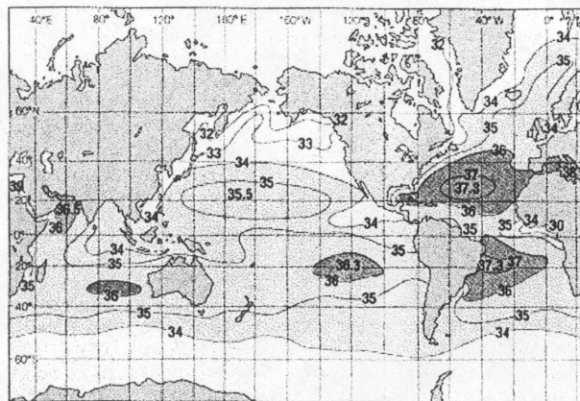
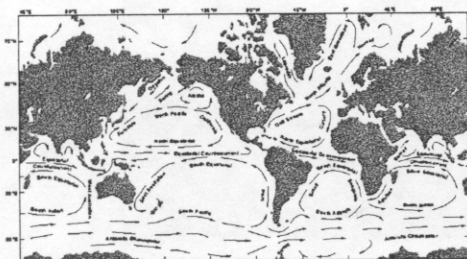
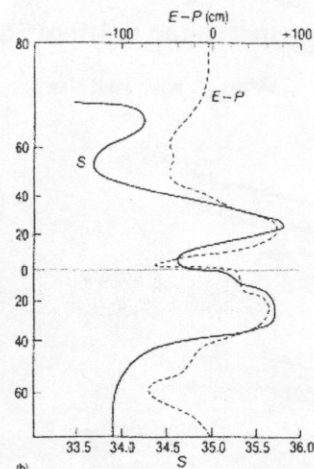


Topic: Oceans

1. Ocean circulation is forced by the exchange of heat, freshwater and momentum with the atmosphere.
2. Distribution of sea surface temperature (SST) reflects the pattern of net heat flux (solar – terrestrial – sensible heat – latent heat) at the ocean surface. SST varies between 30°C to –1.6°C. Similarly, the distribution of salinity of surface waters reflects the pattern of freshwater flux (evaporation – precipitation). Typical value of surface salinity is 35 permil (gm salt/kg water). Na⁺, Cl⁻ comprise 86% by weight of salt. The remainder major ions are sulfates, Mg, Ca, K, bicarbonates.
3. Density of sea water depends on the non-linear relationship between temperature and salinity.
4. Winds drive surface currents → wind-driven or gyre circulation.
5. Density differences drive the thermohaline circulation in the meridional (latitude-depth) plane. Cold very salty water is found in the North Atlantic; very cold salty water is found in the Weddell Sea, off the coast of Antarctica. The dense waters are gravitationally unstable and sink to depths of neutral buoyancy. These are the formation regions for North Atlantic Deep Water (NADW) and Antarctic Bottom Water (AABW).
6. The NADW travels southwards at ~1500 m depth in the ocean, eventually surfaces in the North Pacific, and returns at the surface to the North Atlantic. This is the thermohaline circulation, sometimes called the Conveyor Belt.
7. Marine primary production occurs in convergence zones where nutrients are brought to the euphotic zone. The convergence zones are regions of Ekman upwelling: wind drag + Coriolis → net water movement 90° to the right of the wind in the Northern hemisphere.
8. Hydrothermal vents are found where plate boundaries diverge. A surprise is the oases of life in the dark environment at the bottom of the ocean. Chemosynthetic bacteria oxidize H₂S to form sulfur compounds. The chemical energy released in the process is used by the bacteria to synthesize food.



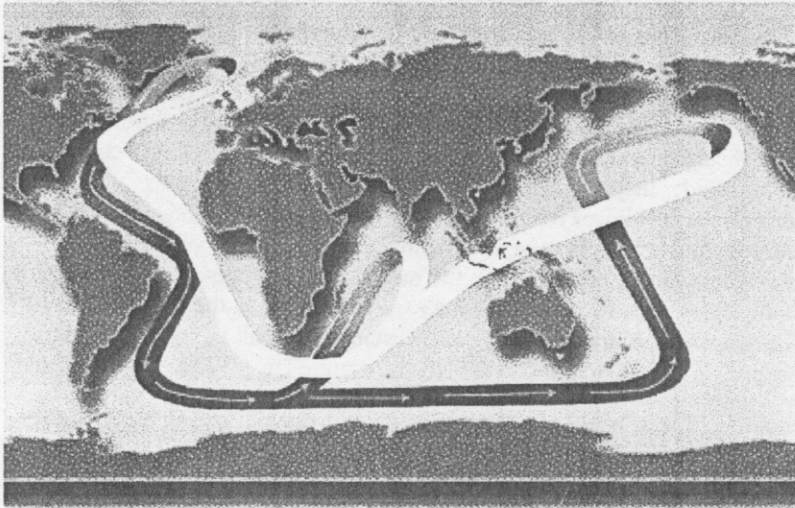
(a)



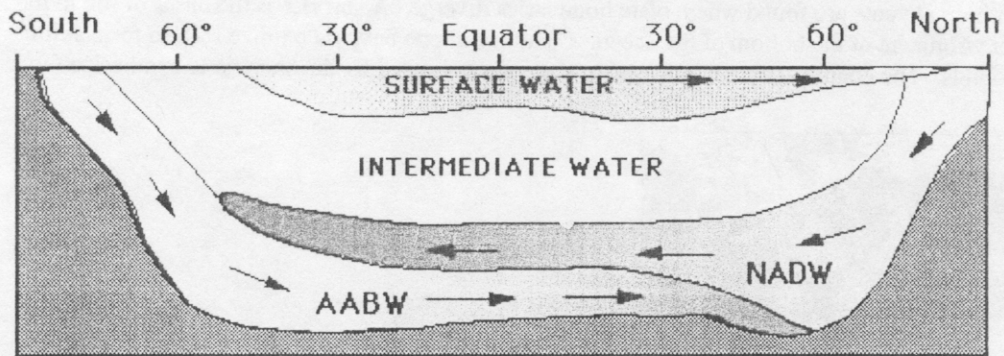
(b)


Figure 6.8 (a) The mean annual distribution of surface salinity.
 (b) Average values of salinity, S (black line) and the difference between average annual evaporation and precipitation (E-P) (blue line), plotted against latitude.

The Global Conveyor Belt



Atlantic Ocean Thermohaline Circulation



Increased nutrients & dissolved CO₂ 

Warm, low nutrients, & oxygenated 