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The use of nutrient distribution in the North Sea in explaining the dynamics of the different watermasses.

By

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INTRODUCTION

Chemical oceanography is according to my interpretation the use of chemical parameters to describe and to understand the course of events in the marine environment.

The conditions for using chemical parameters in this way are that the parameter in question can be measured simple enough to allow routine measurments giving timeseries with a sufficient density in the sampling so that the observations can be used to produce dynamic prosesse in the sea.The old methode for salinity determination by tritation with silver nitrate is a good example of a chemical methode that fullfilled this condition.

Shipboard use of an autoanalyzer for nutrient analysis has made it possible to measure nutrients with a frequensy close enough to give adequate pictures of the vertical and horizontal distribution in the standard hydrographical cross-sections operated.

As part of the late autum fisheries survey in the North Sea and the Skagerrak nutrient measurements have been done on all hydrographic stations. The degree of coverage of the area is to a great extent depending on the weather conditions. Fig. 1 shows the courslines and stations operated in November 1985 and represents a good covering of the area.

MATERIALS AND METHODES

The watersamples for the nutrient analysis have since 1983 been sampled with a Rosette watersampling system mounted around a N.B. CTD. The watersample are mainly collected from standard depths. The watersamples are analyzed consecutive onboard in an auto-analyzer spesially put together for field work,(FØYN et al. 1981). The chemical methodes used are mainly standardized after

STRICKLAND & PARSON,1968. Determinations of nitrate, nitrite, phosphate and silicate are the standard analyzing program. The investigated area is according to Fig.1 with a lesser coverage in some years.

RESULTS AND DISCUSSION

Fig. 2 presents the vertical distribution of nitrate and temperature in the cross-section from Feie to Shetland November 5th.1980. The nitrate distribution indicates three distinct configurations:

1. The Norwegian Coastal Current with small amounts of nitrate, less than 6-7 µM.
2. Two clearly shown cores of nitrate-rich water in the Norwegian Trench.
3. Nutrient-rich water "doming" up over the North sea platau.

From the temperature distribution none of theese configurations are shown.

The Coastal current is however clearly separated with salinity values below 35,0, but the details determined by the nitrate values givs a more distinct picture of the front between the coastal water and the Atlantic water.

FURNES et al. 1986, have used the same nutrient data to indicate the core of inflowing Atlantic water close to the western slope of the Norwegian Trench and the northward return closer to the norwegian coast.Their presentation showes that the cores with high nitrate values have a salinity of 35,3 and they define the Atlantic Inflow Water (AIW) to be water with a salinity between 35,2 and 35,4. The nitrate values can give indications of the origin of the inflowing water and at the late autum cruise in 1980 we operated a hydrographic station out in the deep ocean north of Shetland, Fig.3, in order to trace the origin of the nutrient rich water observed over the North Sea platau.

The data from this station at N 62° 04' W 00° 40' show that water with nitrate values higher than 13 µM are found below 300 m depth. This indicate that the nutrient-rich AIW have somhove been "lifed up" to form the two cores observed in the Trench.

The most peculiar observation is the distinct nitrate-rich water building up over the North Sea platau. Two prosesses may explain the observations; a) Atlantic deep-water from below 300 m have been lifted up 200 meter and distributed in over the North Sea platau, or b) the nutrient-rich water is formed from remineralisation in fairly stagnant water abow the platau.

Figs. 4, 5 and 6 present data from the same cross-section for the years 1982,1983 and 1985. As can be seen from the figures from the Feie - Shetland cross-section the nitrate-rich water is observed over the platau in 1980, 82 and 85 while there was no indications of such water in 1983. The 1983 data are determined aproximately one month later than the other years, and the data show that a complete vertical mixing of the water over the platau had taken place prior to our cruise in 83.

The nutrient-rich water over the North Sea platau is distributed as far south in the North Sea as to some place between the 58 and the 57 lattitude. South of this "border" the nitrate values are almost reduced by 50%, but sometimes traces of more nutrient-rich water are observed at the Hanstholmen - Aberdeen cross-section, Fig.7. My data clearly indicates that there is a complete different regime in the southern part of the North Sea with fairly small amounts of dissolved nutrients in the opne water-masses in a relatvily biological inactive periode as late autum.

The aggregation of nutrient-rich water over the northern platau is obviously taking place every year and it is broken down by the winter mixing. As stated over two different prosses mai explain this pattern. The first one where it is anticipated that nutrient rich water from below 300 m in the Atlantic is flowing in ower the platau and southwards is not likely to occure.

The other prosess where remineralisation is taking place can only be explained by a circulation prosess keeping the water inside a large eddy long enough to let sufficient biological material be broken down. The special form on the nitrate distribution indicates that a doming prosess is taking place which again support the existence of an eddy.

Further south in the North Sea along the west coast of Denmark my data clearly show that the contribution of nutrients from the German Bight to the Skagerrak is rather limited. Fig. 8 and 9 are computer drawings of the nitrate distribution in 10 m depth from November 1983 and 1985, and they demonstrate a fairly sharp boundary between German Bight water and the water masses further out in the North Sea and in the north along the danish coast. The salinity and temperature data, Figs. 10 and 11, from 10 m depth in 1985, do express the same. The low nitrate values close to the northwestern danish coast is also clearly shown in Fig.7.

