

## OCEAN CURRENTS

M.K. Antony  
National Institute of Oceanography,  
Dona Paula, Goa

### ABSTRACT

Anyone having an elementary acquaintance with the oceans knows of the great currents which exist at its surface. Their existence has long been known to the mariners and probably they became aware of the currents by the difference in a course that is attempted and the one actually achieved.

Some of these currents such as the Gulf stream in the North Atlantic and its counterpart in the Pacific, the Kuroshio, have profound influence on continental climate by transporting warm water from the tropics to the higher latitudes. There are surface currents, however, which produce harmful effects on the total environment like the El Nino that causes extensive damage to the Peruvian Fishery.

The oceanic currents can generally be divided into three groups:

1. Currents related to distribution of density in the sea.
2. The currents caused by the stress of the wind on the sea surface.
3. Tidal currents and those due to internal waves.

The first group of currents are called currents without friction or the geostrophic currents and the second group belong to the wind driven currents or the currents with friction. The tidal and the internal wave currents are oscillatory and though they attain great speeds they may not have any direct impact on the circulation of the ocean waters.

#### 1) Currents without friction (Geostrophic currents):

The geostrophic currents are generated when internal pressure gradient exists within the fluid. The internal pressure gradient initiates water movement from high to low pressure region. Once the water starts moving, it is deflected by the Coriolis force towards right (left) in the northern (southern) hemisphere. A balance is reached between the pressure gradient force and the Coriolis force in due course and the current moves with a uniform speed along the isobaric surface.

The actual procedure of computing the geostrophic current require the knowledge of density distribution in the sea which is achieved by computing the density from the measurement of temperature and salinity at different depths in different locations.

Why oceanographers use the geostrophic method of computing the ocean currents is because direct measurement of ocean currents in vast areas is time consuming and expensive, whereas measuring temperature and salinity is much easier than making direct measurement of currents.

There are several drawbacks or disadvantages for this method, but if used intelligently and in parallel with other information, it can be very helpful. In fact, most of our knowledge of ocean circulation below the surface has been obtained by this method.

## 2) Currents with friction (Wind driven currents):

The currents produced by the stress of the wind passing over the sea surface is the wind driven current. Fridtjof Nansen, the eminent Norwegian Scientist during the Norwegian North Polar Expedition (1893-96) found that drift produced by the wind did not follow the wind direction, but deviated by  $20-40^\circ$  to the right of the wind. He explained this as an obvious consequence of the earth's rotation.

V.W. Ekman in 1905 showed theoretically that the effect of wind blowing steadily over an ocean of infinite depth, extent and uniform eddy viscosity is to drive the surface layer at an angle of  $45^\circ$  to the right of the wind direction in the northern hemisphere and towards left in the southern hemisphere. The successive deeper layers deviate more and more towards right until at a given depth the direction of motion is opposite to that at the surface. In addition to this, the speed of motion decreases with depth giving the shape of a spiral called "Ekman spiral". The depth at which the water motion is opposite to that at the surface is called the "depth of frictional influence",  $D$ . At this depth, the flow has a speed of about  $1/23$  of the surface value. A characteristic value for  $D$  is about 100 m.

In association with the decay of velocity with depth, a net horizontal transport of water (which is independent of any change of eddy viscosity) is present. This transport is at right angles to the wind direction and towards right in the northern hemisphere and left in the southern hemisphere. This transport of water is generally known as "Ekman Transport".