Geography of the world’s oceans and major current systems

Lecture 2

WHY is the GEOMORPHOLOGY OF THE OCEAN FLOOR important?

(in the context of Oceanography)

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- Ocean circulation, tides, and mixing on regional and basin scales are heavily controlled by the topography of the ocean.
- The nature of the earth, its origin, and its characteristics have a profound effect on the properties and the composition of the biota that are contained in the ocean.
- The structure and distribution of sediments can be understood based on the geomorphology of the ocean floor. These sediments are important because they tell us about the geochemistry of the ocean floor. Also they can be used to reconstruct ocean circulation of the past and improve our understanding of the climate system.

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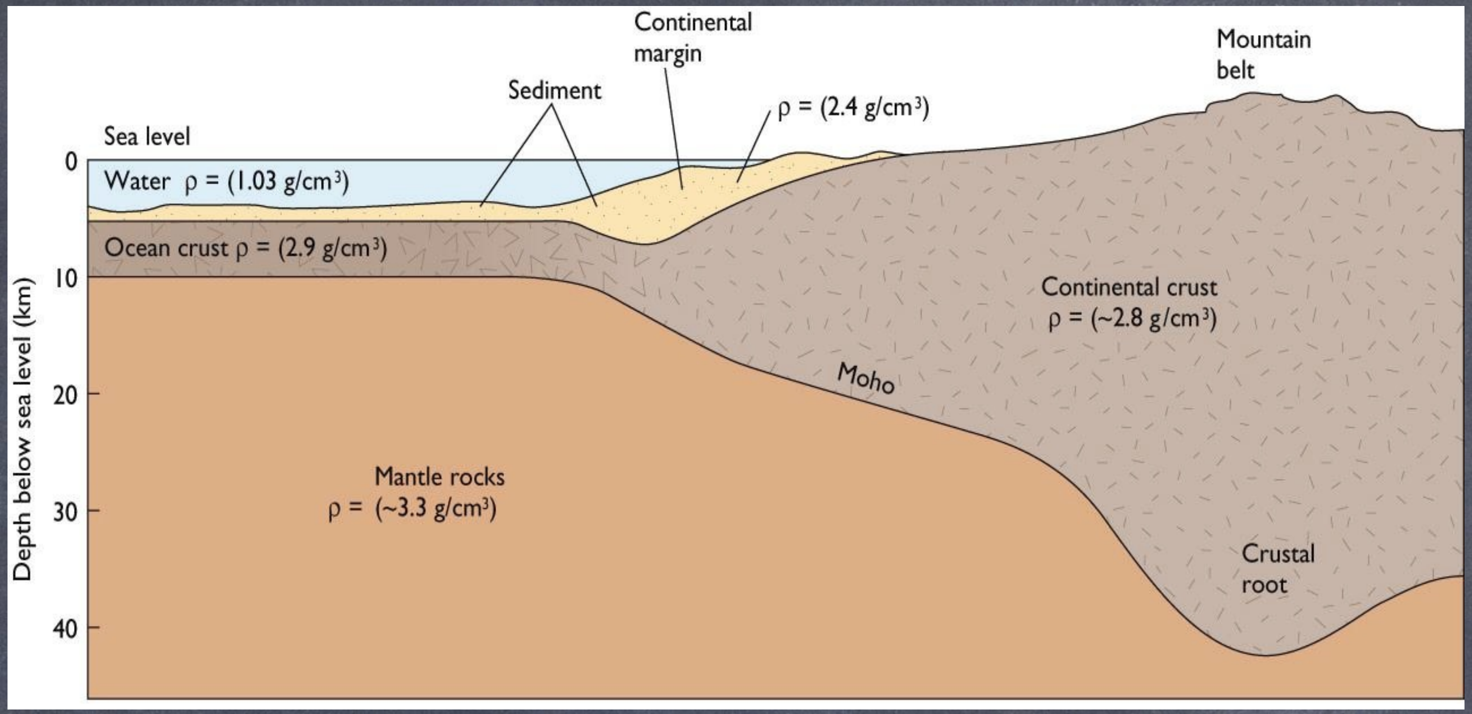
Geologic Differences between Continents and Ocean Basins



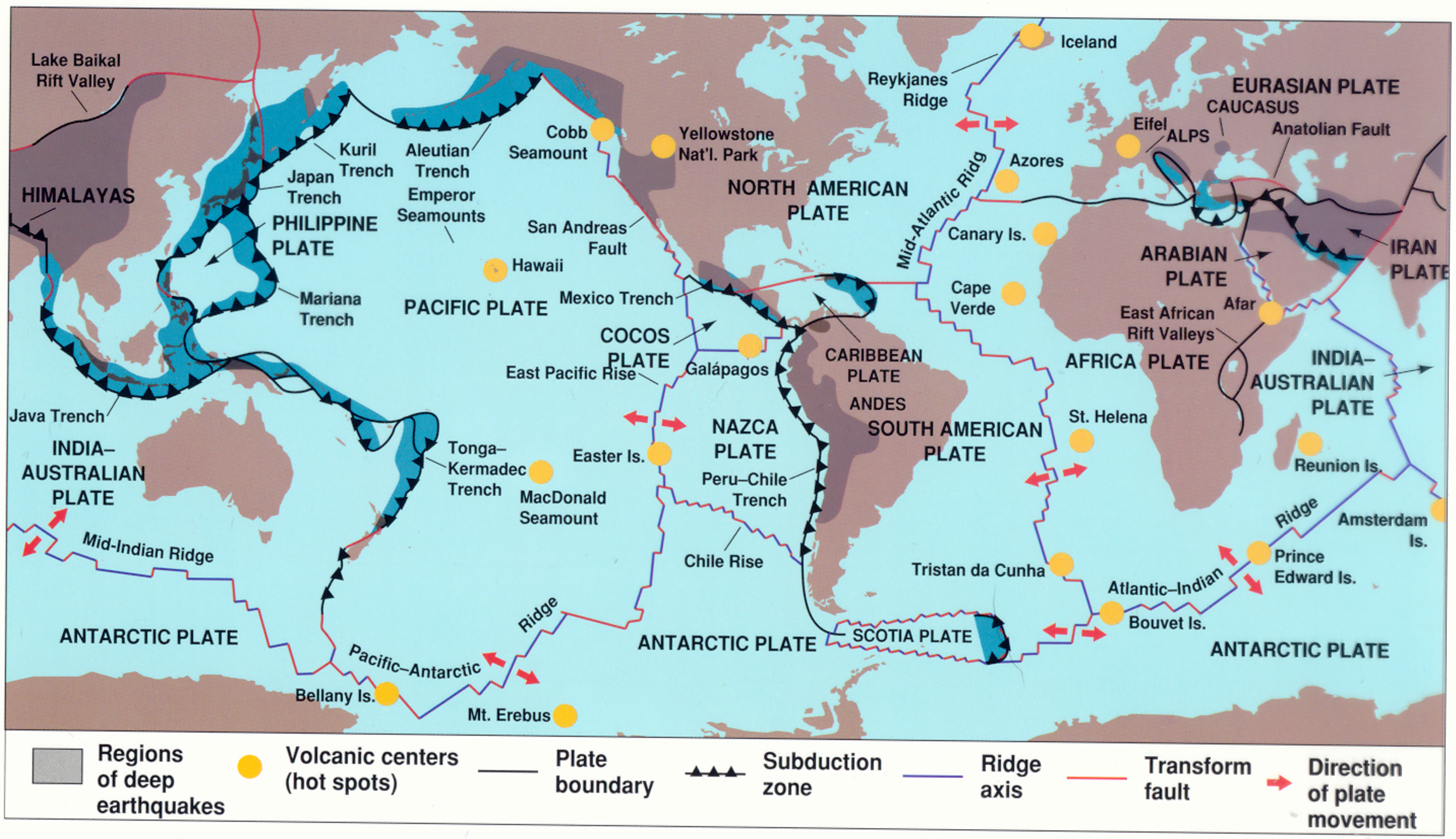
- Continental crust is mainly composed of granite, a light colored, lower density (2.8 gm/cm3) igneous rock rich in aluminum, silicon and oxygen.

- Oceanic crust is composed of basalt, a dark colored, higher density (2.9 gm/cm3) volcanic rock rich in silicon, oxygen and magnesium.

