Oceans and Climate Change

ATM/MSC 118

Yu Cheng

Climate change caused by changes in ocean circulation (Hollywood's version):

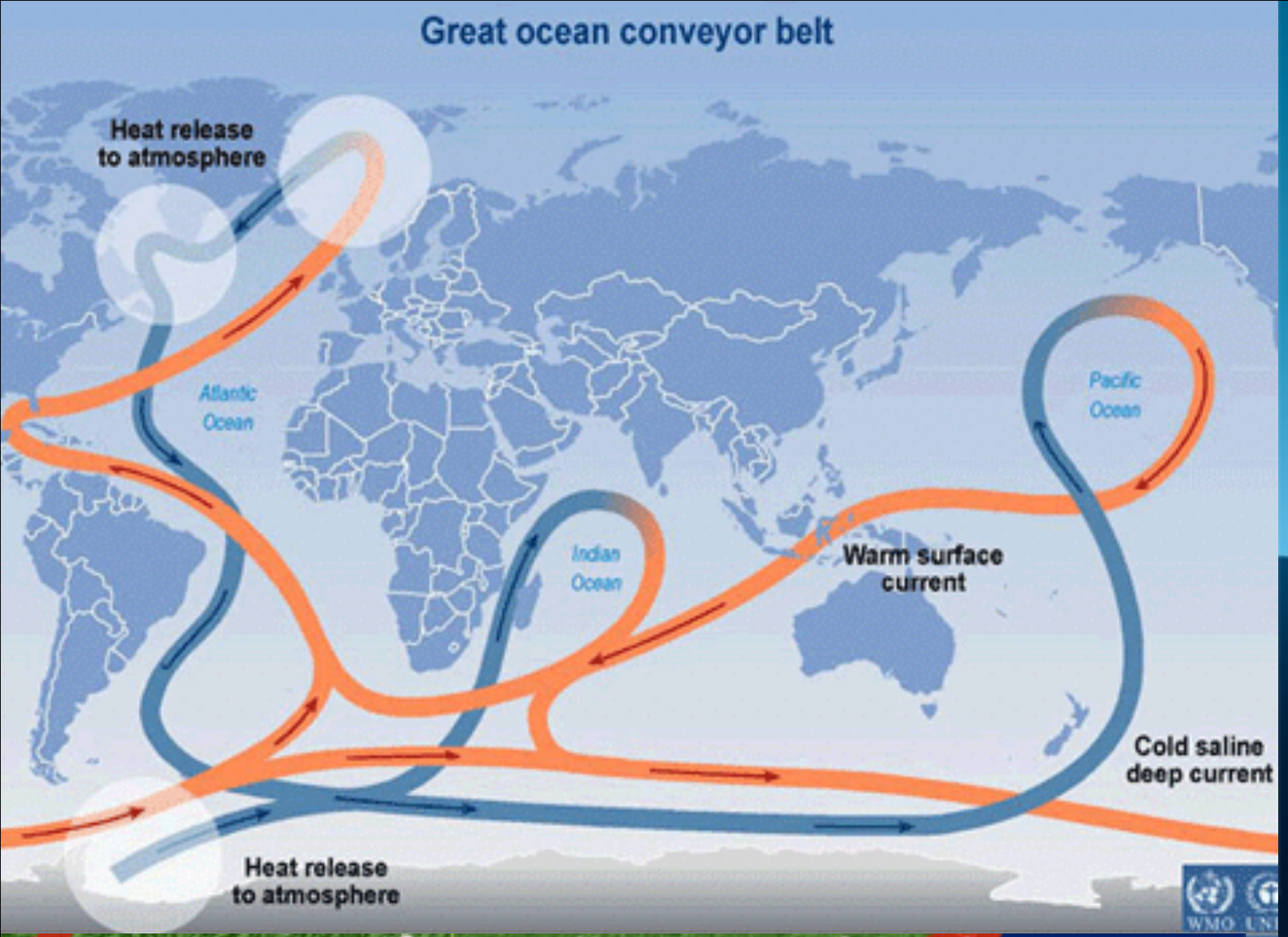
The role of ocean in climate system

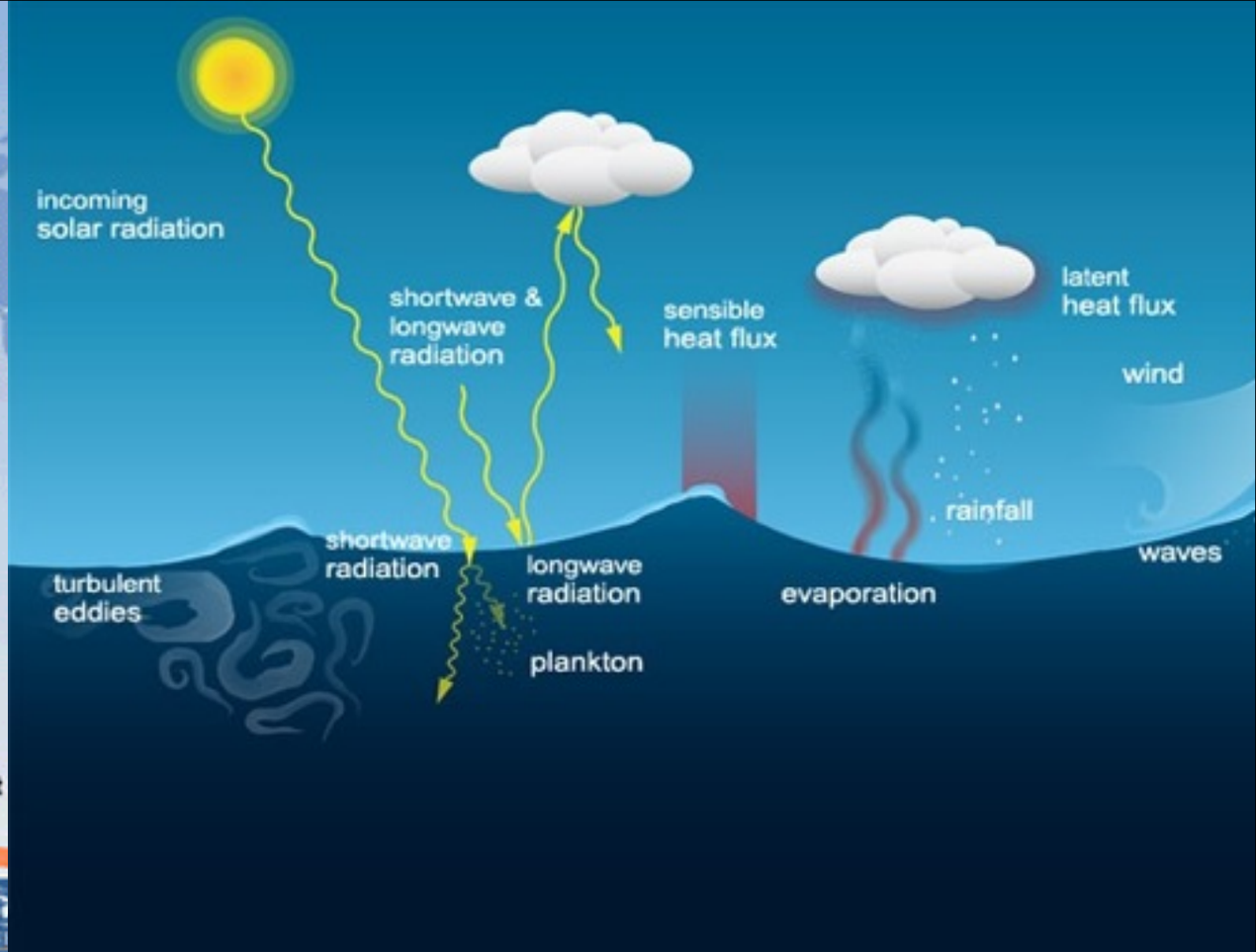
Ocean / Climate

The impacts of climate change on oceans

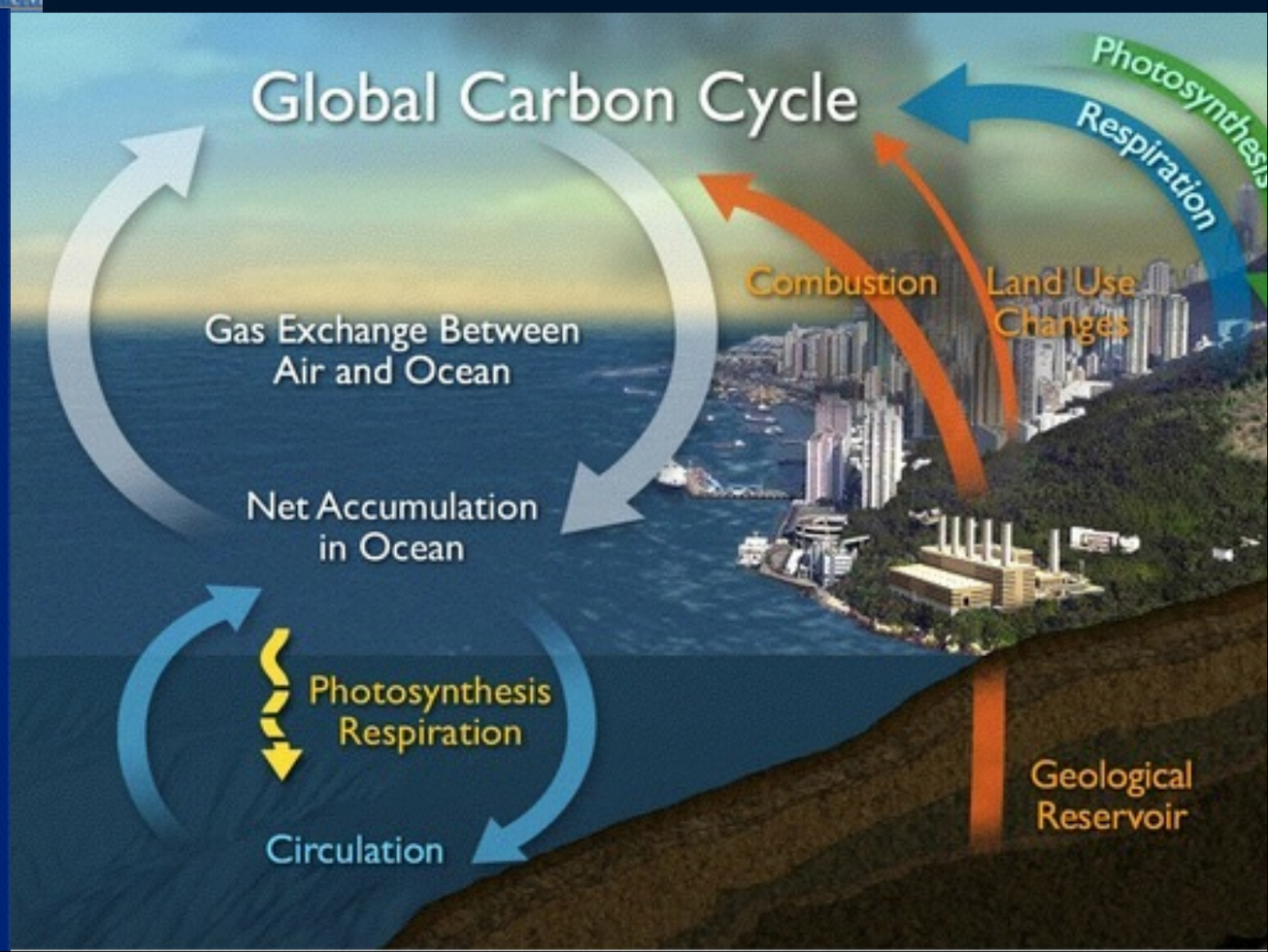
Quick facts about Oceans

- 71% of Earth's surface covered by oceans, avg. depth 4km (maximum 11km)
- The mass of the oceans is ~250 times the mass of the atmosphere.
- It takes ~1,000 times more heat to warm the oceans than to warm the atmosphere by the same number of degrees.


Great ocean conveyor belt
Heat release to atmosphere
Atlantic Ocean
Pacific Ocean
Indian Ocean
Warm surface current
Cold saline deep current
Heat release to atmosphere


incoming solar radiation
shortwave & longwave radiation
sensible heat flux
latent heat flux
wind
rainfall
waves
shortwave radiation
longwave radiation
turbulent eddies
evaporation
plankton

