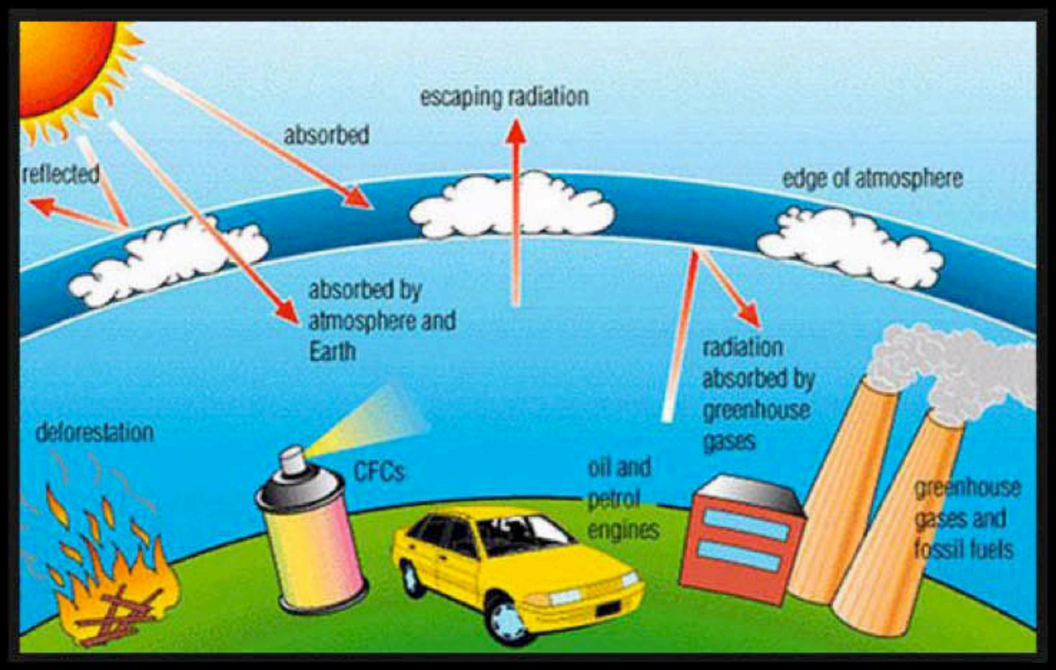
- Either irreversible or will take 10,000s of years to naturally re-equilibrate
- Any chemical additions to the ocean to offset the effect would have at best local effects
- Any move to change ocean pH would drive CO_2 into the atmosphere, increasing greenhouse effects

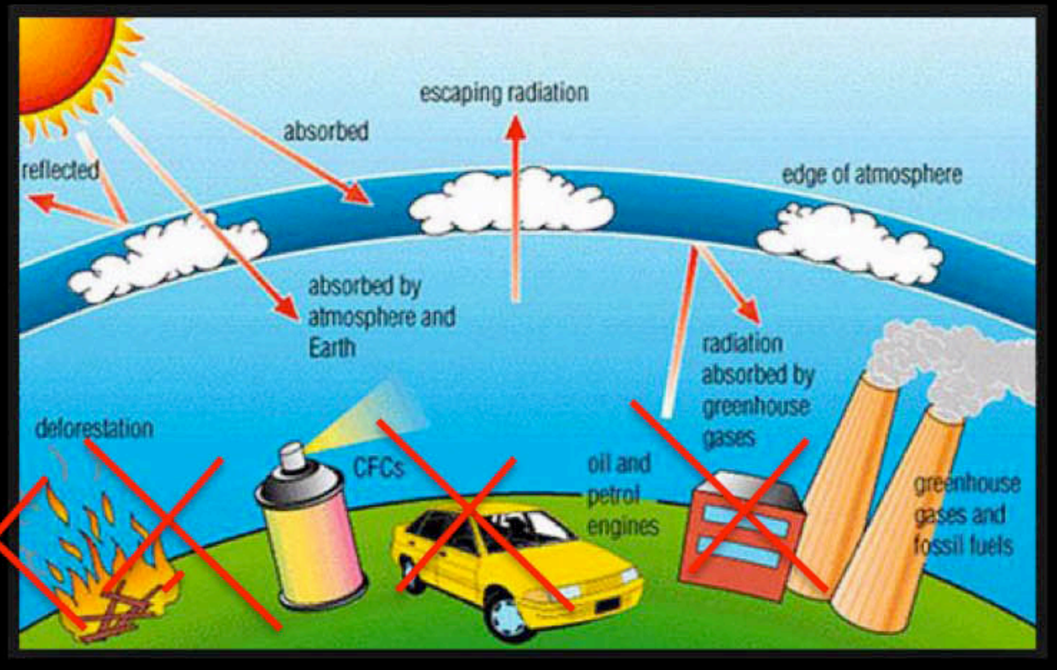
Is it preventable?

- No, and yes
- Change has started and will continue
- Can’t be stopped, but can be slowed down
- Reduction of CO_2 emissions is the only response

A better way to think about this, considering how to return to a stable equilibrium, is to reduce the thickness of the glass and allow more energy to escape. Which means reducing greenhouse gases, especially carbon dioxide emissions.



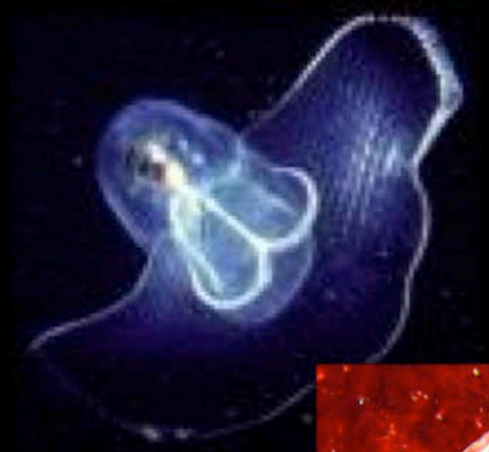




You can cut your CO_2 emissions

- **Don’t burn**
- Turn machines off, walk or bike
- Insulate, double glaze
- Leave fossil fuels in the ground
- Insist on government policies that reward reduced emissions rather than just trading them around

Do it for them



Activity 5A and 5B:

- What do you know about ocean acidification now?
- What can you and your community do to reduce future ocean acidification?