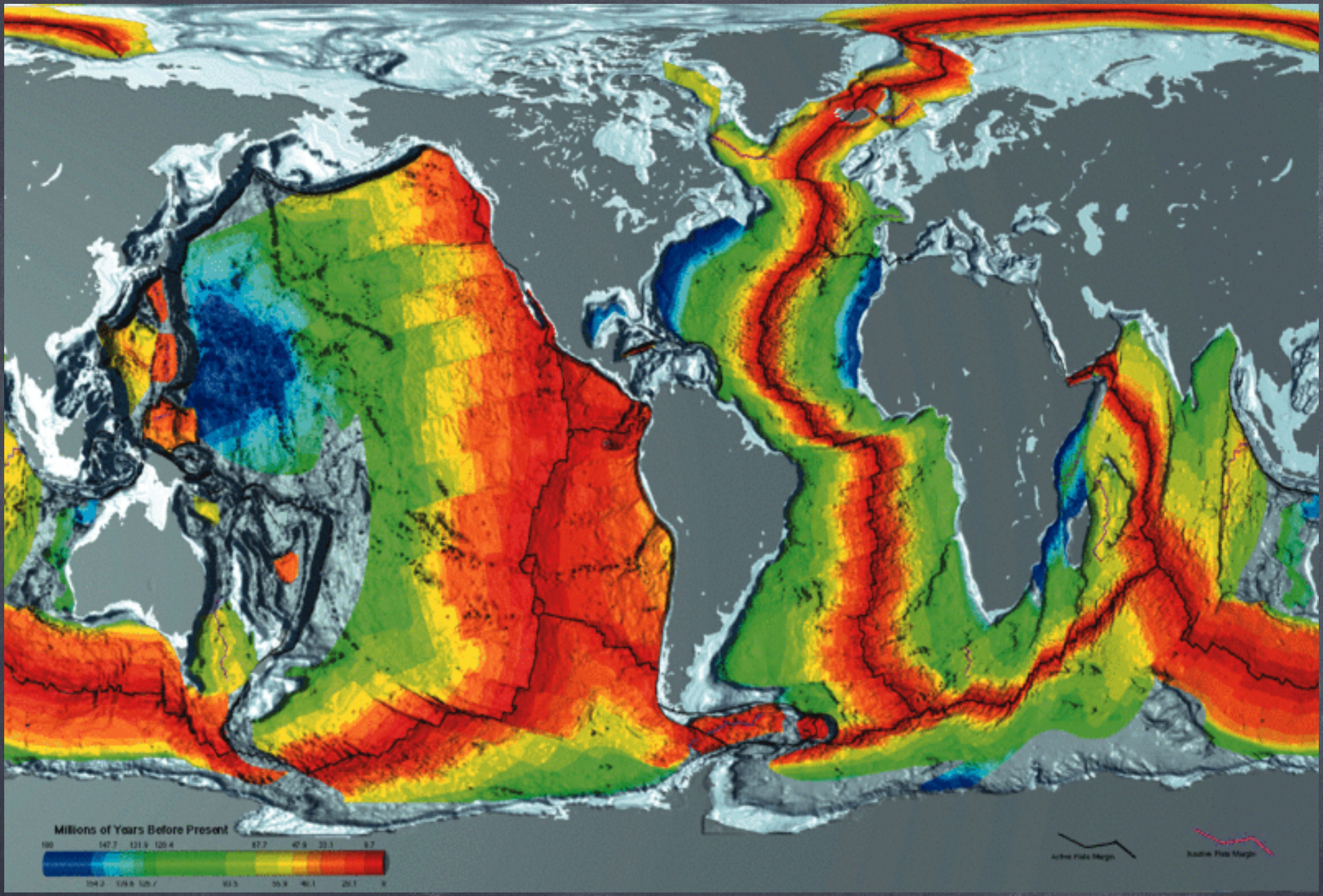
- Oceanic crust is thin and dense. Continental crust is thick and light.

Isostasy is a term used in Geology to refer to the state of gravitational equilibrium between the Earth's lithosphere and asthenosphere such that the tectonic plates (continental and ocean crusts) "float" at an elevation which depends on their thickness and density. (similar to ice floating in water).

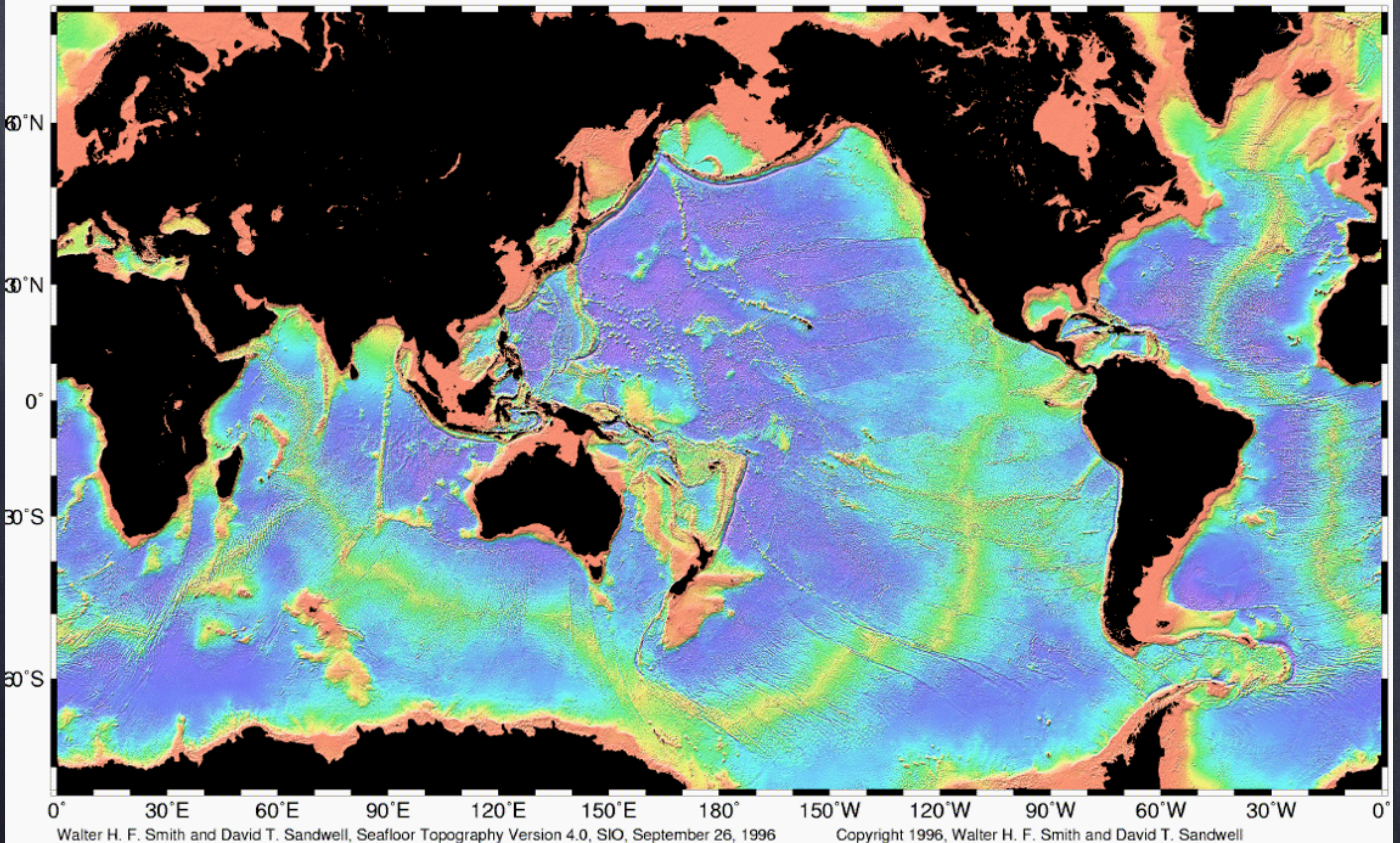
In the 1960's there was a geological revolution: the realization that the surface of the earth is in motion, slowly recycling the material that makes up our environment and shapes the ocean basins and seafloors.

