

a paper on the Vertical Distribution of Temperature in the Ocean,<sup>1</sup> in which more especially attention is paid to the effect of the surface climate on the waters of the subtropical North Atlantic. Here the surface of the ocean is exposed to the action of the northeast trade wind, which blows from colder to warmer regions, so that while it is continually taking up moisture it is continually increasing its power of doing so. In this region the removal of water from the ocean is effected in the form of vapour, in polar regions it is effected in the form of ice. In whichever way it is removed the effect is the same, the remaining water is salter than the original water, and therefore denser at the same temperature. In other words, the concentrated water will have the same density as the original water at a higher temperature, and it will have power to sink into or penetrate the original water before it has sunk to the same temperature. In this way the high winter temperatures of subtropical regions and the low temperature of freezing sea water, tend to be propagated downwards. In the Atlantic, Indian, and Pacific Oceans, there are return currents of dense warm water from tropical seas, along the eastern shores of South America, Africa, and Australia. The high salinity of this water gives it when cooled great penetrative power, as it can bear much dilution and still sink through the water of high latitudes at the same temperature.

It is probable therefore that the cold water at the bottom of the ocean, in so far as it is drawn from the southern hemisphere, leaves the surface between the parallels of 40° and 55° of south latitude. From this zone the water is drawn northwards to make good deficiencies, and it no doubt flows southward also in order to replace the ice and cold surface water drifted northward in the summer. The comparatively warm water which reaches the Antarctic Circle at a depth of 300 fathoms can only come from such a source. Its temperature is of course lowered by being drawn into polar regions, but it probably persists as a warmer stratum until it is arrested by the shoaling of the water. If within the Antarctic Circle there are seas like the Norwegian Sea within the Arctic, that are almost completely shut off from the general oceanic circulation, their waters will certainly have the same low temperature of about 29° F. from surface to bottom. In the Arctic Ocean a brisk superficial circulation is kept up by the warm North Atlantic current which penetrates it along the eastern side of the Norwegian Sea, and is in a measure compensated by cold polar currents which leave the Arctic Ocean along the eastern coast of Greenland and by Baffin's Bay along its western side, removing with them a large portion of the winter's ice. A circulation similar to this appears to be entirely wanting in the Antarctic regions; hence their ice-bound character.

*Icebergs.*—Sir James Ross, in his celebrated voyage, having discovered Victoria Land, sailed along its coast to the southward as far as the 76th parallel, where he

<sup>1</sup> *Proc. Roy. Soc. Lond.* vol. xxiii. p. 124 (1874), 1875.