The transport of pollutants from the southern part of the North Sea via the Jutland current have been reconed as a major source for pollutants in the Skagerrak. If the transport of nutrients may act as an example, the influence of the polluted water in the southern North Sea on the watermasses further north is limited.

CONCLUSION

The abowe brief exampels of nutrient distribution intend to show that nutrient data may give sharper boundaries between the different watermasses and therfore may help to identify dynamical prosesses taking place. Nutrient data are valuable in that they may act as the link between physical prosesses and biological events as is demonstrated by the assumption of a large eddy established over the northern North Sea platau in the autum.

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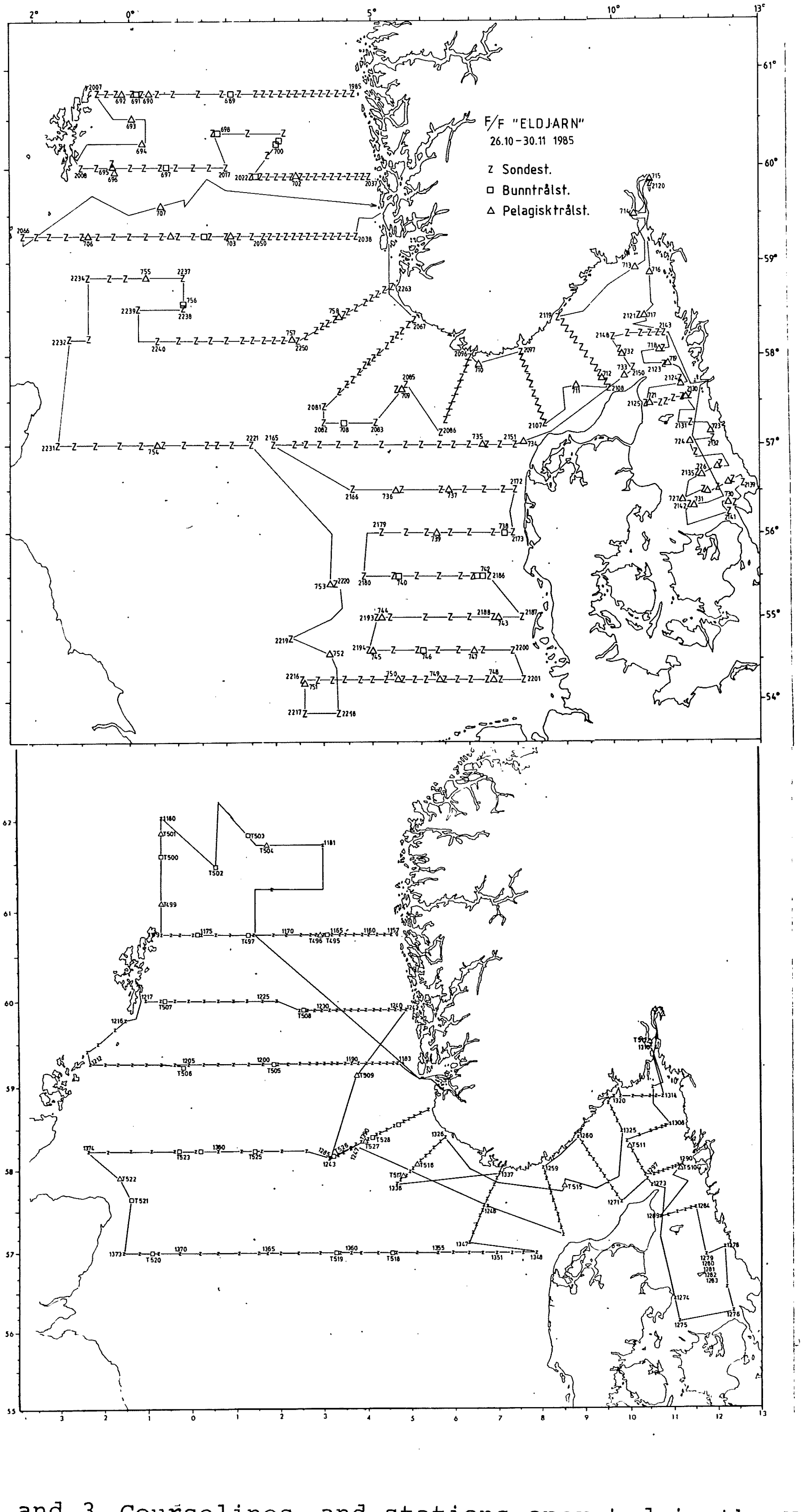


Fig. 1 and 3. Courselines and stations operated in the North Sea by "Eldjarn" in November 1985 and by "G.O. Sars" in November 1980.