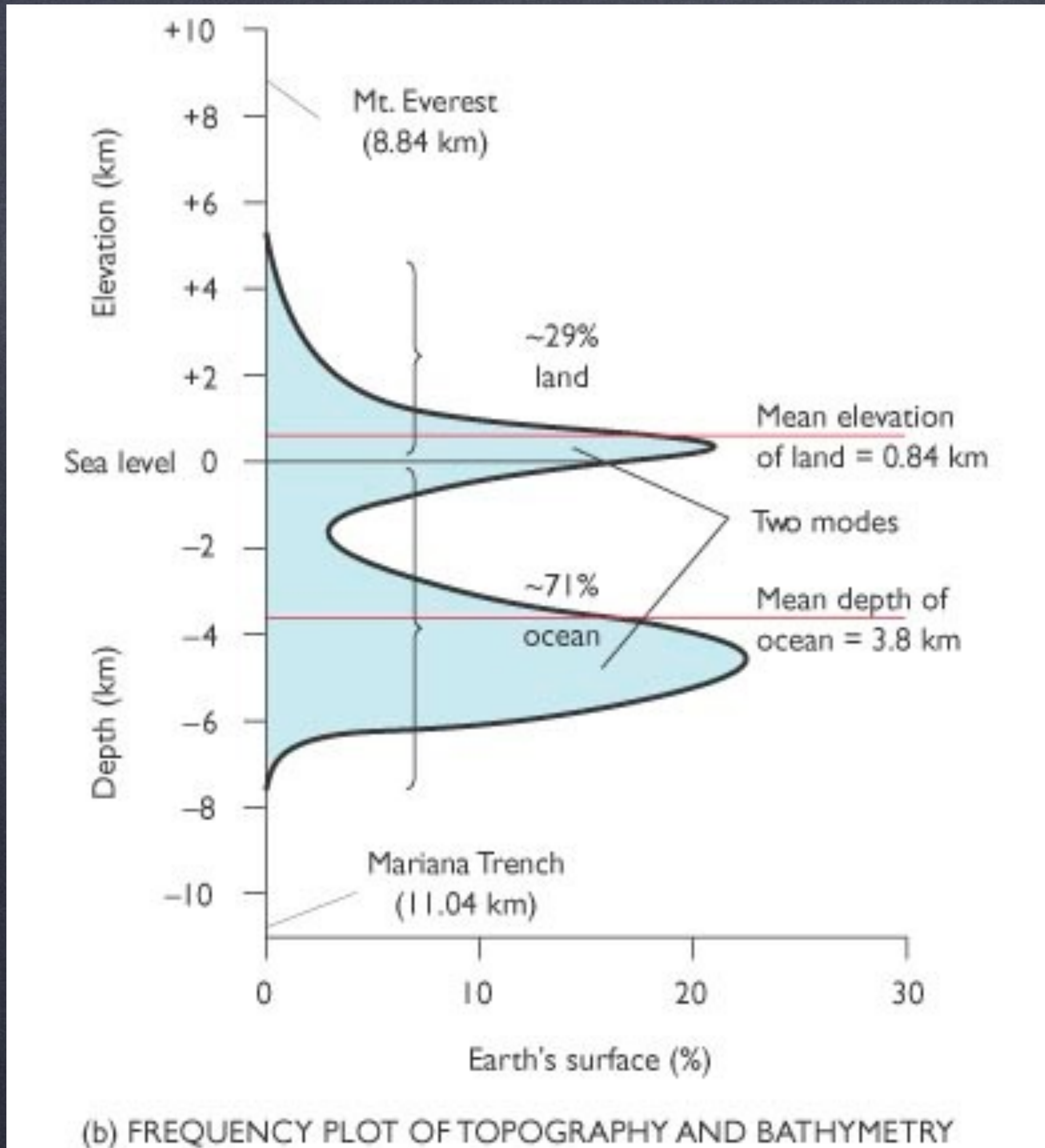


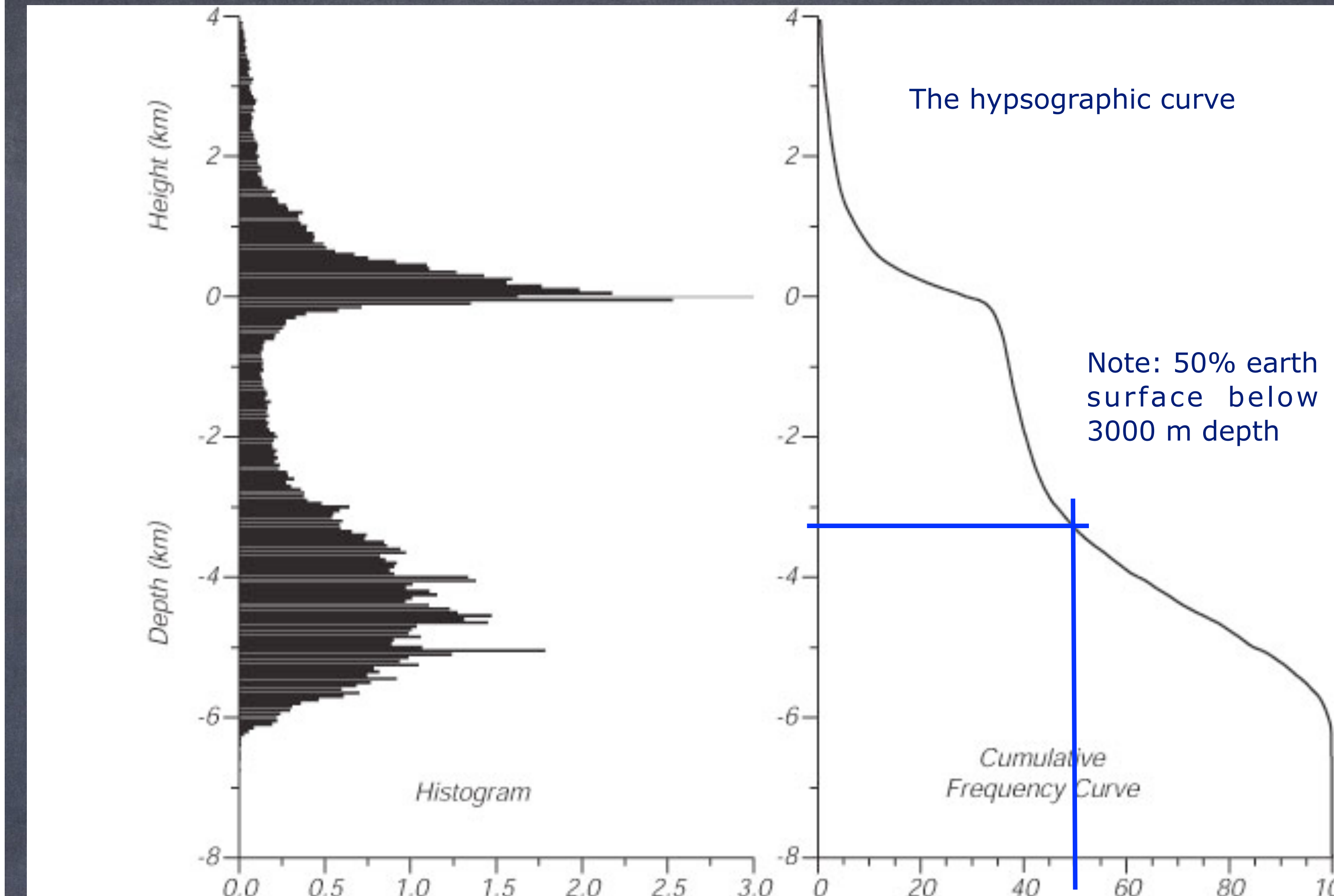
The major lithospheric plates



Age of oceanic crust.
Youngest crust is along spreading centers (in red) - these are the mid-ocean ridges


60°N
30°N
0°
30°S
60°S
0°
30°E
60°E
90°E
120°E
150°E
180°
150°W
120°W
90°W
60°W
30°W
0°
Walter H. F. Smith and David T. Sandwell, Seafloor Topography Version 4.0, SIO, September 26, 1996
Copyright 1996, Walter H. F. Smith and David T. Sandwell

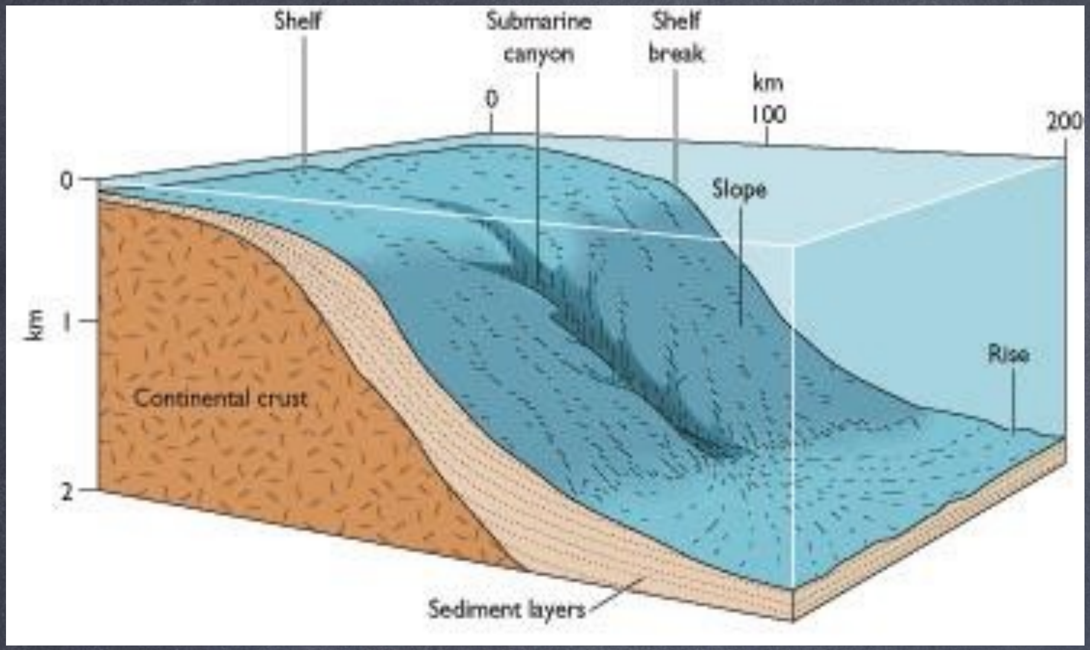




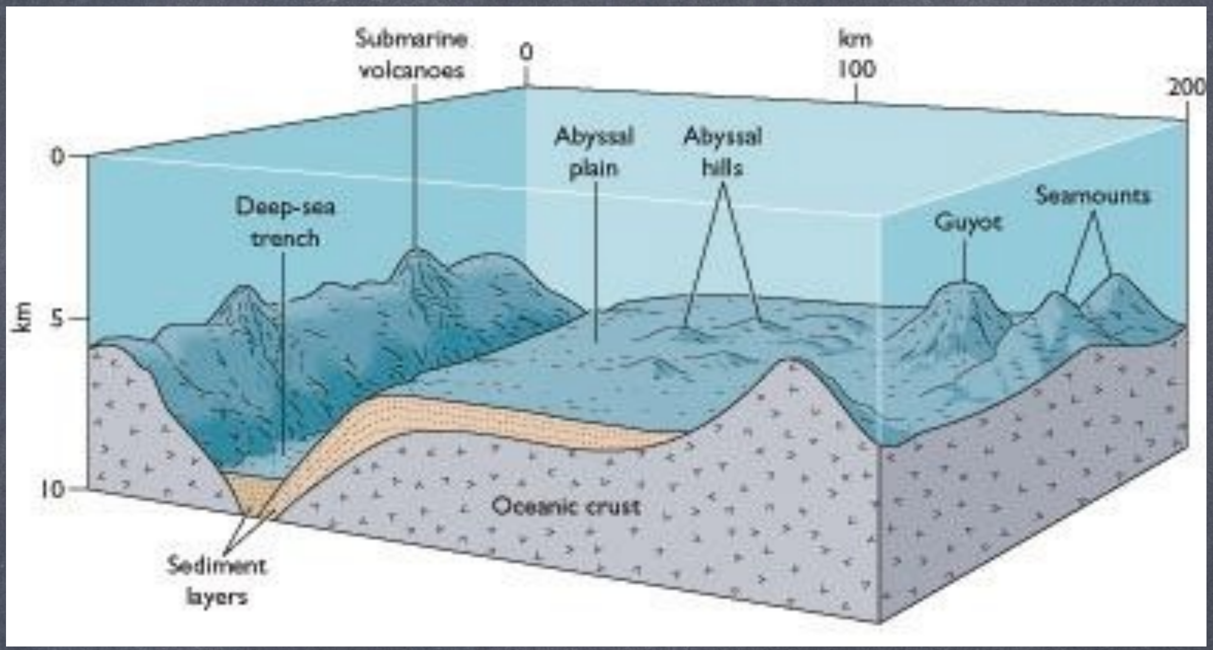
%

Elevation of Earth's surface displays a bimodal distribution with about 29% above sea level and much of the remainder at a depth of 4 to 5 kilometers below sea level.

