

by the rise and fall of the tides. The effect of this cause is, as before observed, most striking in estuaries and channels between islands.

A third cause of oceanic currents is evaporation by solar heat, of which the great current setting through the Straits of Gibraltar into the Mediterranean is a remarkable example, and will be fully considered in the next chapter. A stream of colder water also flows from the Black Sea into the Mediterranean. It must happen in many other parts of the world, that large quantities of water raised from one tract of the ocean by solar heat, are carried to some other where the vapour is condensed and falls in the shape of rain, and this, in flowing back again to restore equilibrium, will cause sensible currents.

These considerations naturally lead to the inquiry whether the level of those seas out of which currents flow, is higher than that of seas into which they flow. If not, the effect must be immediately equalized by under-currents or counter-currents. Arago is of opinion that, so far as observations have gone, there are no exact proofs of any such difference of level. At the same time he admits the important and remarkable fact that the level of the Mediterranean near Alexandria is lower by 26 feet 6 inches, than the Red Sea near Suez at low water, and about thirty feet lower than the Red Sea at the same place at high water. This result was obtained during the French expedition to Egypt, from the measurements of M. Lepère.*

It was formerly imagined that there was an equal, if not greater diversity, in the relative levels of the Atlantic and Pacific, on the opposite sides of the Isthmus of Panama. But the levellings carried across that isthmus by Capt. Lloyd, in 1828, to ascertain the relative height of the Pacific Ocean at Panama, and of the Atlantic at the mouth of the River Chagres, have shown, that the difference of mean level between those oceans is not considerable, and, contrary to expectation, the difference which does exist is in favour of the greater height of the Pacific. According to the result of this survey, on which great dependence may be placed, the mean height of the Pacific is three feet and a half, or 3.52 above the Atlantic, if we assume the mean level of a sea to coincide with the mean between the extremes of the elevation and depression of the tides; for between the extreme levels of the greatest tides in the Pacific, at Panama, there is a difference of 27.44 feet; and at the usual spring tides 21.22 feet: whereas at Chagres this difference is only 1.16 feet, and is the same at all seasons of the year.

The tides, in short, in the Caribbean Sea are scarcely perceptible, not equalling those in some parts of the Mediterranean, whereas the rise is very high in the Bay of Panama; so that the Pacific is at high tide lifted up several feet above the surface of the Gulf of Mexico, and then at low water let down as far below it.† But astronomers are agreed that, on mathematical principles, the rise of the tidal wave above the mean level of a particular sea must be

* An. du Bureau des Long. pour l'an 1836. † Phil. Trans., 1830, p. 59.