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Investigations of the North Sea Thermocline

by

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It is a well-known fact that in summer a thermocline is regularly forming in the North Sea. This thermocline originates from the heating of the surface water in spring due to insolation and is gradually gaining more depth in summer as a consequence of the turbulent mixing. The thermal convection caused by the cooling of the surface water dissolves the thermocline in autumn so that the water masses of the North Sea will be thermally homogeneous in winter. The thermocline may generally be assumed to form and dissolve in May/June and September/October respectively and the intensity of the temperature gradient will change from year to year, as it depends - apart from the insolation - on the cloudiness, evaporation, wind, and sea. An investigation of G. Prahm (Deutsche Hydrographische Zeitschrift, 1961, No.6) describing the weekly measurements of the vertical course of the temperature near the German lightvessel S2, south of the Dogger Bank, over a period of 5 years will give an impression of the possible year to year differences. Unfortunately, this vessel was not situated in that part of the North Sea where a thermocline may regularly be expected. No long-term measurements at all are available from this part. We have therefore tried to get an idea of the mean behaviour of the thermocline by means of the temperature measurements in the years 1902-54 published in the Bulletins Hydrographiques. We started from the monthly mean values of the temperature in 1/2° and 1° fields determined for the depths 7.5, 20, 30, 40, 60, 80, 100 m and for the near bottom regions which were already applied in an Atlas of monthly charts of the temperature for the above-mentioned depths (Deutsche Hydrographische Zeitschrift. Supplement, Series B, No. 7). We have, moreover, used the monthly mean values for the surface given by G. Dietrich in the ICES atlas. This material enabled us to draw longitudinal and latitudinal sections showing the monthly mean course of the temperature. Some of the latitudinal sections will be shown. They give an idea of:

a) the forming and discontinuance of the thermal layering by means of sections at 56°30'N from January to December.

b) The difference in the thermal layering of the North Sea during one month, August, by means of 11 latitudinal sections between 61°30'N and 51°30'N.

The sections show the division into two water bodies above and below an area of a strong temperature gradient limited to a few metres. It should be borne in mind, that these sections do not represent actual but mean conditions. It is most probable that the actual gradients will be greater during some years. We will come back to this later.

In case these sections shall be used to represent the mean behaviour of the thermocline, the definition of a critical gradient will be necessary. A survey of all sections and experiments with different gradients gave a vertical change in temperature of 0.2°C./m as the best value for definition of the thermocline. This critical value may for the first time be observed in some places of the North Sea in May, in the whole Central North Sea, however, only in June. It is not reached in the North Sea - apart from a negligible number of places - in October. But if, e.g. a gradient of 0.15°C./m is taken as basis, this will lead to the result that already in April a thermocline is existing in the greater part of the North Sea which will not be completely dissolved in November. This result would not correspond to our knowledge of

the thermal layering. From 132 latitudinal and 84 longitudinal monthly representations of the temperature distribution in distances of 10 to 10 nm we have therefore selected those depths in which the gradient was $\geq$ 0.2°C. and have characterized them by 4 dimension figures: a) upper boundary of the thermocline; b) lower boundary of the thermocline; c) depth of the strongest gradient; d) value of the strongest gradient. These figures were used to map the North Sea thermocline from June to September. No representation is given for May and October when the first or last symptoms of the thermocline can be observed. The representations demonstrate the extent of the thermocline, its increasing and decreasing intensity, and its migration into the depth within the course of the year. It has to be pointed out, however, that only mean gradients could be processed. In the individual case the critical value which was taken as basis ($\geq$ 0.2°C./m) will mostly occur earlier and also outside the represented area. Here the above-mentioned investigations of G. Prahm serve as a clue. Although the lightvessel S2 is situated south of the area where according to our representations the thermocline can regularly be expected, a gradient of $\geq$ 0.2°C./m was temporarily observed. The same will hold for the more or less broad belt around the "thermocline area". It may also be assumed that smaller areas will exist already in May and still in October with a thermocline surpassing the critical gradient. This report shall only give an idea of the mean distribution and mean intensity of the North Sea thermal layering by means of the mean temperature values resulting from observation material covering a period of 53 years for the 1/2° and 1° fields in the North Sea.