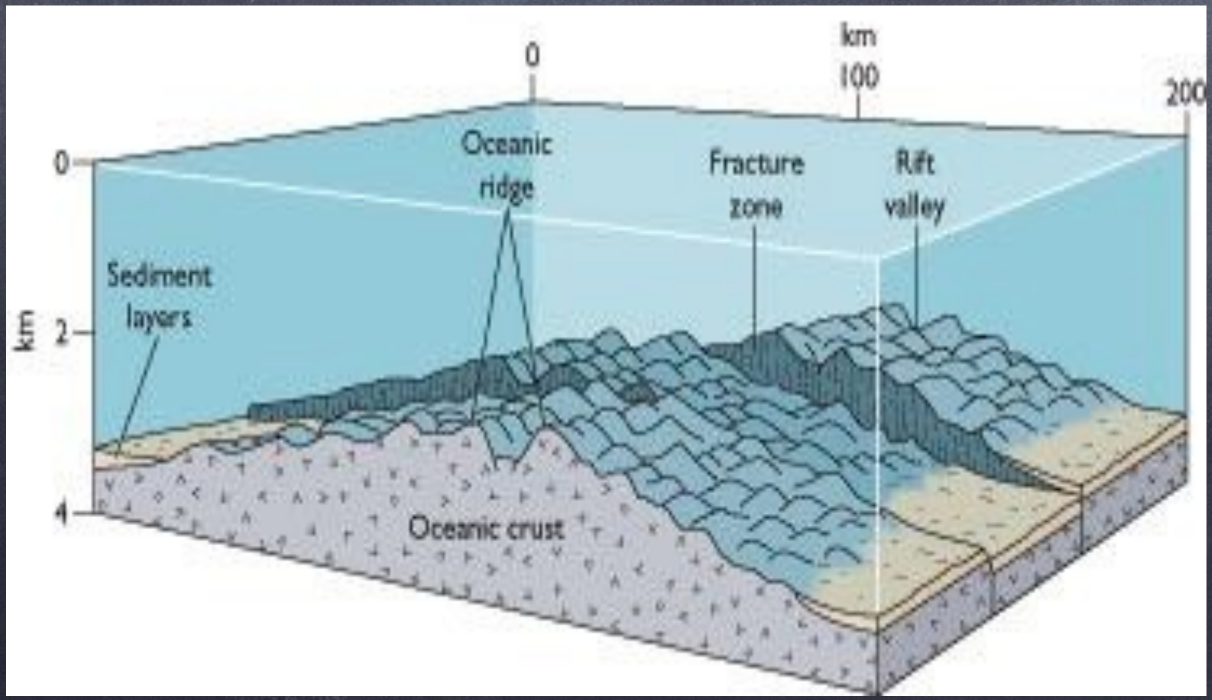
Continental margin



Ocean basin

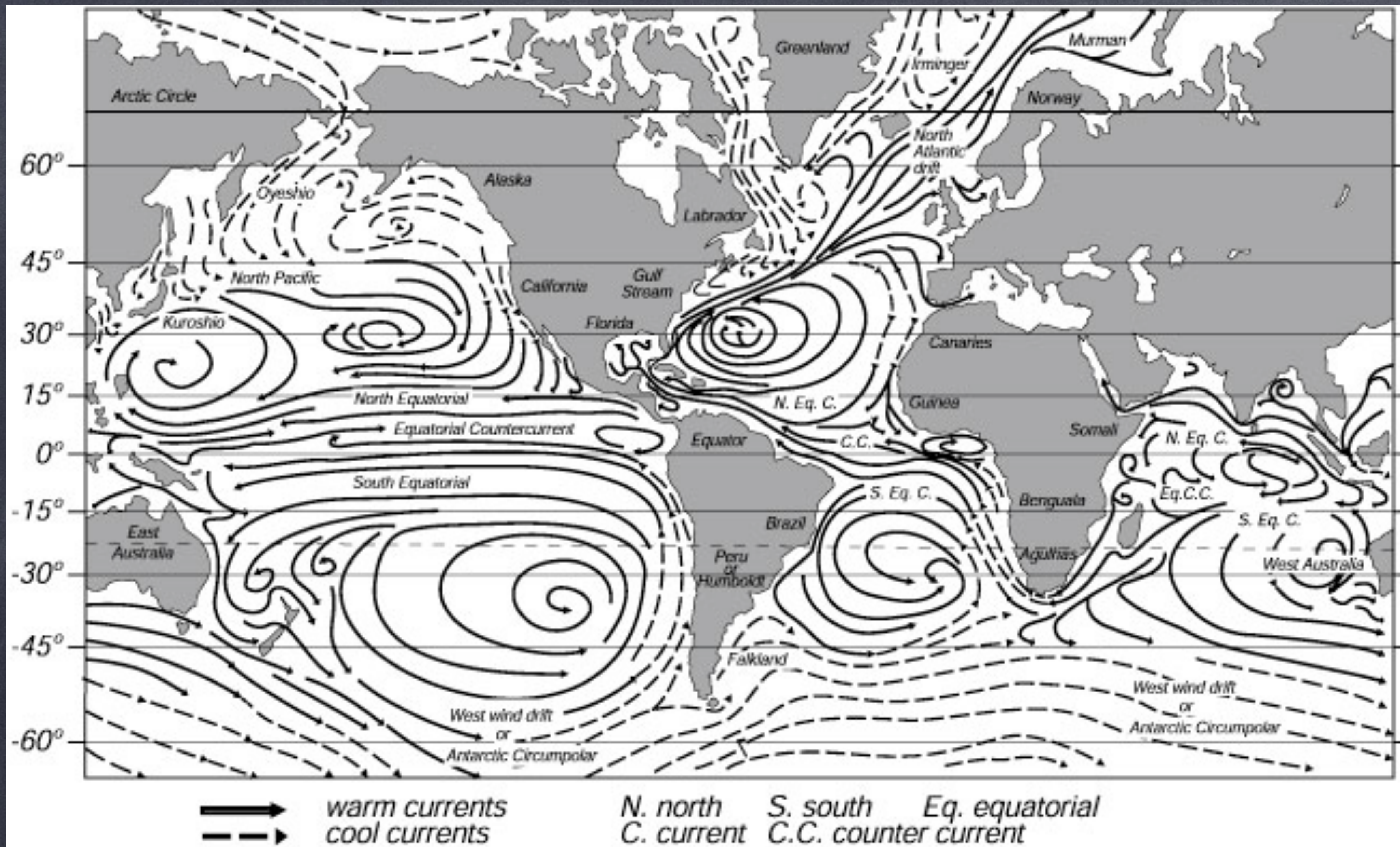


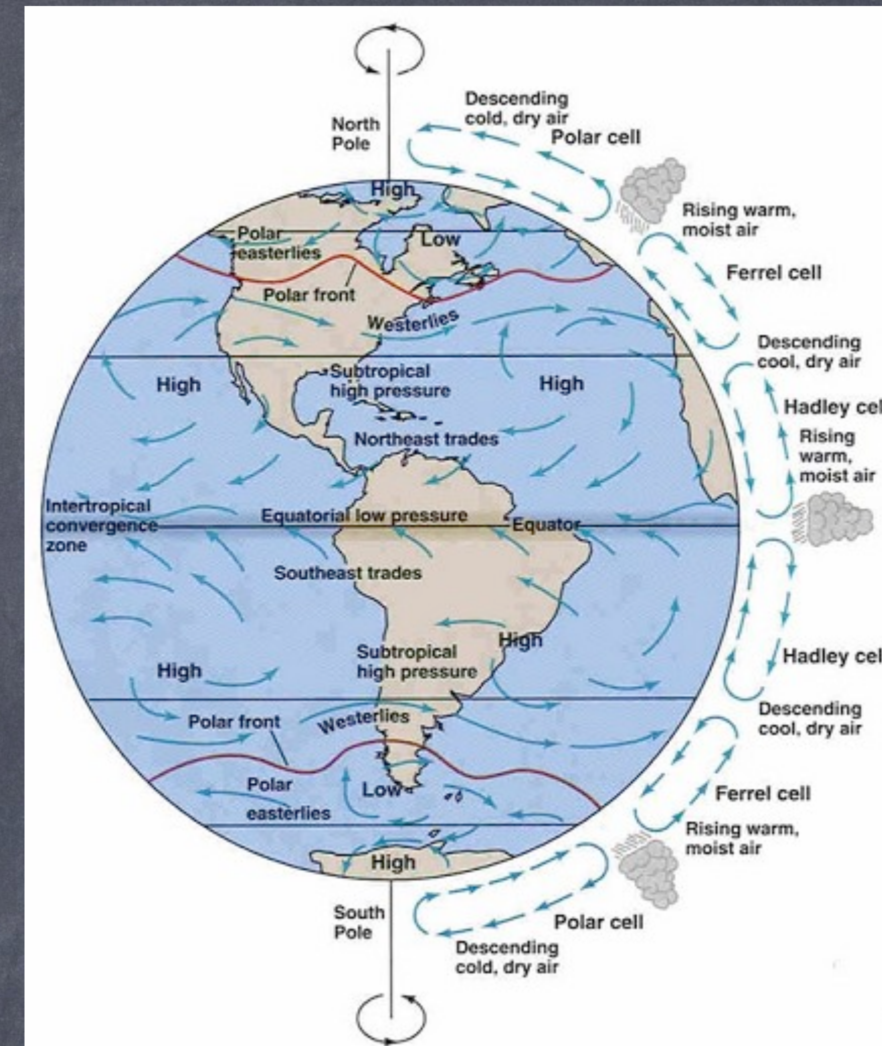
Mid-ocean ridge



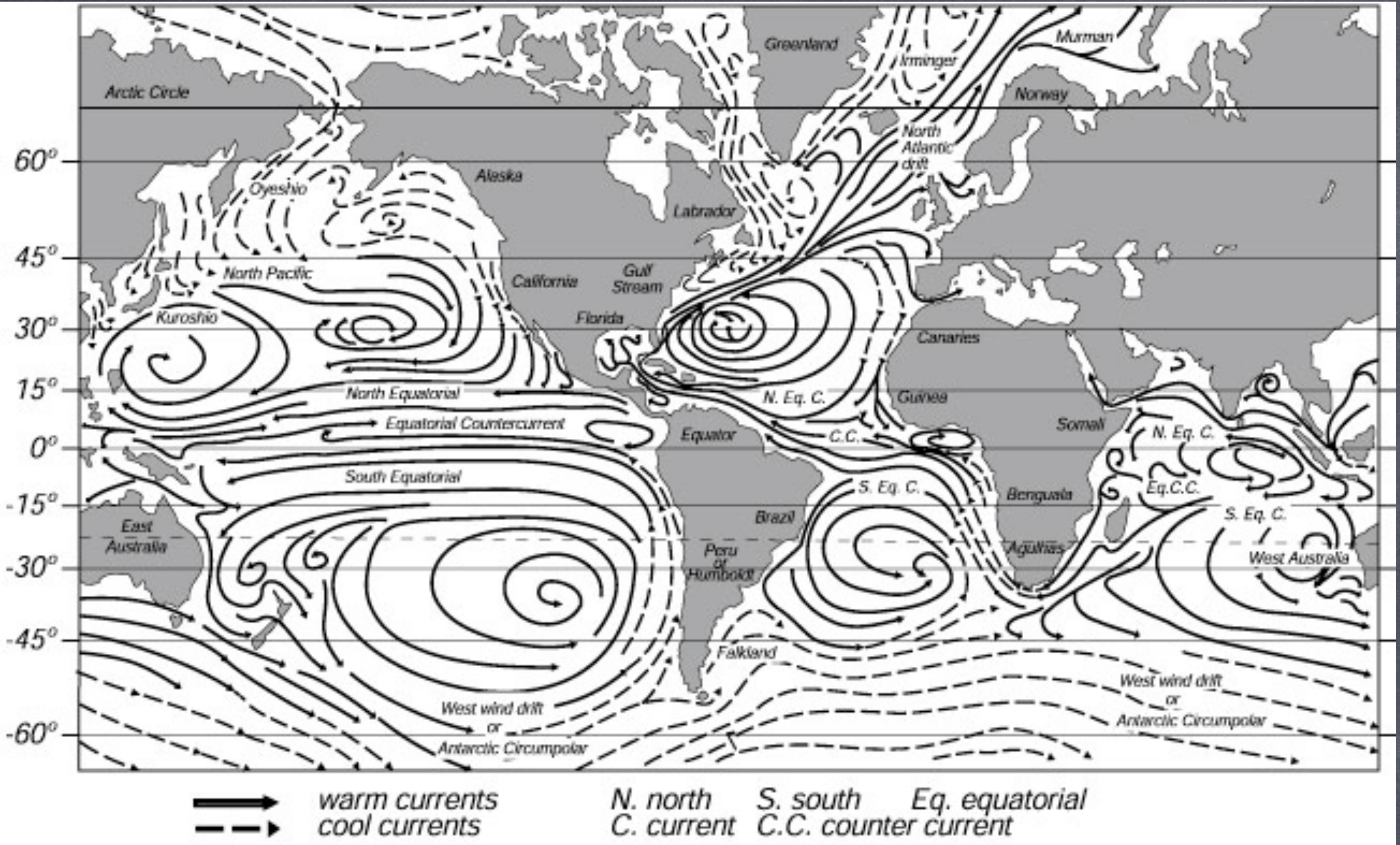
Major current systems

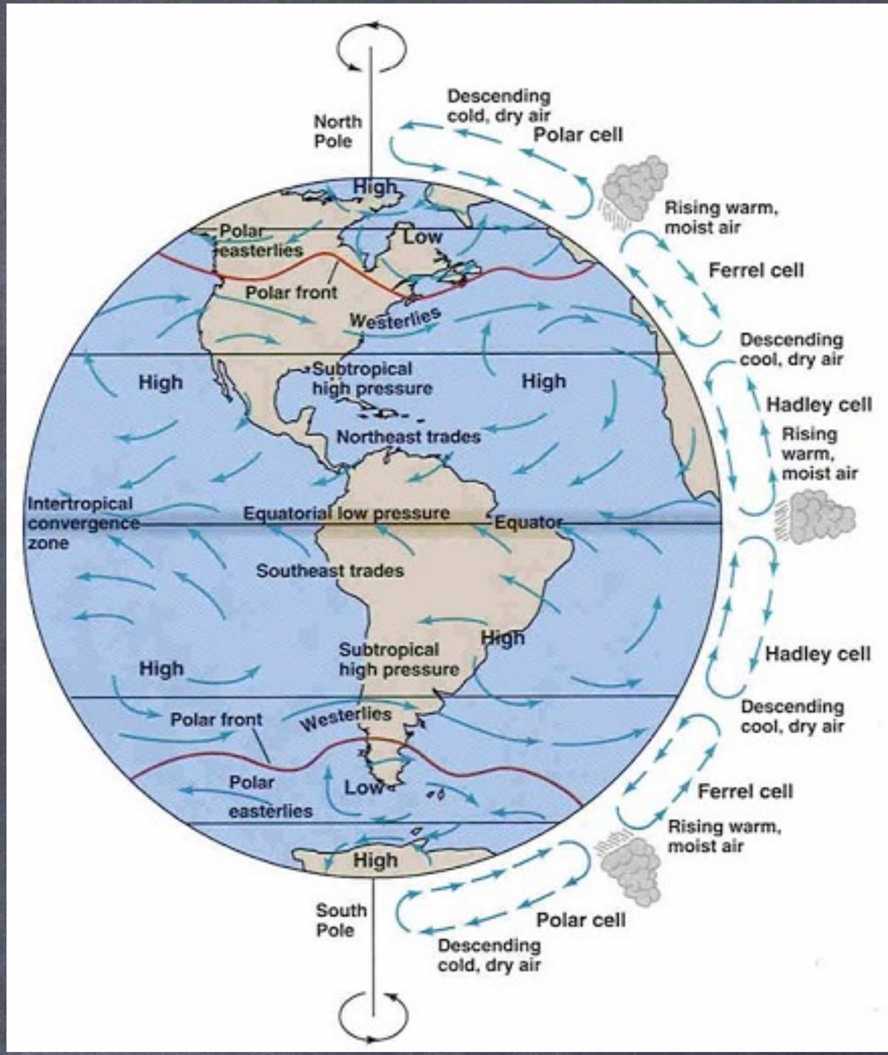