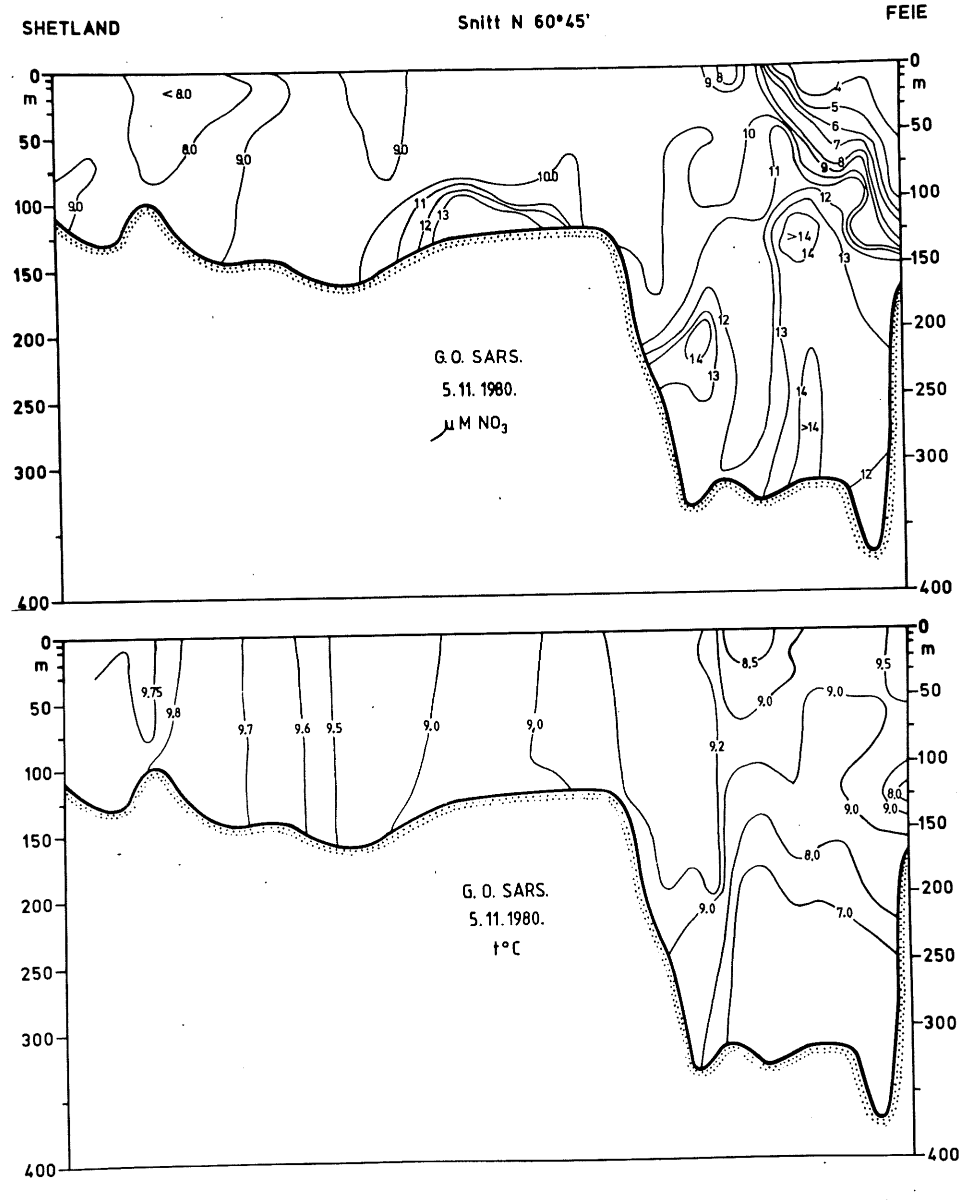


Fig. 2. Nitrate and temperature observations in the cross-section Feie - Shetland November 1980.