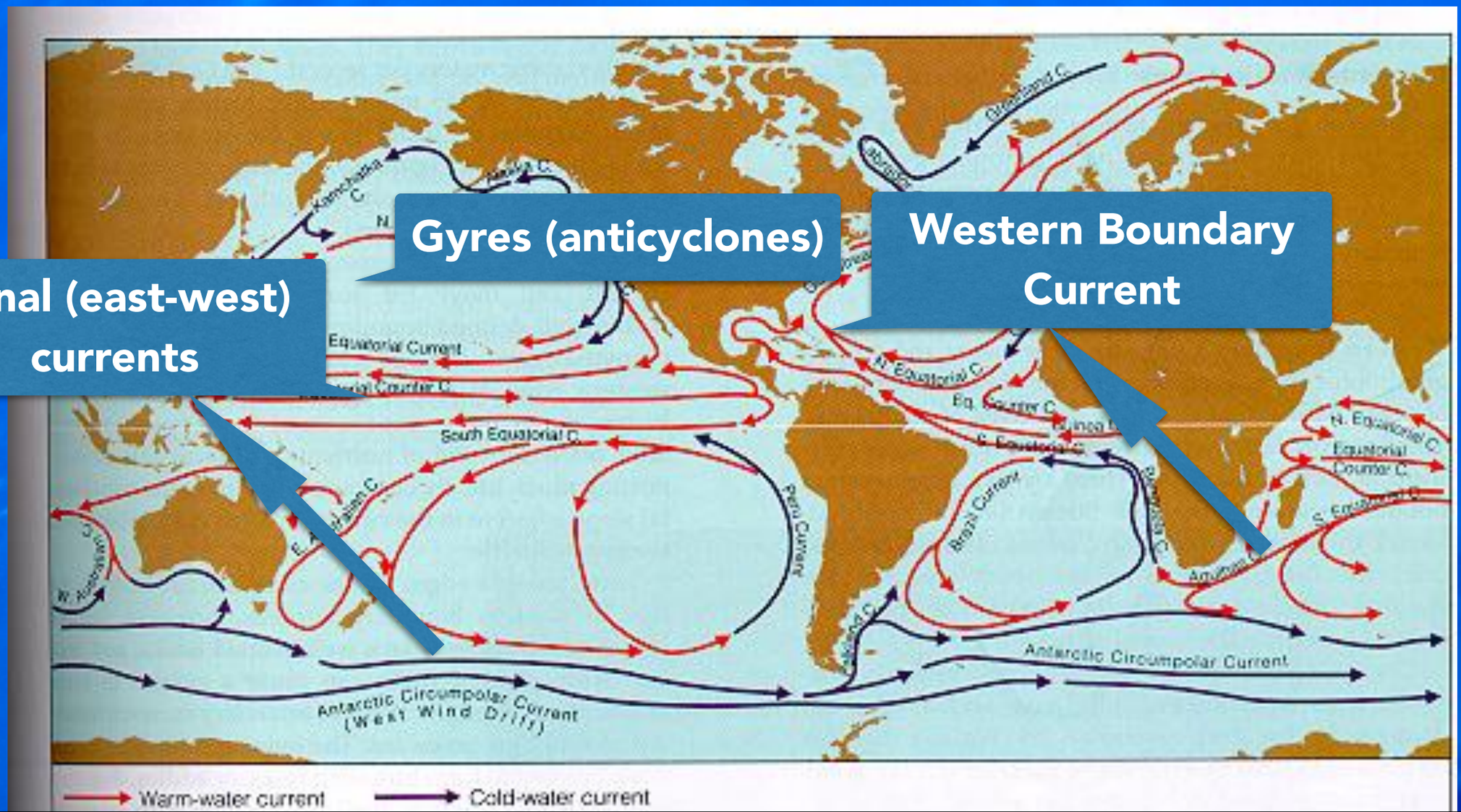

ALABAMA
GEORGIA
Atlantic Ocean
Panama City
Tallahassee
Pensacola
Jacksonville
Gainsville
Daytona Beach
Gulf of Mexico
Orlando
Cape Canaveral
Saint Petersburg
Tampa
FLORIDA
Fort Myers
Fort Lauderdale
Miami
+ 6 meters
USA: Florida


Global Carbon Cycle
Photosynthesis
Respiration
Combustion
Land Use Changes
Gas Exchange Between Air and Ocean
Net Accumulation in Ocean
Photosynthesis
Respiration
Circulation
Geological Reservoir

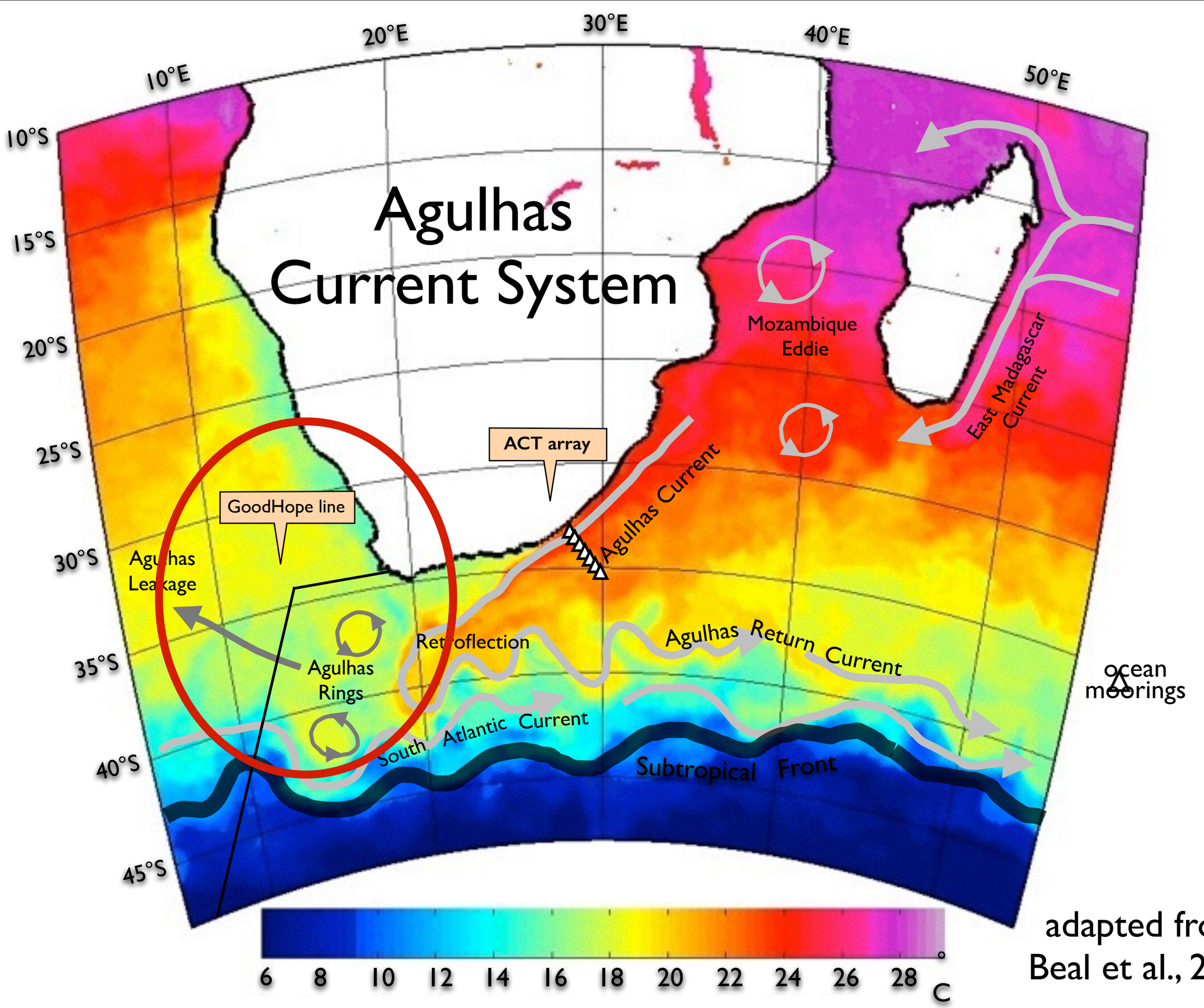
Ocean circulation

- Two major ways to drive ocean circulation on large scale: by atmospheric winds (“wind-drive”) and density difference (“thermohaline”)

- Winds “drag” the ocean surface, pile up water and creating pressure gradient.