You see gyres separated by zonal flow at equator



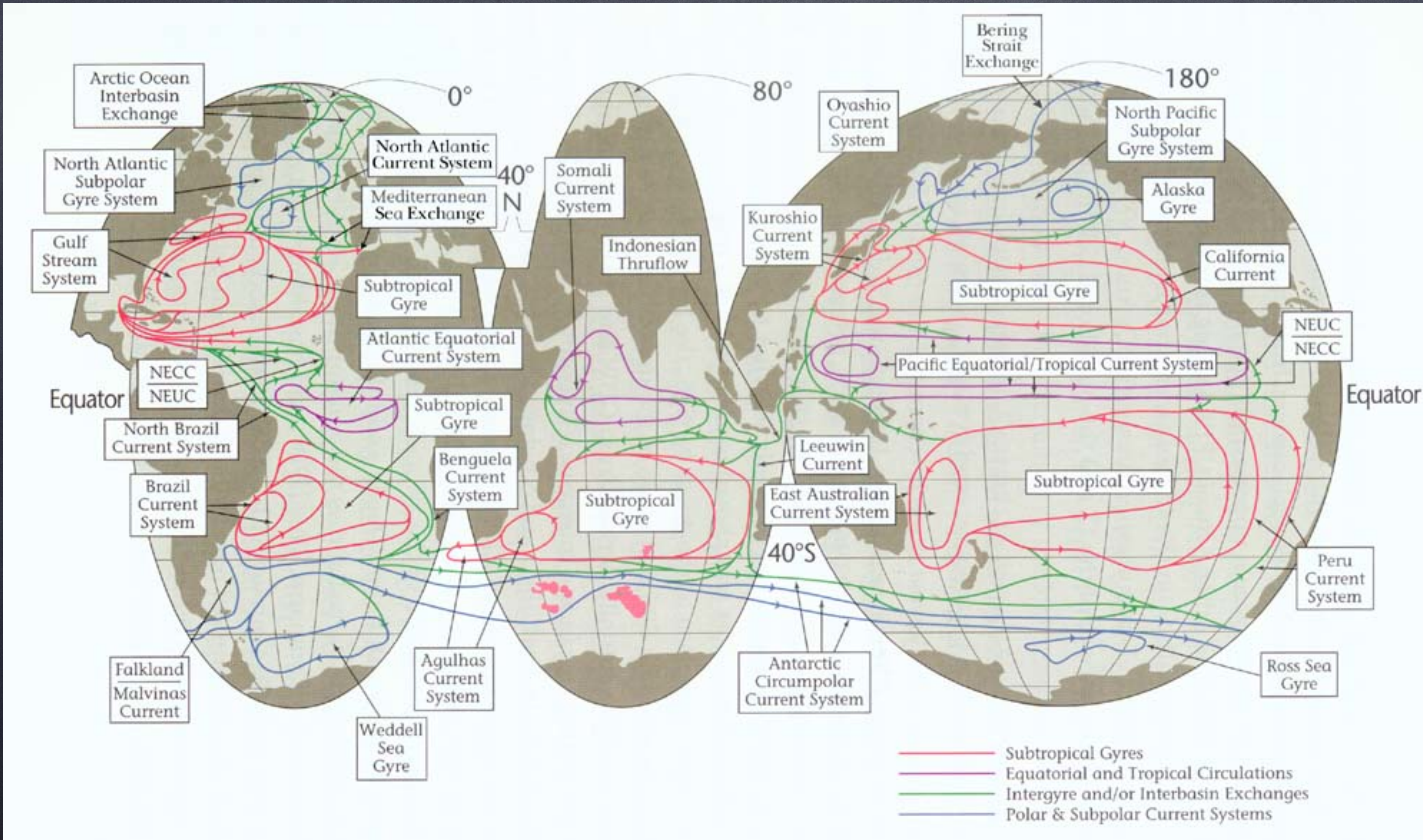


Now see gyres offset to west and zonal currents and countercurrents on equator, plus subpolar gyres in northern hemisphere, and north-south excursion of ACC in Southern Ocean

