

Why does the ocean flow?

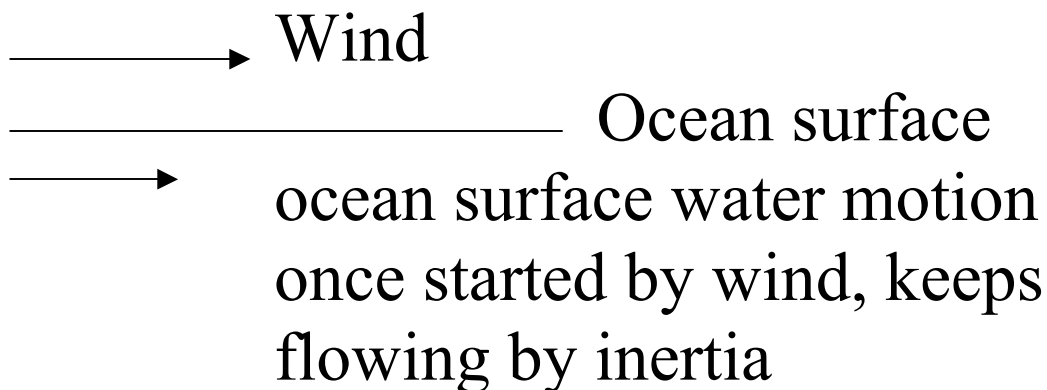
The winds give energy to the sea surface and the currents are the result.

The currents carry heat from one location to another



altering the Earth's surface temperature and modifying the air temperature above

Surface currents and Gyres



Currents flow more in response to the
AVERAGE ATMOSPHERIC
CIRCULATION than to the daily
weather (Compare Fig. 9.1 with 9.2)

Water moves slower than air above
thus, due to the Coriolis effect, it is
deflected to a greater extent than the
overlying air

Large-scale pattern of wind driven
surface currents is determined by

- prevailing winds
- the deflection of water due to the
Coriolis effect
- shape and distribution of
landmasses

Clockwise continuous flow in Northern hemisphere

Counterclockwise continuous flow in Southern hemisphere

This circular-motion surface-current system is called GYRES.
(See Figures 9.3 & 9.4)

How deep into sub-surface does the wind have an influence?

Low friction coupling in the water
→ every next, deeper layer moves slower than the layer above and is DEFLECTED to the right (Northern Hemisphere, NH); or to the left (Southern Hemisphere, SH)

The result is a SPIRAL in which each deeper layer moves *more slowly* with *greater angle of deflection*.

This is EKMAN SPIRAL (Figure 9.5)

Net water transport (flow) moves 90° to the right (NH) or to the left (SH)

Ekman transport along GYRES produces a CONVERGENCE LENS elevated ~ 1m above the equilibrium sea.



it depresses the underlying deeper water

This mound (lens of accumulated water) rises to the point when gravitational force (F_g) becomes equal to deflection force due to Coriolis (F_c)

$$F_g = F_c$$

Thus, no further deflection, at balance point



GEOSTROPHIC FLOW (Figure 9.7)
= currents flow smoothly around the gyre parallel to its elevation

Subsurface water density distribution is the key to describe the extent of the depression/elevation of the convergence lens.

Ocean currents map (Figure 9.8)

Current speed

- $1/100^{\text{th}}$ of the wind speed 10 m above the sea surface
- (0.1 to 0.5 m/s)
- faster flow when large volume is forced through a narrow strait (gap).

Gulf stream carries 500 times more water than the Amazon River (Figure 9.11)

Ocean currents are influenced by

1. wind
2. depth they flow
3. width of the current
4. influence of other currents
5. rotation of the Earth

Currents flowing on the western side of the Pacific and Atlantic flow FASTER than on the eastern side.

→ WESTERN INTENSIFICATION of currents

Why?

On western side they flow from low to high latitudes

1. increase in the Coriolis effect

2. the changing strength and direction of the east-west wind field (trade winds vs. westerlies)
3. the friction between landmasses and ocean water currents (there is compression of the currents towards the western side of the ocean)

Surface currents have strong impact on climate of Japan, N. Asia, British Isles and N. Europe