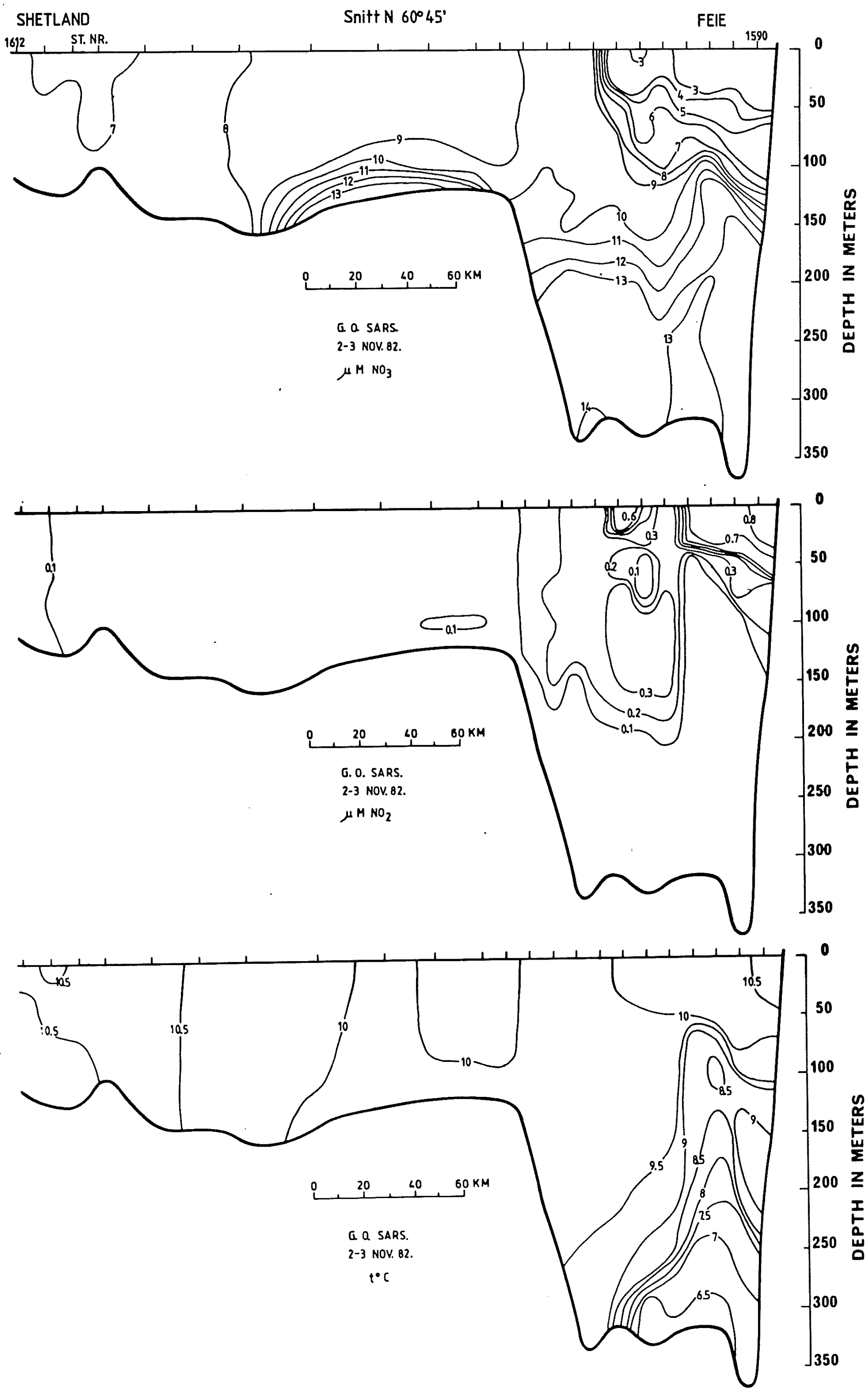


Fig. 4. Nitrate, nitrite and temperature observations in the cross-section Feie - Shetland, November 1982.

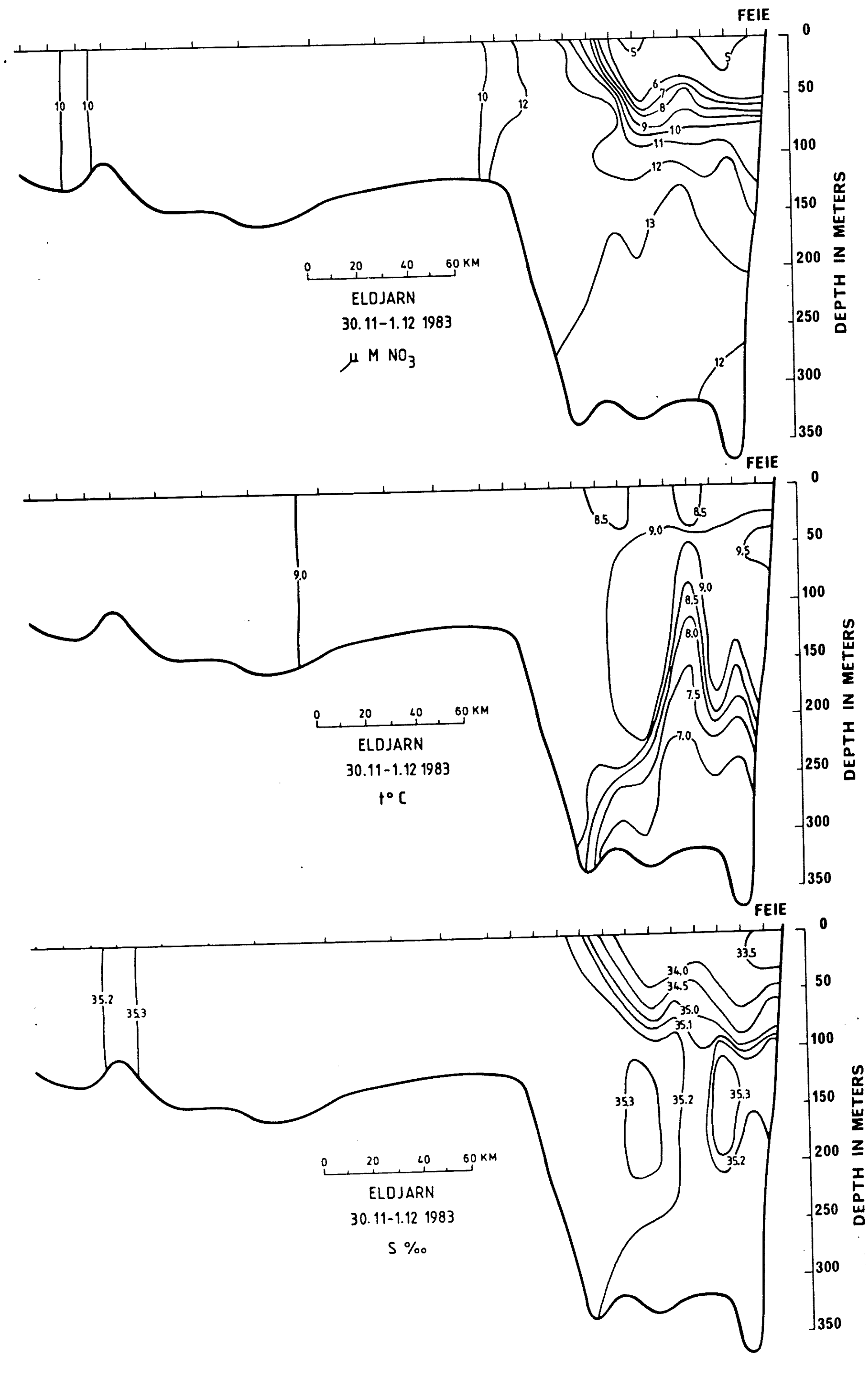
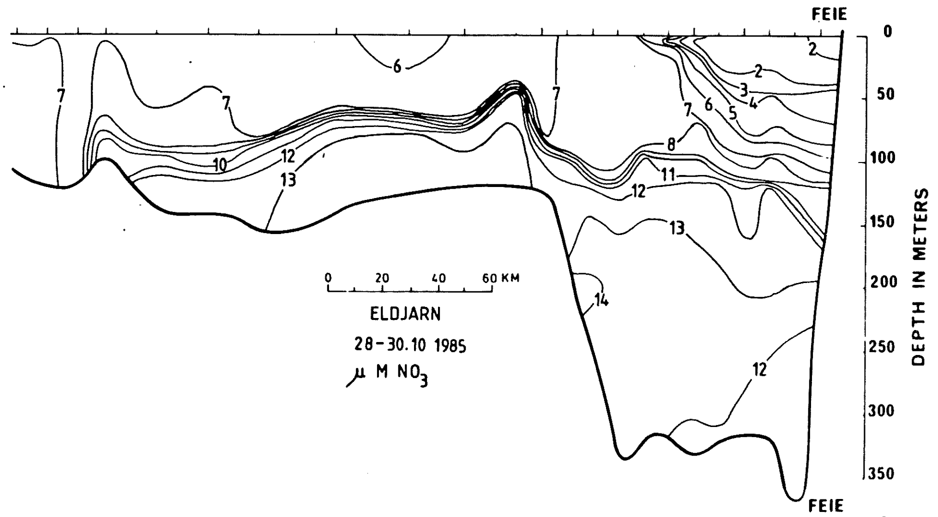