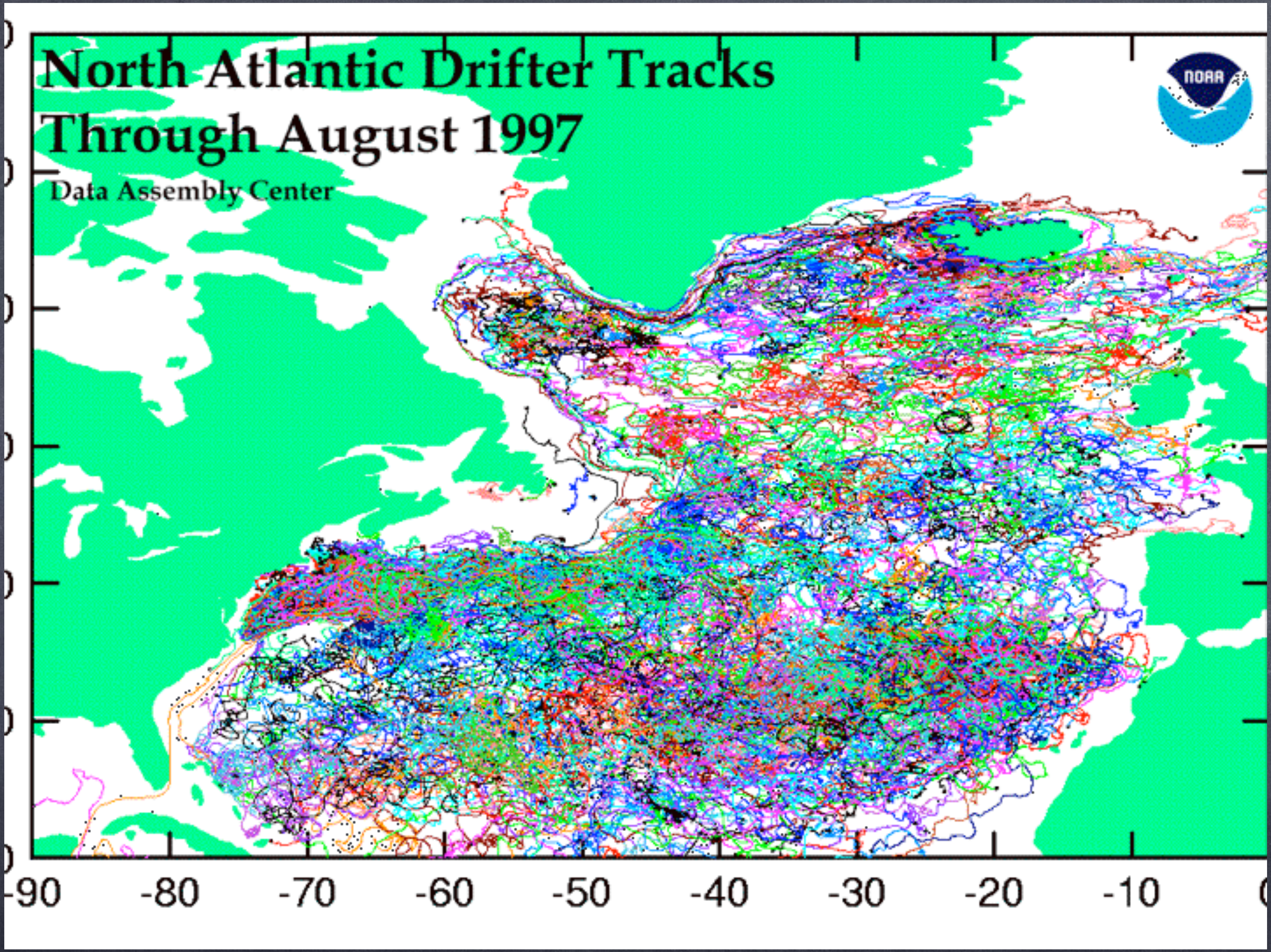




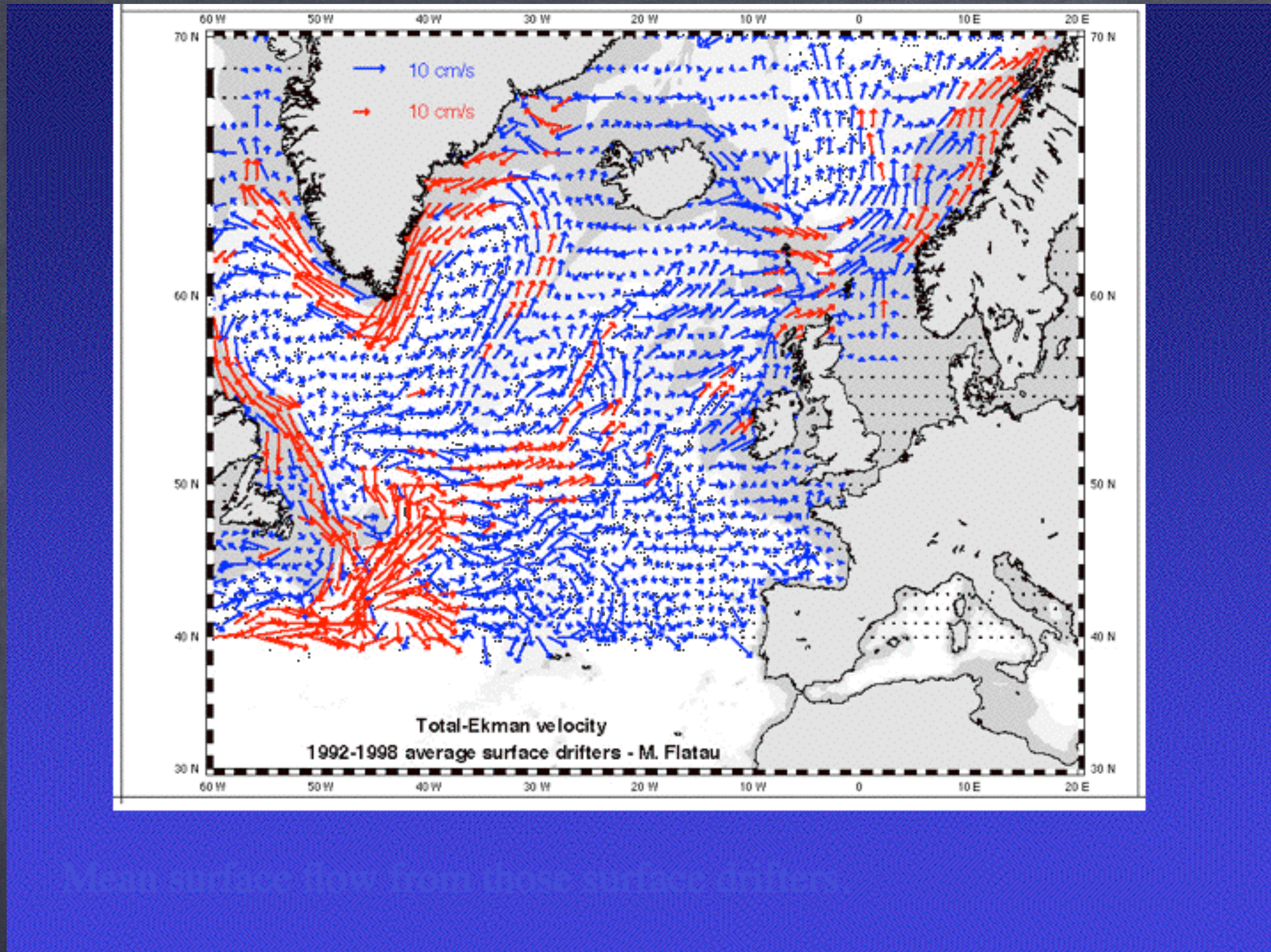
Wind systems look somewhat similar to ocean gyres, but not asymmetric... (ECC in opposite direction!)
Notice: subtropical gyre centers at latitude 30 - where air descends (high P). Gyre boundaries at 45 - rising air (low P)



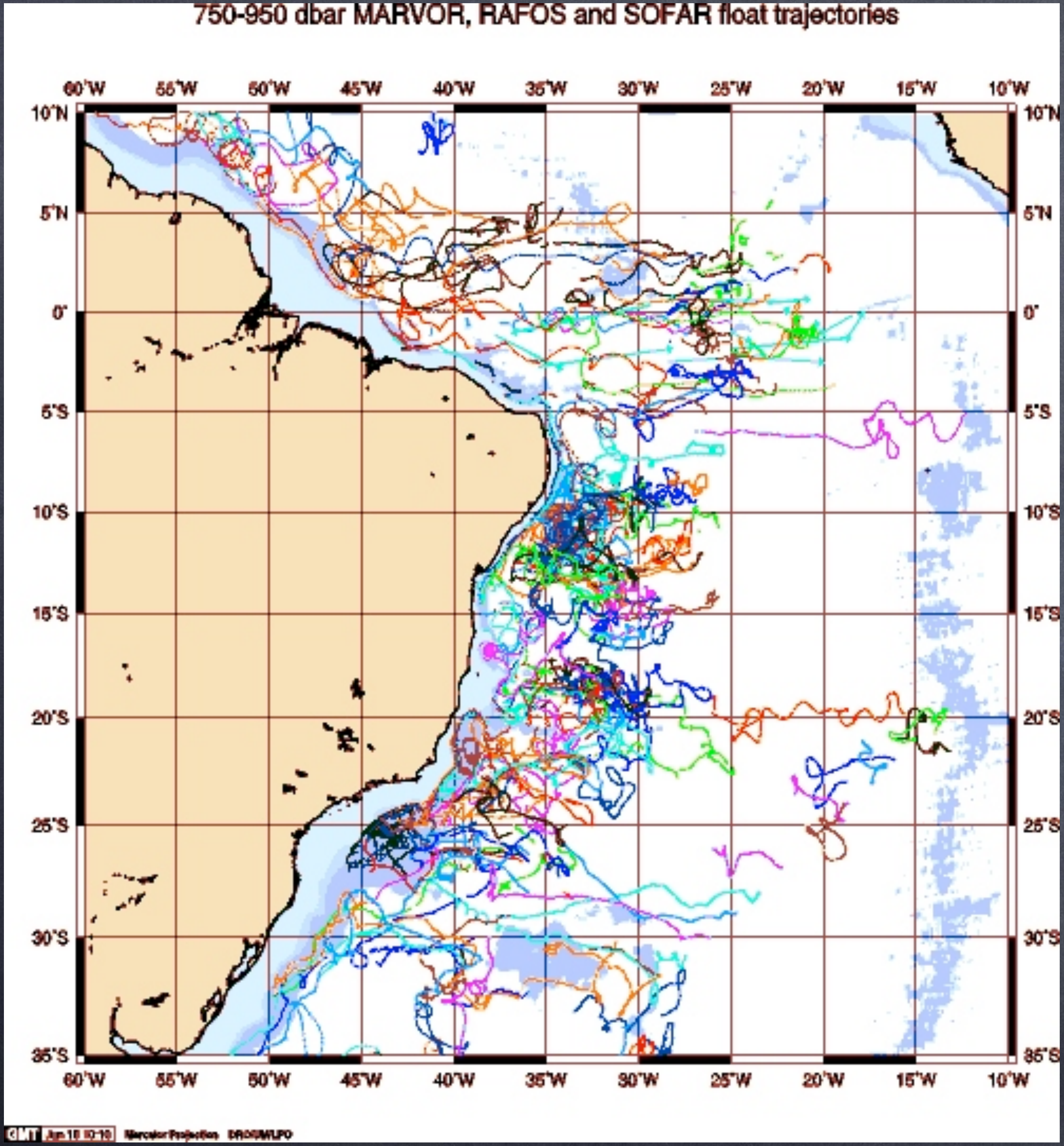
Arctic Ocean Interbasin Exchange
0°
80°
Bering Strait Exchange
180°
North Atlantic Subpolar Gyre System
North Atlantic Current System
Mediterranean Sea Exchange
40° N
Somali Current System
Oyashio Current System
North Pacific Subpolar Gyre System
Alaska Gyre
Kuroshio Current System
Gulf Stream System
Indonesian Thruflow
California Current
Subtropical Gyre
Subtropical Gyre
Atlantic Equatorial Current System
NEUC
NECC
Pacific Equatorial/Tropical Current System
NECC
NEUC
Equator
Equator
North Brazil Current System
Subtropical Gyre
Benguela Current System
Leeuwin Current
Subtropical Gyre
Brazil Current System
East Australian Current System
Subtropical Gyre
40°S
Peru Current System
Falkland
Malvinas Current
Agulhas Current System
Antarctic Circumpolar Current System
Ross Sea Gyre
Weddell Sea Gyre
Subtropical Gyres
Equatorial and Tropical Circulations
Intergyre and/or Interbasin Exchanges
Polar & Subpolar Current Systems

