Marine current

A current is a moving mass of water, the displacement of which occurs in three dimensions, both on the surface and in the depths. In the marine environment, currents (and masses of water) differ from the surrounding waters in their speed of movement, temperature and salinity. Although marine currents are a phenomenon that has been known for a long time, if only from the drift of ships from their set courses, it is only in the 18th century that the different water masses in the oceans began to be distinguished, by Â«measuresÂ» of temperature and salinity using thermometers and water sampling flasks immersed from boats. Later, the improvement of instruments enabled direct measures of currents, either using fixed current meters giving temporal series of current measures (Eulerian measures) or using the analysis of the trajectories of free-floating buoys (Lagrangian measures). In recent years, satellite remote detection has revolutionised our view of the oceans by enabling data to be obtained on ocean currents over vast surface areas (surface temperatures, tides etc.).

Marine currents exhibit great variability in speed, flow rate, and they can be stable or intermittent. There are indeed currents that are very stable, contributing to the general ocean circulation patterns (the Gulf Stream in the north Atlantic, Kuroshio in the subtropical north Pacific, the Benguela current along the Atlantic coast of Africa), and the volumes involved, even if they can vary over time, are colossal – commonly of the order of tens of millions of cubic metres a second for any one of them. In comparison, the combined flow rates of all the rivers emptying into the oceans is only around one million cubic metres a second. Other currents are intermittent and seasonal, such as the Somalia current, which changes direction with the Monsoons, and which, despite its rather smaller flow rate, is one of the most violent marine currents in the world, with speeds in excess of three metres a second. Unlike river currents, which are channelled by the relief, the trajectories of marine currents are far more variable, and characterised by the existence of loops and eddies over several dozen kilometres, lasting from a few weeks to a few months. The continental land masses are however obstacles for oceanic circulation, and they affect the extent of various basins, the morphology of which influences the dynamics of marine currents. Thus in each oceanic basin there are counter-currents and sub-currents compensating the enormous masses of water drifting towards the continents. This is what occurs in the Pacific for instance, with the north-equatorial and south equatorial currents which flow west, while part of the flow returns eastwards in the equatorial counter-current.

In seas and oceans, water can be moved by wind, by the tides, by variations in water density or by ocean swell (swell currents are only perceptible near coastlines). Wind, by driving the surface water molecules, generates surface currents which initially move in the same direction as the wind, but as a result of the Coriolis effect, linked to the Earth's rotation, they are deflected to the right in the northern hemisphere and to the left in the southern hemisphere. Wind does not only generate surface currents, it also produces vertical circulation. Since the forces brought to bear by wind are not uniform on the ocean surface, they lead to movements of convergence or divergence of water masses, for instance when two currents flow obliquely one towards the other, generating compensatory currents. A convergence phenomenon causes one of the water masses to plunge downwards, while a divergence has the opposite effect. A classic example of the vertical movement of a water mass resulting from wind action is the upwelling that can occur at any point in the oceans, but which is more marked along coastlines. If the wind blows in such a way that the surface waters are driven away from the coast, this surface water is replaced by colder water from deeper down, generally rich in nutrients which favour biological production. Among the best-known examples of this phenomenon is the coast of Chile and Peru, which is among the richest fishing zones in the world.

While wind is a frequent cause of marine currents, it is however not the only one. Water masses differ in terms of density, which varies with temperature, salinity and atmospheric pressure. Waters in the ocean depths are generally fairly similar in density, but surface water densities are extremely variable, in particular because of differences in salinity as a result of evaporation, the arrival of fresh water from the rivers, and the meting of the ice caps. Since wind can only generate currents on or near the surface, it cannot be the cause of intermediate and deep currents, which occur at depths of several thousand metres. These waters well up to the surface under the influence of exchanges between ocean and atmosphere which alter their density. The cooling of the Gulf Stream in the north Atlantic when it comes into contact with the masses of polar air is a well-known phenomenon, leading to an increase in density of the water. These denser waters, colder and more salty (because of the formation of sea ice) plunge downwards from the surface to enter into a long circuit, known as thermohaline circulation because it is determined by differences in both temperature and salinity. This circuit, often likened to an ocean "conveyor belt", whereby deep waters slowly rise to the surface in the Indian and Pacific oceans after several hundred years, has a regulating effect on the earth's climate, ensuring the transport of heat from the Equator towards the Poles, and conversely transferring masses of cool surface water to regions in the lower Â«latitudesÂ».

See also: Â«deltaÂ», Â«estuaryÂ», Â«litoralÂ»

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