

distribution of animals and plants, as well as the nature and causes of oceanic circulation, will be greatly aided by a more accurate knowledge of the contour of the ocean-bed.

*Surface-Temperature.*—The surface-temperature of the sea, as also the temperature of the air as determined by the dry- and wet-bulb thermometers, should be regularly recorded every two hours during the day and night throughout the voyage.

These records should be reduced to curves, for the purpose of ready comparison: and the following points should be carefully attended to:—

1. In case of a general correspondence between the temperature of the sea and that of the air, it should be noted whether in the diurnal variation of both the sea appears to *follow* the air, or the air the sea.

2. In case of a marked discordance, the condition or conditions of that discordance should be sought in (a) the direction and force of the wind, (b) the direction and rate of movement of the ocean surface-water, (c) the hygrometric state of the atmosphere. When the air is very dry, there is reason to believe that the temperature of the surface of the sea is reduced by excessive evaporation, and that it may be below that of the subsurface stratum a few fathoms deep. It will be desirable, therefore, that every opportunity should be taken of comparing the temperature at the surface with the temperature of the subsurface stratum,—say at every 5 fathoms down to 20 fathoms.

*Temperature Soundings.*—The determination of the temperature, not merely of the bottom of the ocean, over a wide geographical range, but of its various intermediate strata, is one of the most important objects of the Expedition; and should, therefore, be systematically prosecuted on a method which should secure comparable results. The following suggestions, based on the experience already obtained in the North Atlantic, are made for the sake of indicating the manner in which time and labour may be economised in making serial soundings, in case of the employment of the Miller-Casella thermometer. They will be specially applicable to the area in which the work of the Expedition will commence; but the thermal conditions of other areas may prove so different, that the method may need considerable modification.

The following strata appear to be definitely distinguishable in the North Atlantic:—(a) a “superficial stratum,” of which the temperature varies with that of the atmosphere, and with the amount of insolation it receives. The thickness of the stratum does not seem to be generally much above 100 fathoms; and the greatest amount of heating shows itself in the uppermost 50 fathoms. (b) Beneath this is an “upper stratum,” the temperature of which slowly diminishes as the depth increases down to several hundred fathoms; the temperature of this stratum in high latitudes is considerably *above* the normal of the latitude; but in the intertropical region it seems to be considerably *below* the normal. (c) Below this is a stratum in which the rate of diminution of temperature with increasing depth is rapid, often amounting to 10° or more in 200 fathoms. (d) The whole of the deeper part of the North Atlantic, below 1000 fathoms, is believed to be occupied by water not many degrees above 32°. With regard to this “glacial stratum,” it is exceedingly important that its depth and temperature should be carefully determined.

It will probably be found sufficient in the first instance to take, with each deep *bottom* sounding, *serial* soundings at every 250 fathoms, down to 1250 fathoms; and then to fill up the intervals in as much detail as may seem desirable. Thus, where the fall is very small between one 250 and the next, or between any one and the bottom, no intermediate observation will be needed: but where an abrupt difference of several degrees shows itself, it should be ascertained by intermediate observations whether this difference is sudden or gradual.

The instrument devised by Mr. Siemens for the determination of submarine temperatures is peculiarly adapted for *serial* measurements, as it does not require to be hauled up for each reading. It should, however, be used in conjunction with the Miller-Casella thermometer, so as to ascertain how far the two instruments are comparable: and this point having been settled, Mr. Siemens' instrument should be used in all serial soundings; and frequent readings should be taken with it, both in descending and ascending.

A question raised by the observations of the U.S. Coast Surveyors in the Florida Channel, and by those of our own surveyors in the China Sea, is the extent to which the colder and therefore heavier water may run *up*