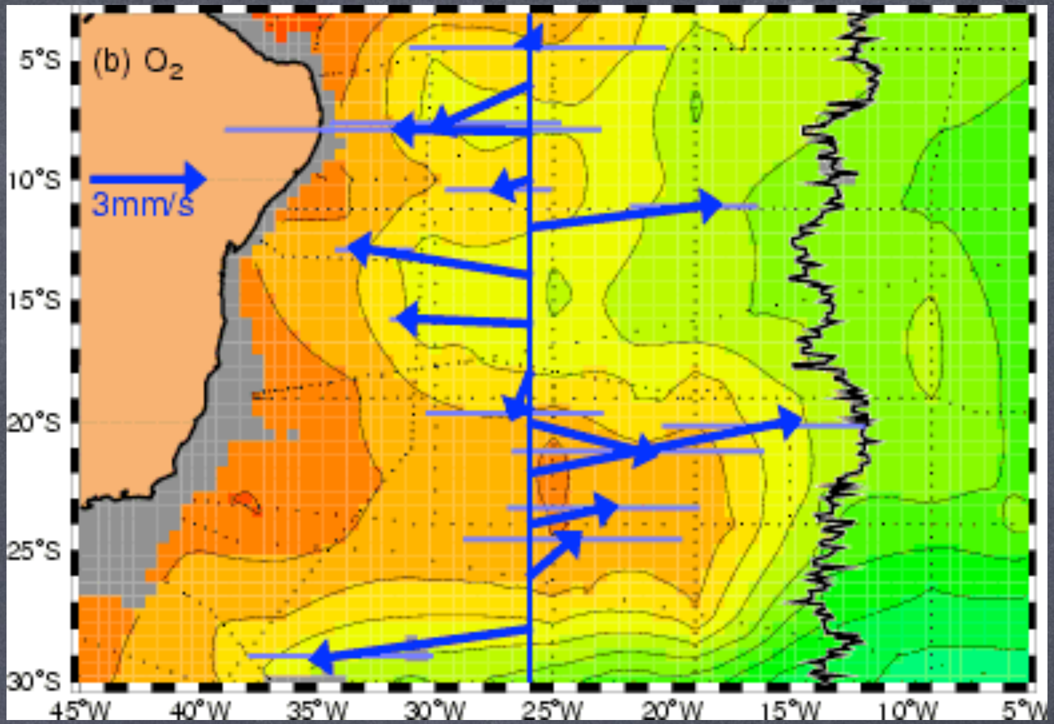


North Atlantic Drifter Tracks
Through August 1997
Data Assembly Center
NOAA
-90
-80
-70
-60
-50
-40
-30
-20
-10