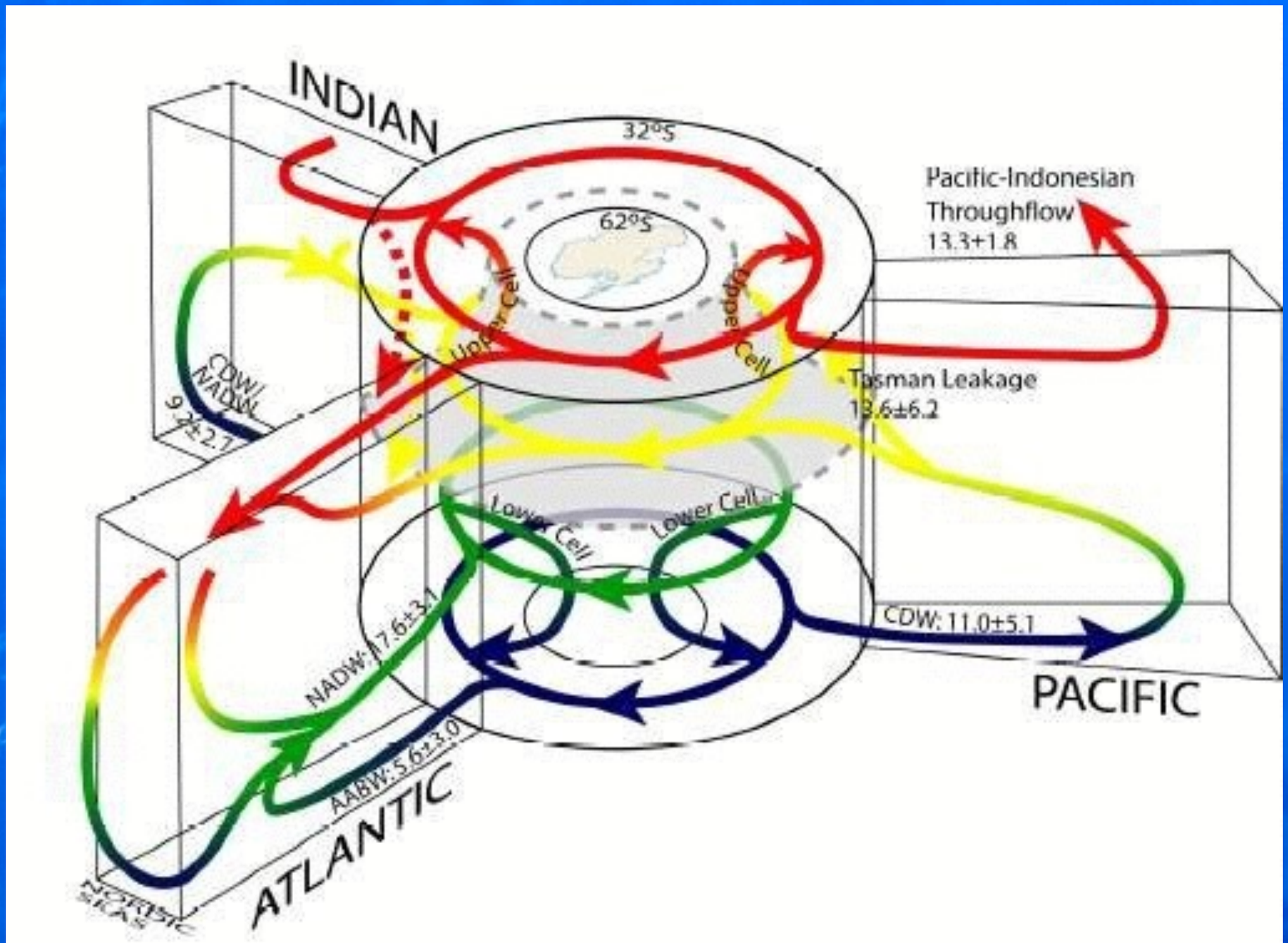


Agulhas Current System

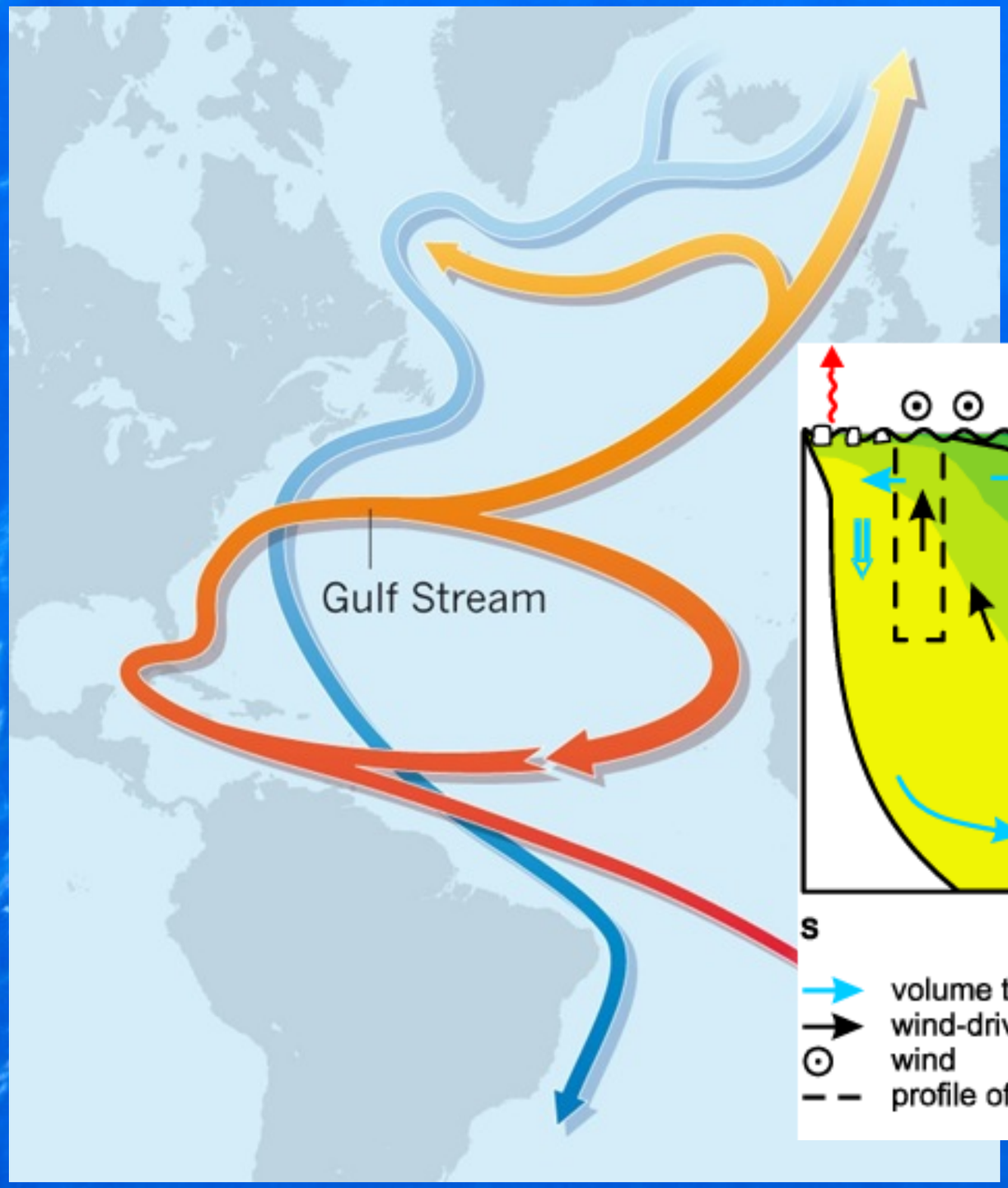


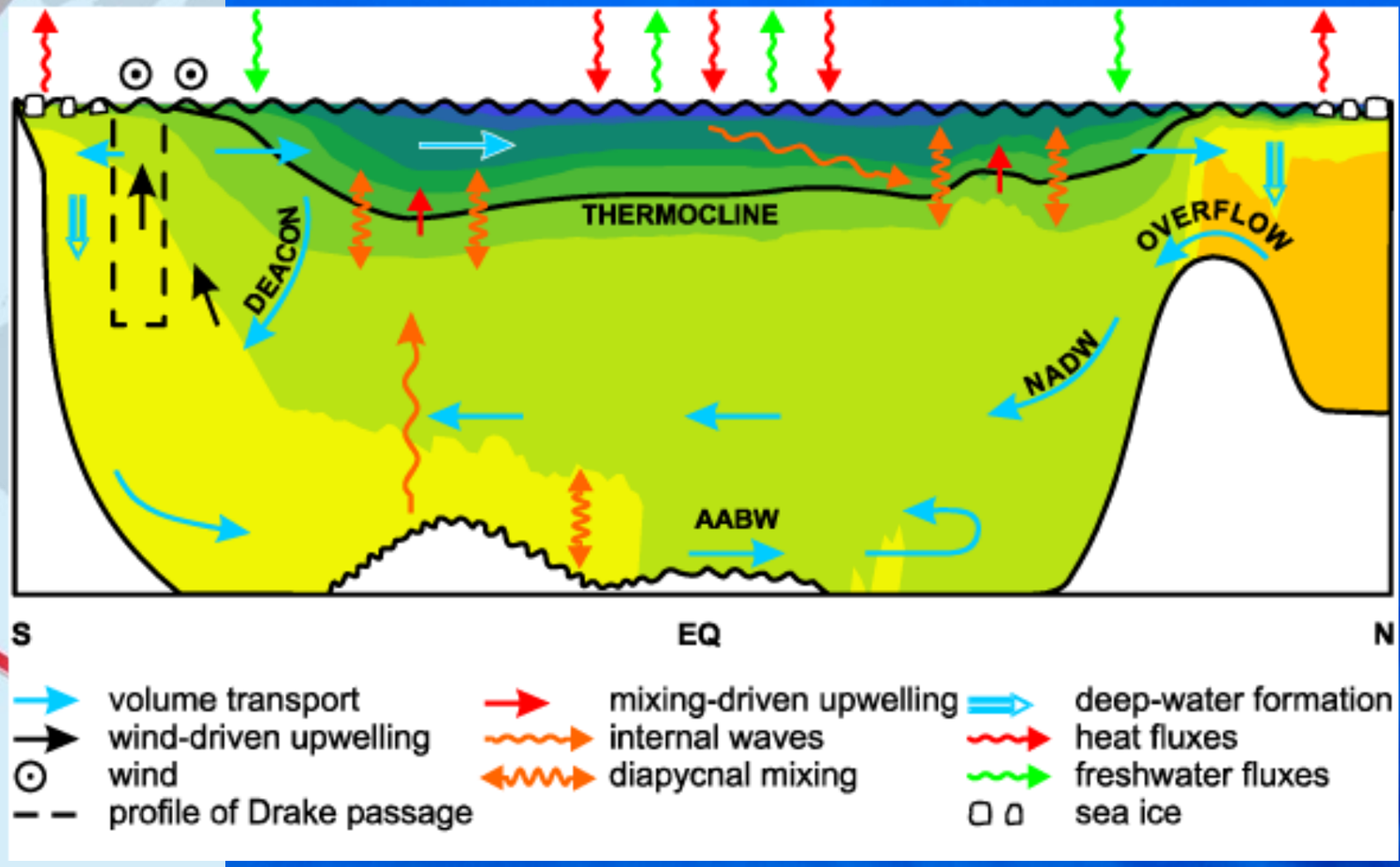
adapted from Beal et al., 2011

Thermohaline circulation
“The great conveyor belt”



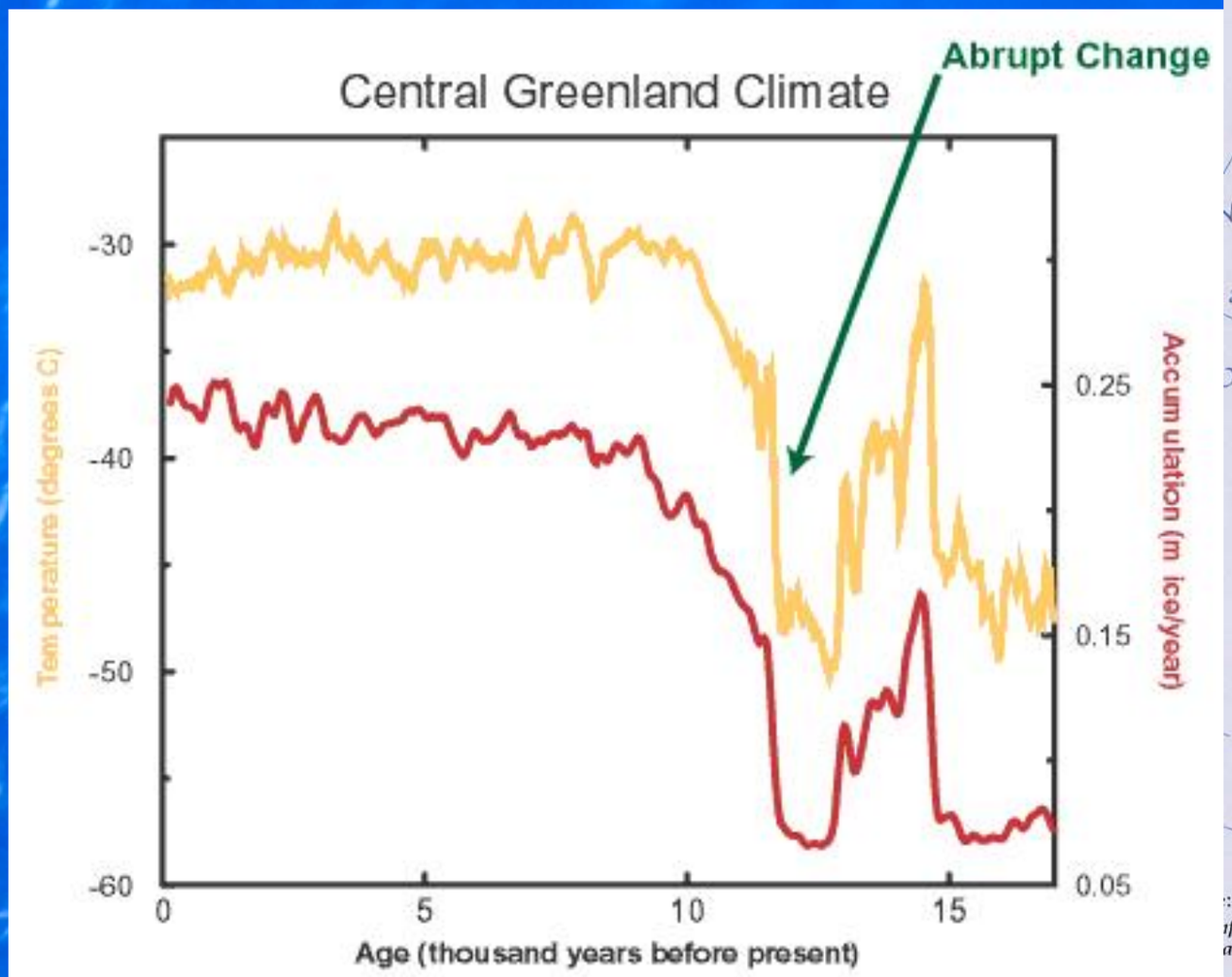
Atlantic Meridional Overturning Circulation

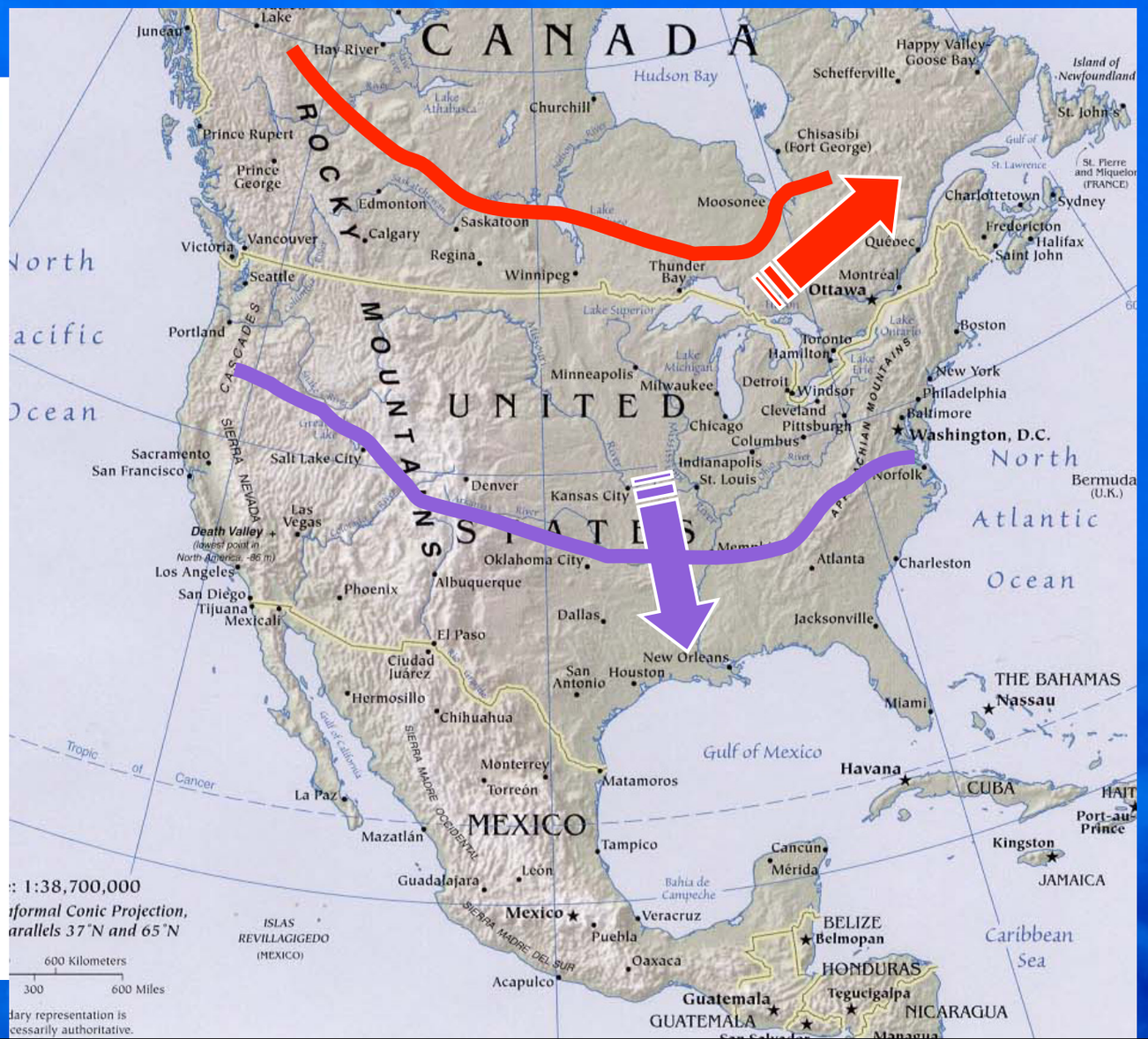




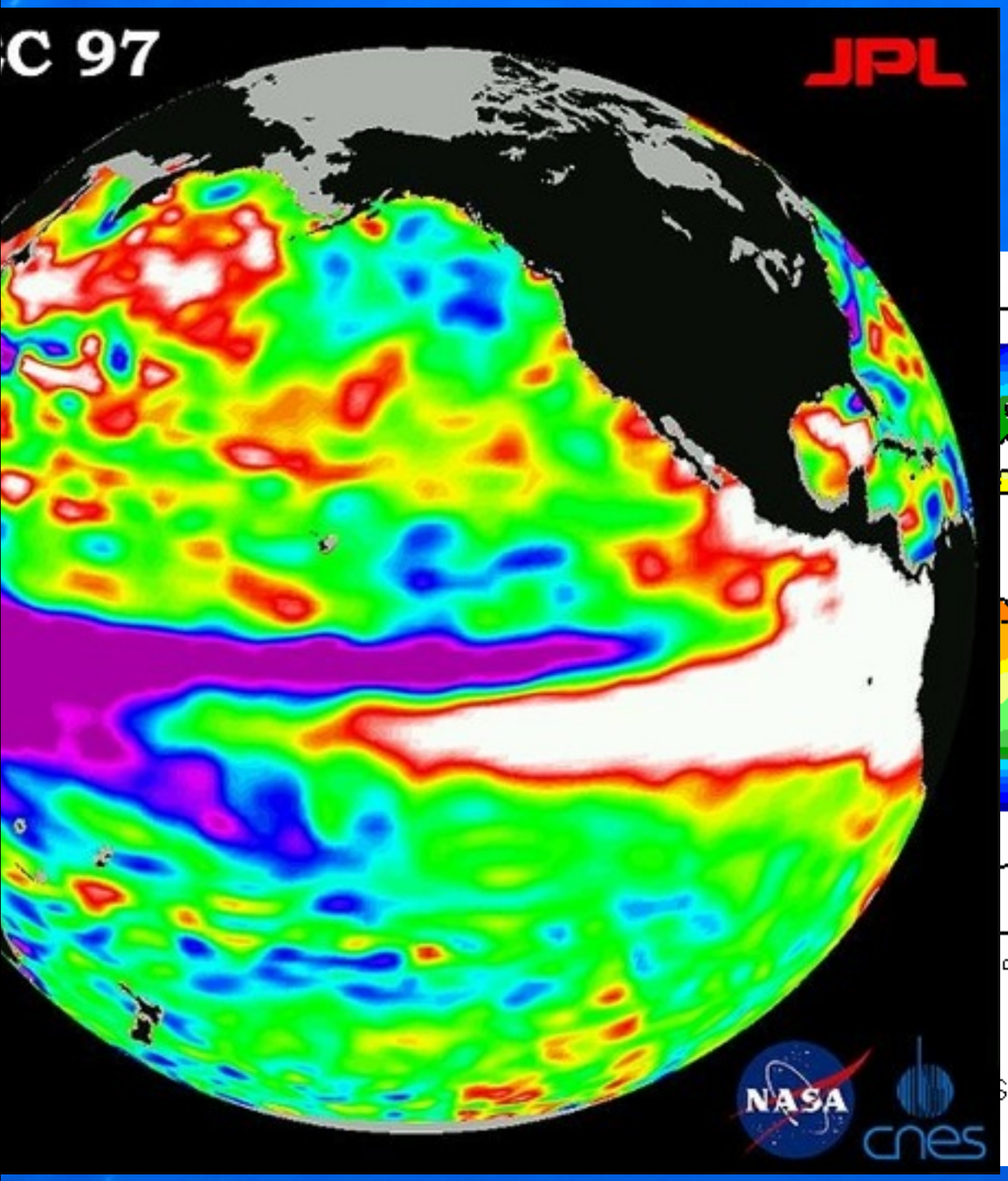
Abrupt climate shift

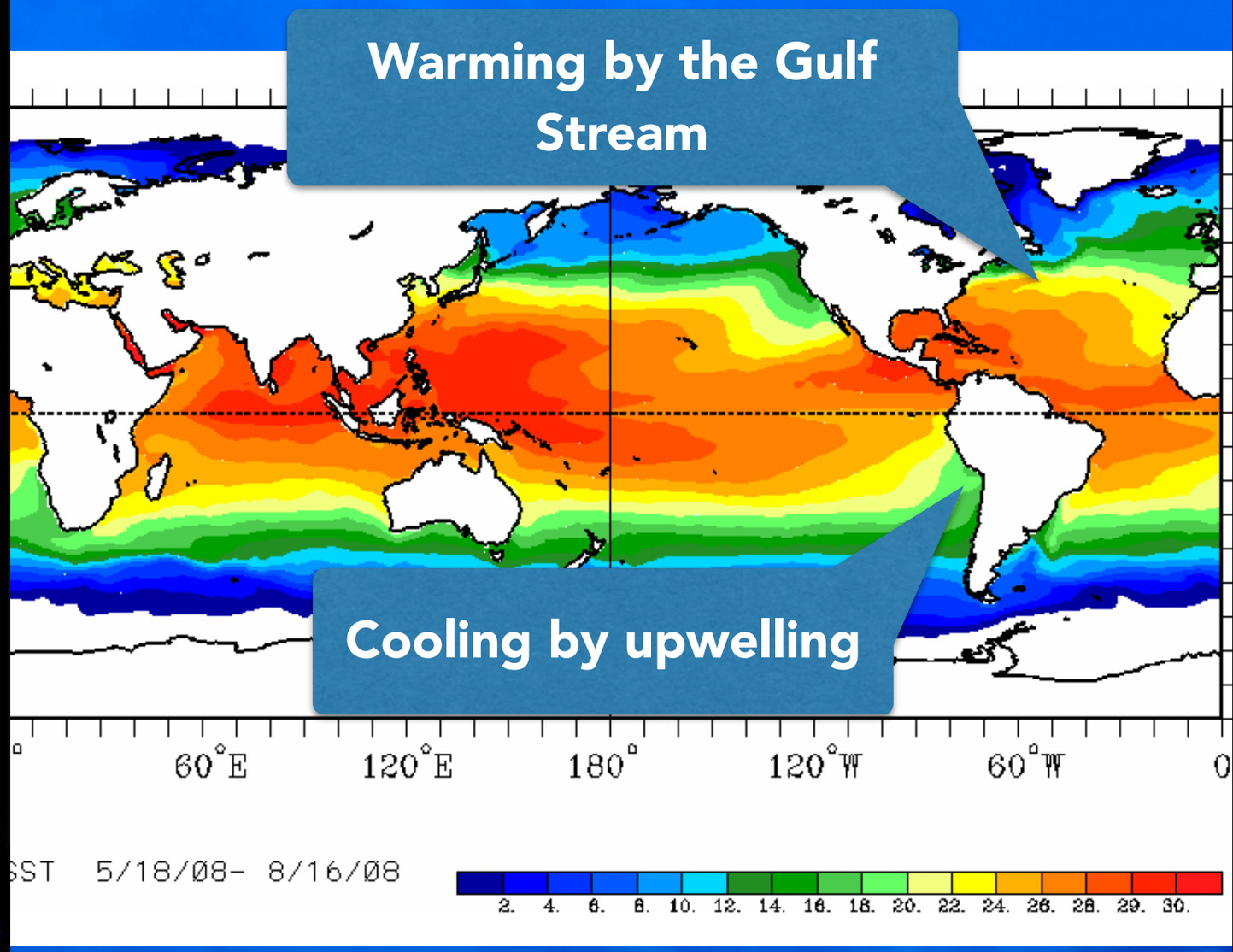
- So is the mechanism described by the movie valid?
- The Younger Dryas event





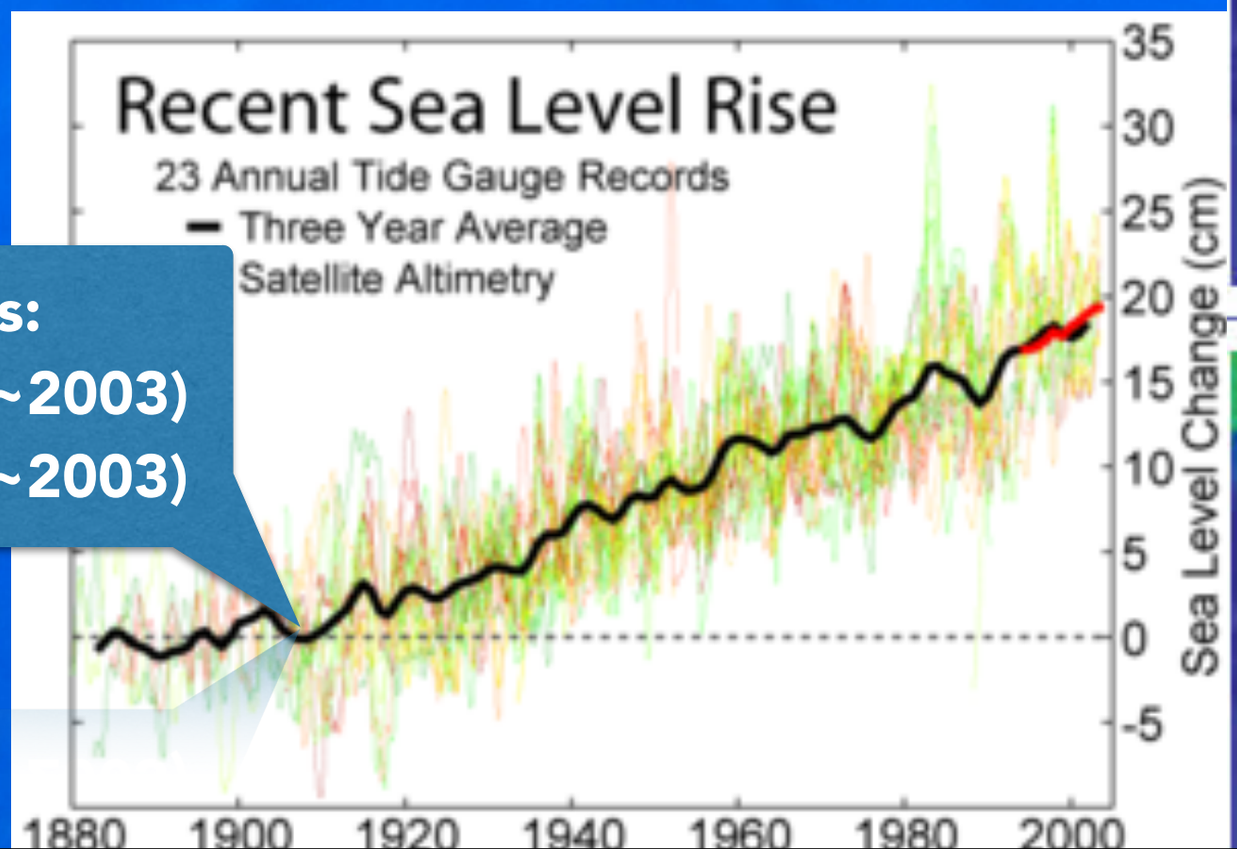
Air-Sea Interaction





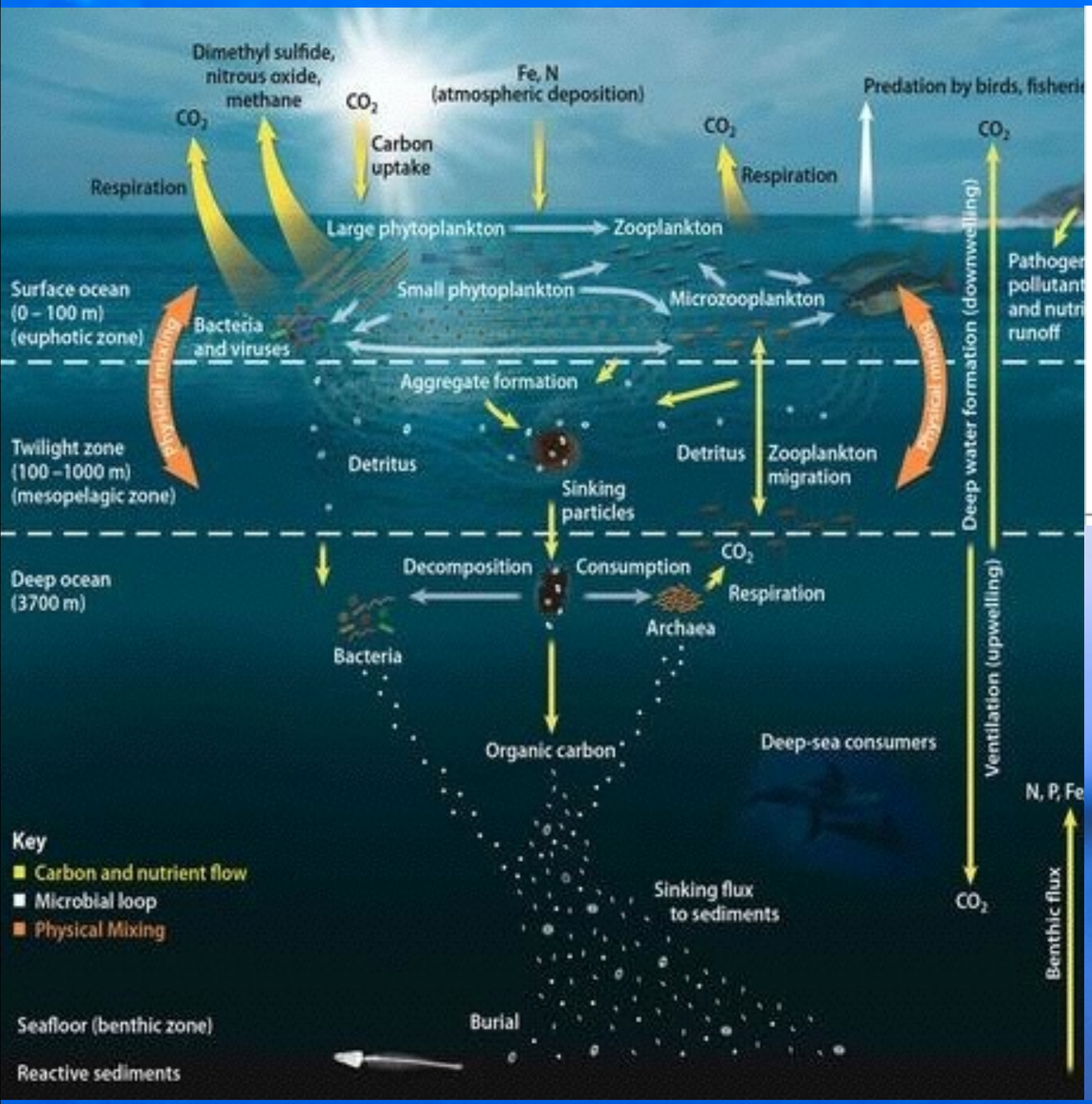
Sea level change

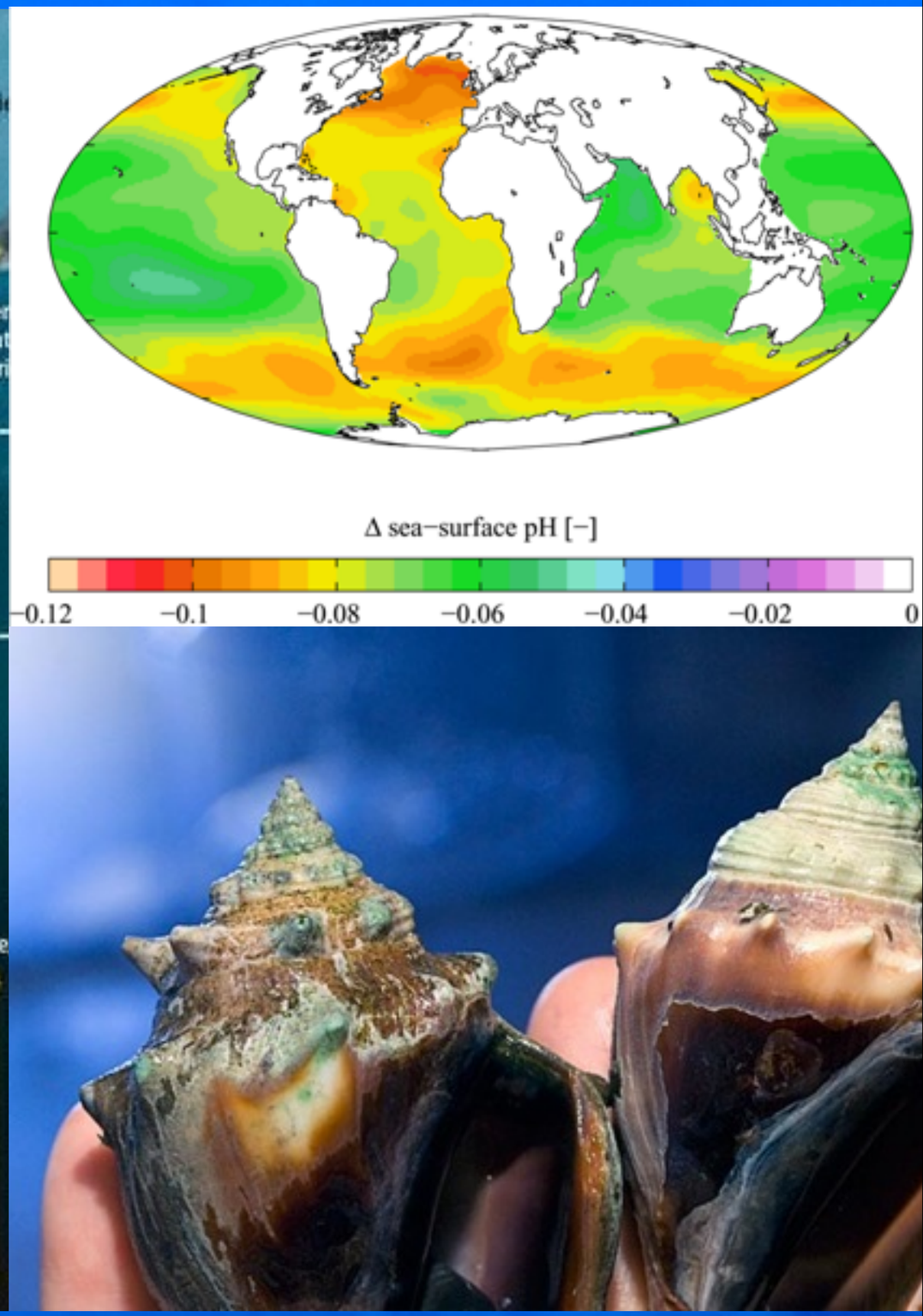
- Lives of ~100,000,000 people would be affected by a sea level rise of 1 meter
- 10,000 square miles would be erased by a 2 feet rise
- 33% of wetlands would be converted to open water by 2080



Current issues:
~1.8 mm/yr (1963~2003)
~3.1 mm/yr (1993~2003)

Carbon Cycle





Summary

- Ocean as the largest heat reservoir of the climate system, modulate the climate in long time scale.

- Ocean circulation transports heat to the poles, influences the atmosphere above, and ocean is a major sink of atmospheric carbon dioxide, which acts as acid bumper.

- Climate change has following effects on ocean that impacts us the most: changing circulation pattern, sea level rises, ocean acidification, impacts on marine ecosystem.