Fig. 5. Nitrate, temperature and salinity observations in the cross-section Feie - Shetland, December 1983.



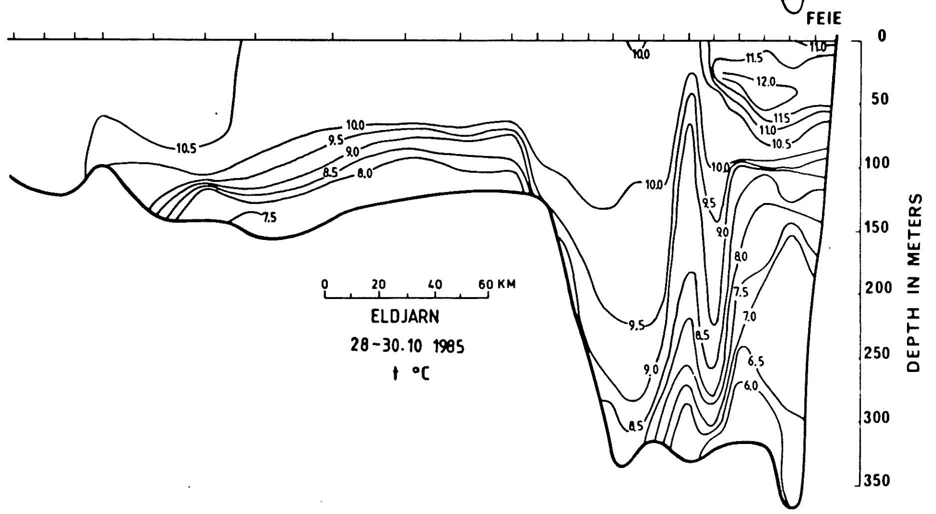


Fig. 6. Nitrate and temperature observations in the cross-section Feie - Shetland, November 1985.

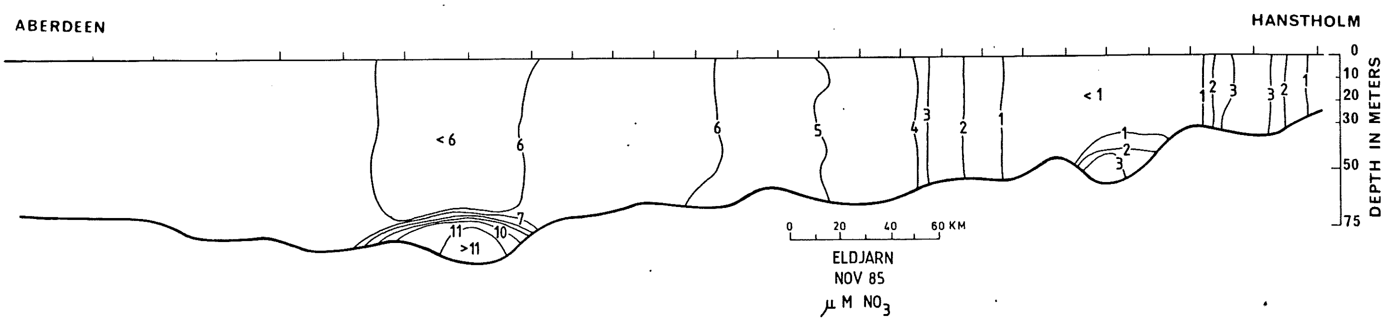


Fig. 7. Nitrate observations at the Hanstholmen - Aberdeen cross-section in November 1985.

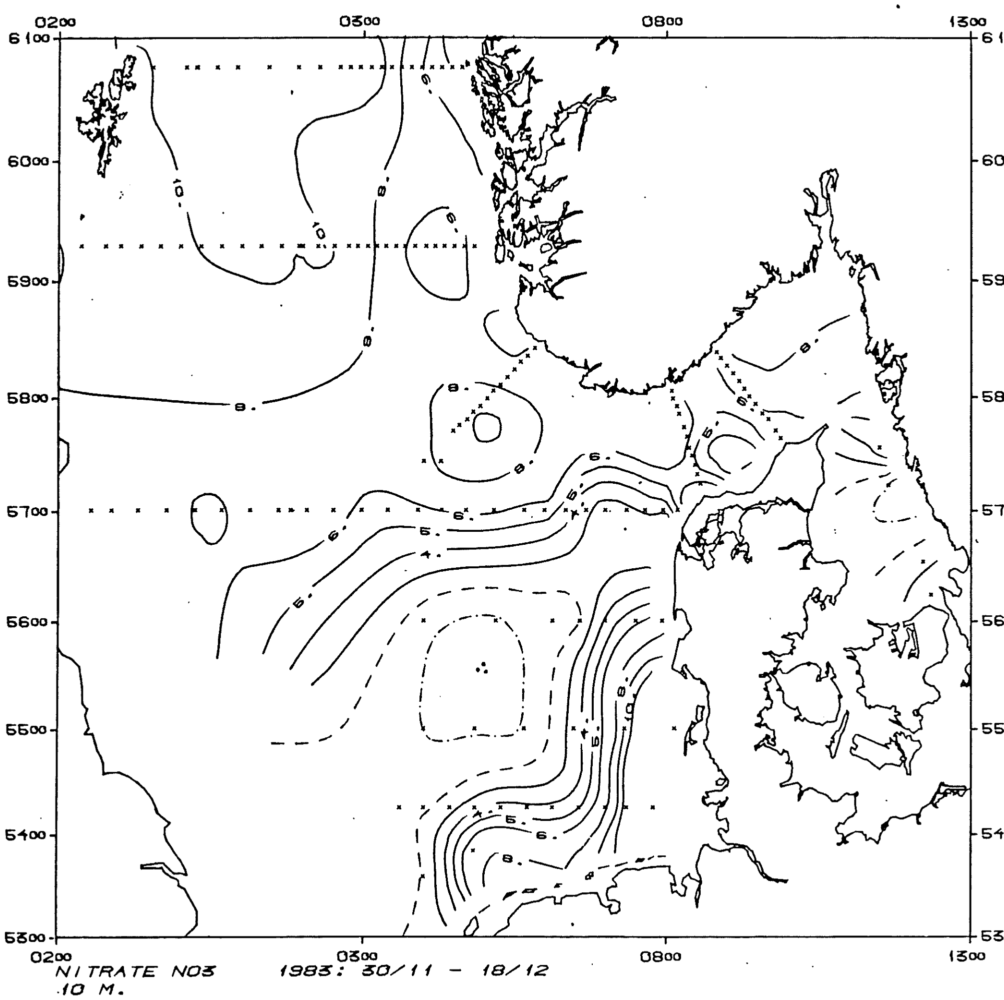


Fig. 8. The horizontal distribution of nitrate at 10 m depth in November 1983.

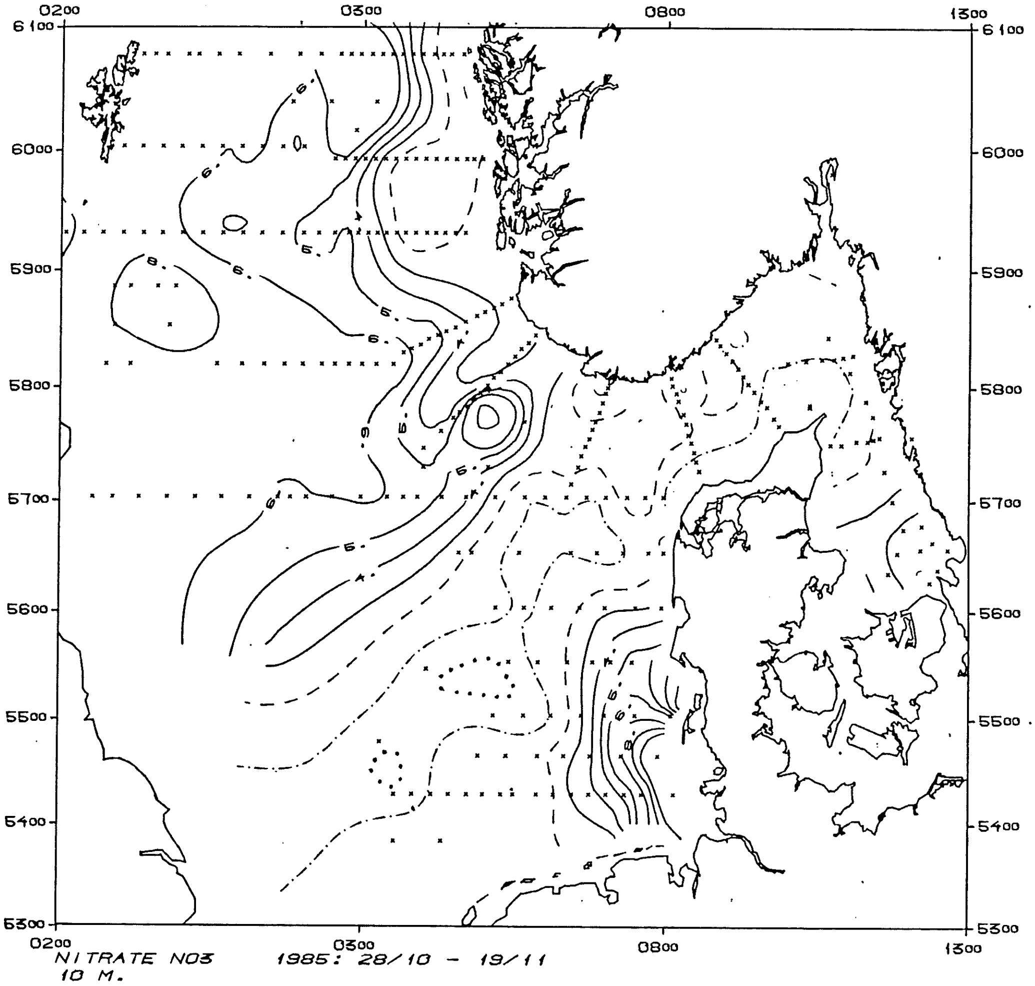


Fig. 9. The horizontal distribution of nitrate at 10 m depth in November 1985.

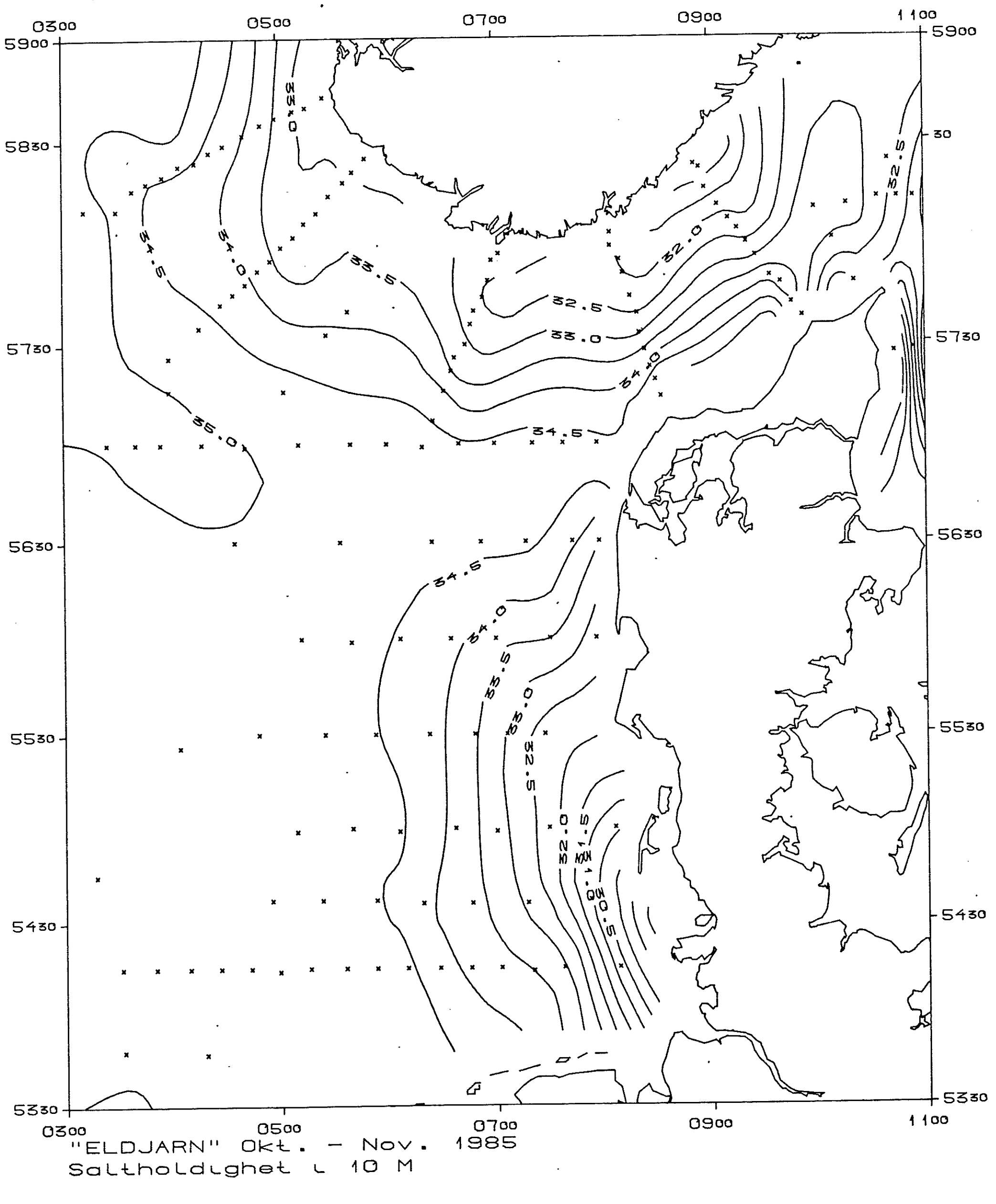


Fig. 10. The horizontal salinity distribution at 10 m depth in November 1985.

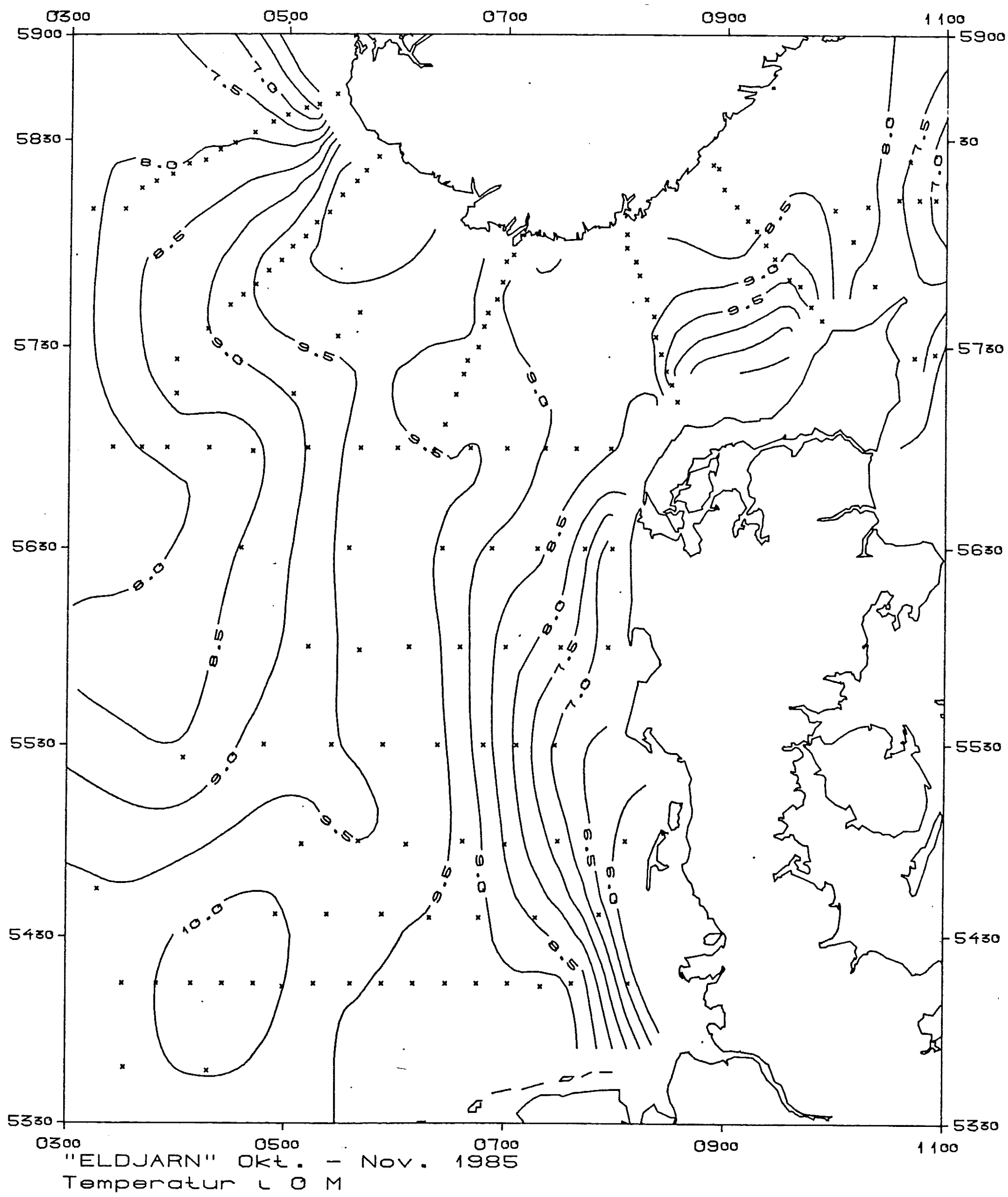


Fig. 11. The horizontal temperature distribution at 10 m depth in November 1985.