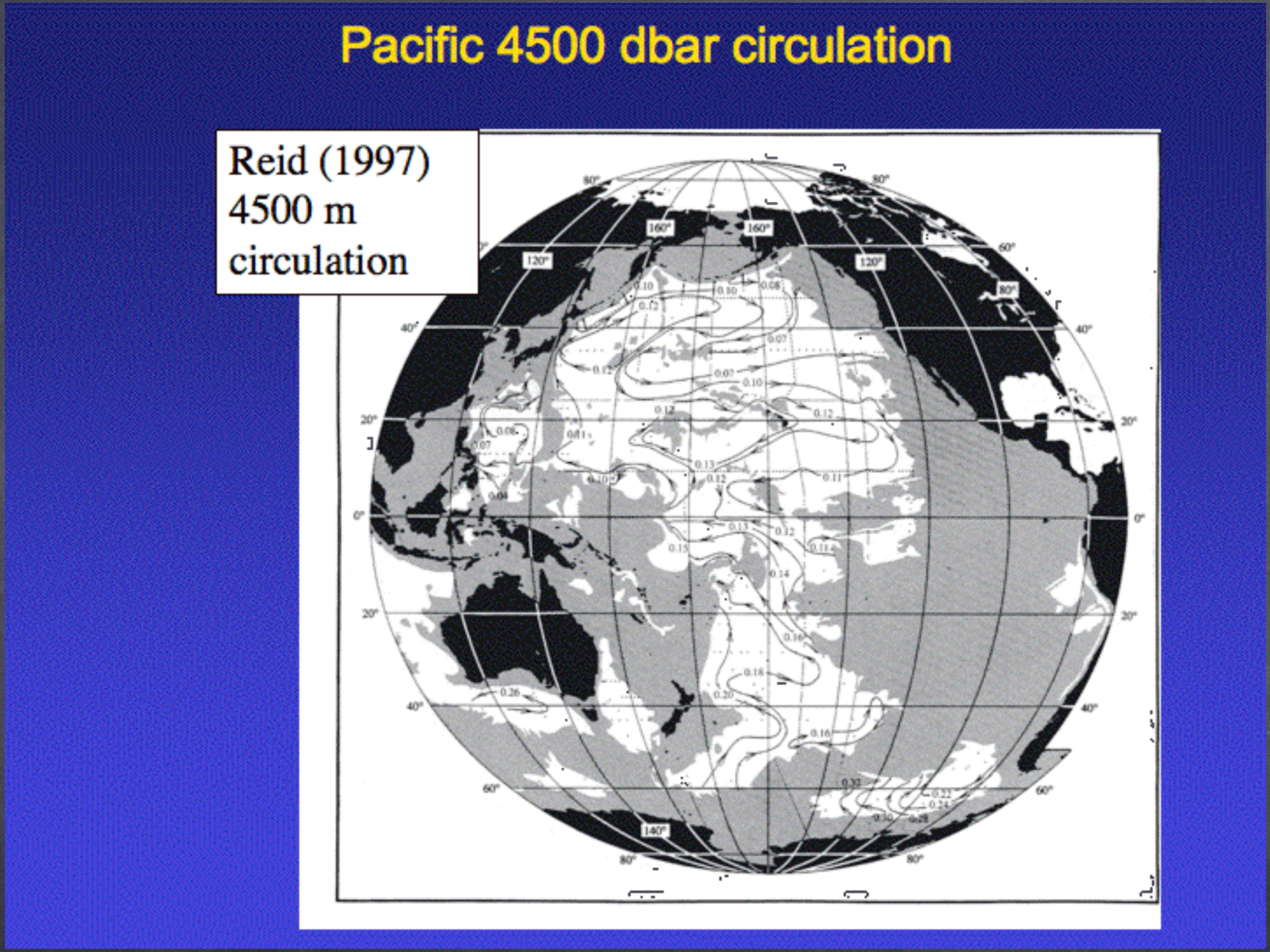


Drifter tracks averaged over six years





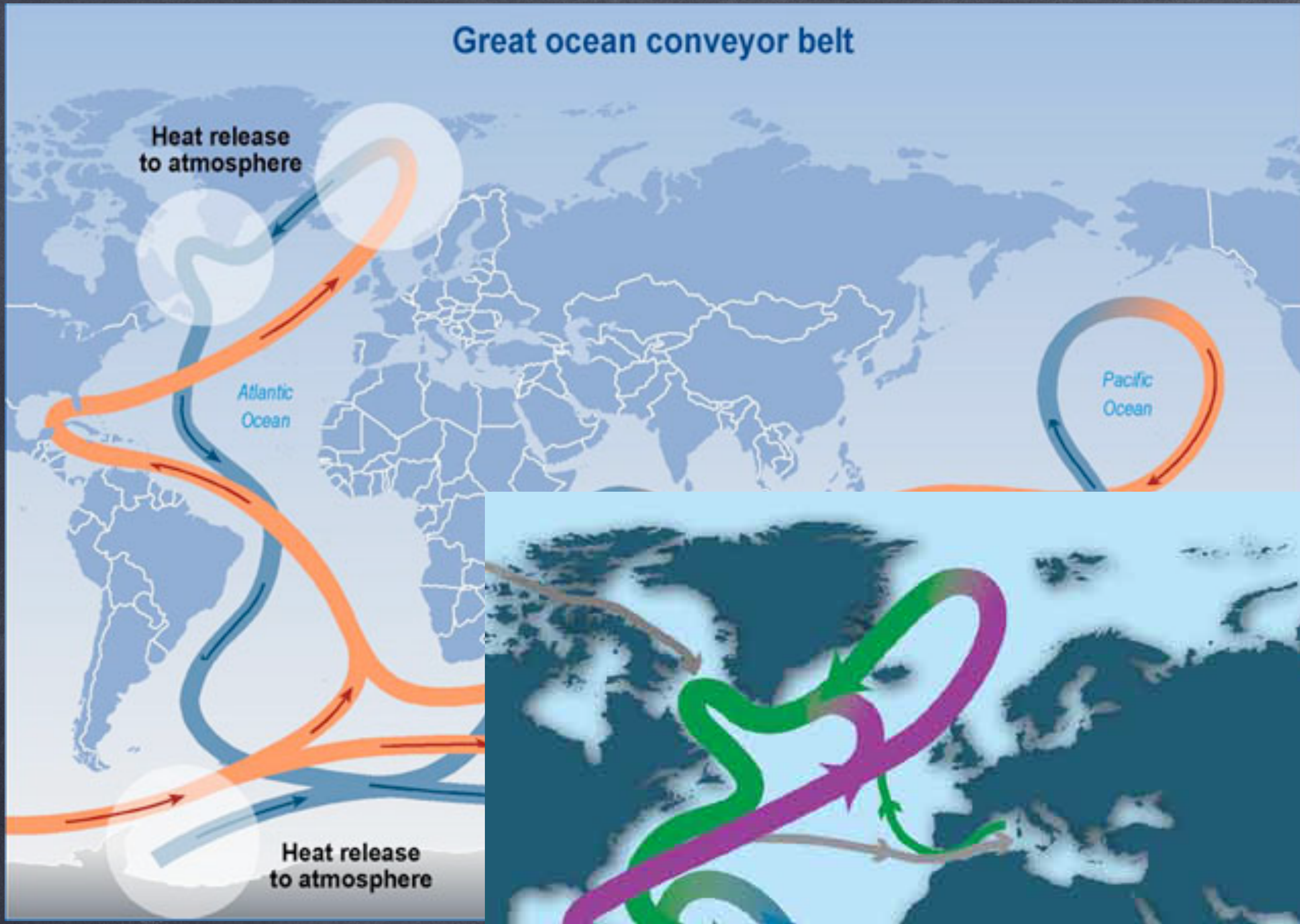
Intermediate and Deep circulation more complex and energetic than previously thought

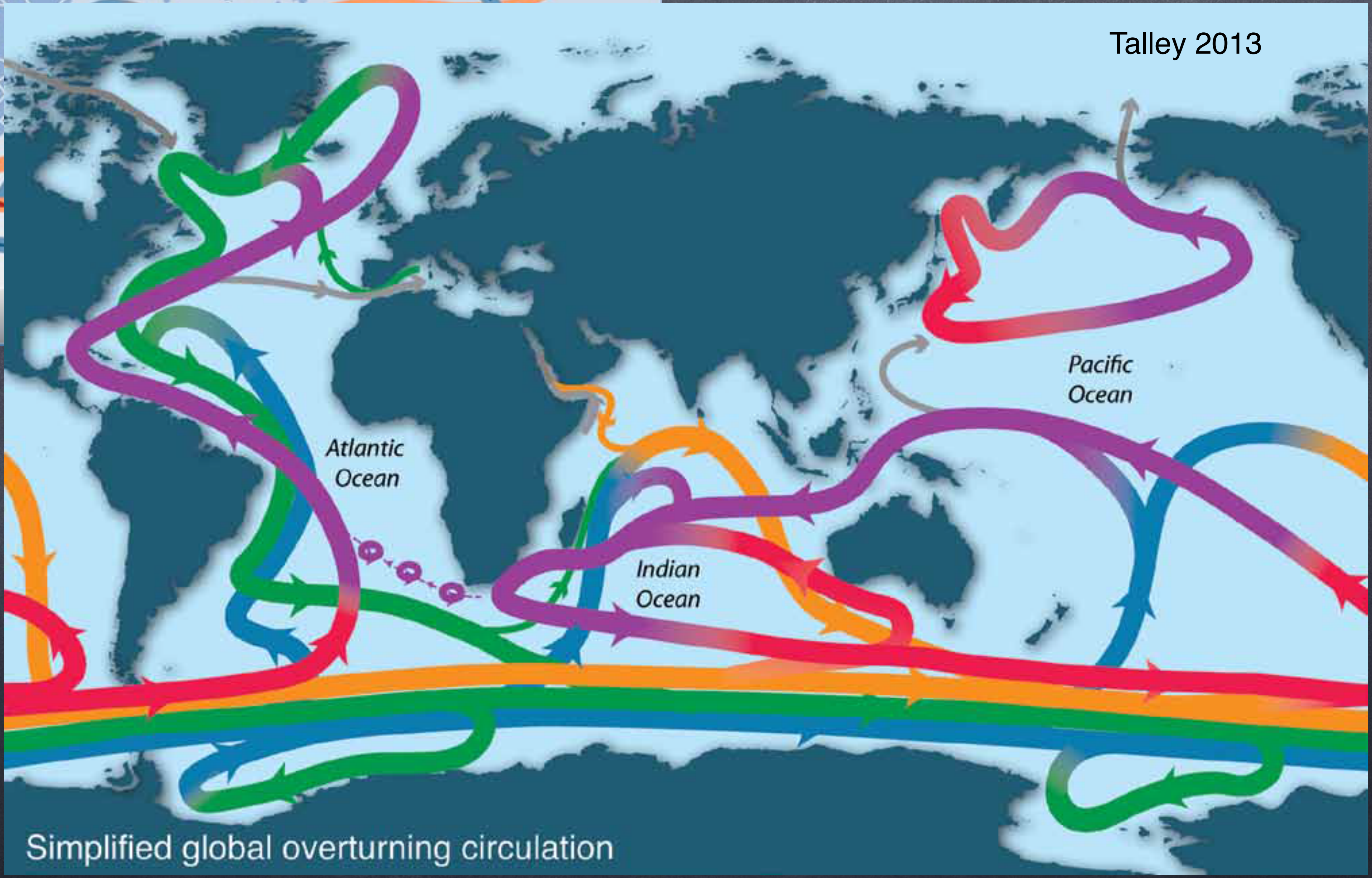


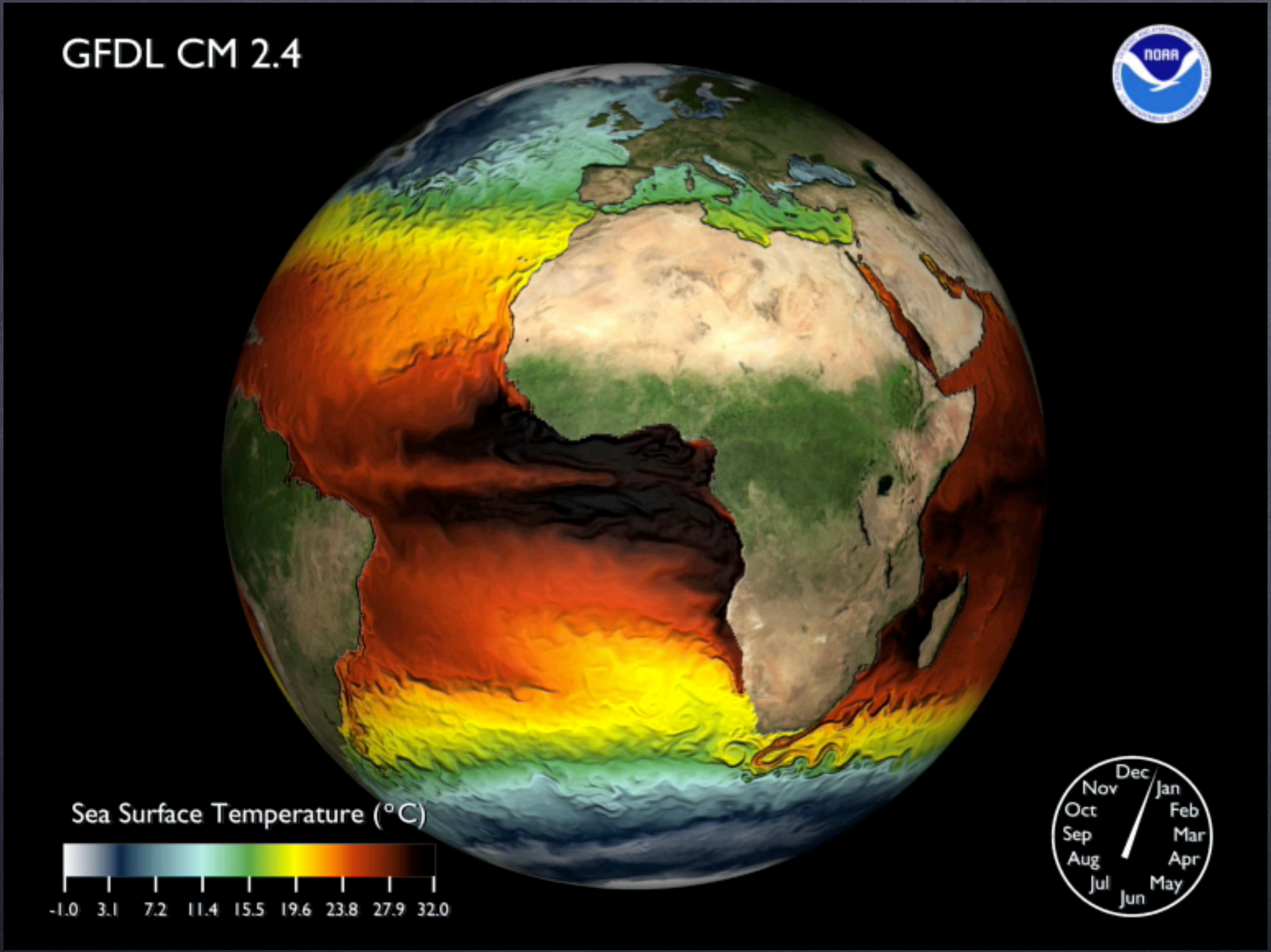
Deep circulation steered by bathymetry of ocean floor

Global thermohaline circulation

Meridional overturning circulation






GFDL CM 2.4
Sea Surface Temperature (°C)
-1.0 3.1 7.2 11.4 15.5 19.6 23.8 27.9 32.0
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov