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WINTER/LATE AUTUM DISTRIBUTION OF NUTRIENTS IN THE NORTH SEA

By
Lars Føyn
INSTITUTE OF MARINE RESEARCH
P.O. Box 1870, N-5011 Bergen, Norway.

INTRODUCTION

In many cases the best way to visualize physical prosesses and differences in the various watermasses is by means of chemical parameters. As an illustration of dillution and transport routes the measurments of caesium-137 concentrations (HUNT,1986) are a good example of how a clearly defined chemical parameter can be used. On a routine basis for shipboard use and for describing both the vertical and the horizontal distribution the measurments have to be extensive. This do not allow laboreous methodes.

Nutrients, although part in biological cycles, may serve the purpose of describing watermasses if they are sampled in a biological off-season (FØYN,1986). As part of fisheries surveys in november - december, in the North Sea and Skagerrak, nutrients have been sampled from ICES standard depths at hydrography stations and consecutively analysed on board.

MATERIALS AND METHODES

Watersamples for the nutrient analysis have, since 1983, been collected with a General Oceanics Rosette watersampling system mounted around a Neil Brown CTD. The analysis are carried out onboard in an auto-analyzer spesially put together for field work,(FØYN et al.1981). The chemical methodes are standardized after STRICKLAND and PARSONS (1968). Phosphate, nitrate, nitrite and silicate are the main components analysed, in addition chlorophyl is measured for control of biological activity.

Until 1982 only stations north of 57°N in the North Sea were worked in addition to stations in the Skagerrak and Kattegat. Depending on weather conditions the following cross-section were operated in the northern part of the North Sea; Fedje - Shetland (61° 45´ N), Slotterøy ($59^{0}54'$N) - Shetland (60^{0}N), Utsira- Start Point ($59^{0}17'$N),, Jærens Rev ($58^{0}44'$N) SW and W ($58^{0}00'$N $01^{0}40'$W), Hanstholmen (57^{0}N $07^{0}57'$E) - Aberdeen (57^{0}N $01^{0}28'$W). In the years 1982, 1983 and 1985 stations covering the area from the German Bight along the Jutland coast and into the Skagerrak were worked in addition to the northern part of the area.

In november - december 1986 two ships, R/V ELDJARN and R/V G.O.SARS, worked the area at the same time. Fig. 1 presents the staion grid.

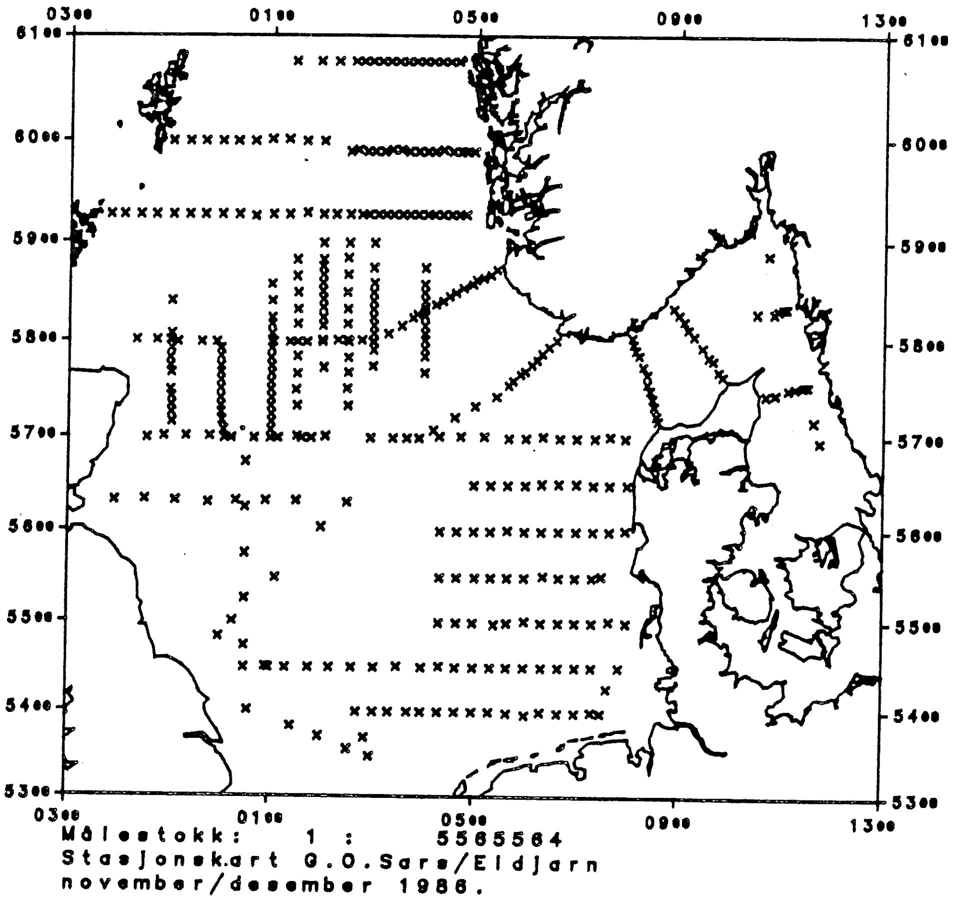

Fig. 1. Hydrographical stations worked by R/V ELDJARN and R/V G.O.SARS in november - december 1986. Nutrients were measured in standard ICES-depths .

The samples sampled by R/V G.O.SARS were analysed on board while the samples from R/V ELDJARN were conserved whith chloroform and stored cool and dark until analysis could be performed ashore. Storing samples with use of chloroform do not alter the nitrate and silicate values while the phosphate values tend to be slightly elevated (HAGEBØ and REY, 1984). For this reason only nitrate values from the combined 1986 sampling are presented. R/V ELDJARN worked mainly in the northern central part concentrating on north-south cross-sections, while R/V G.O.SARS covered the southern and eastern parts as well as the three northernmost cross-sections.

RESULTS AND DISCUSSION

Fig.2 presents the nitrate values at 10 m depth of the combined data from the R/V ELDJARN and R/V G.O. SARS cruises.

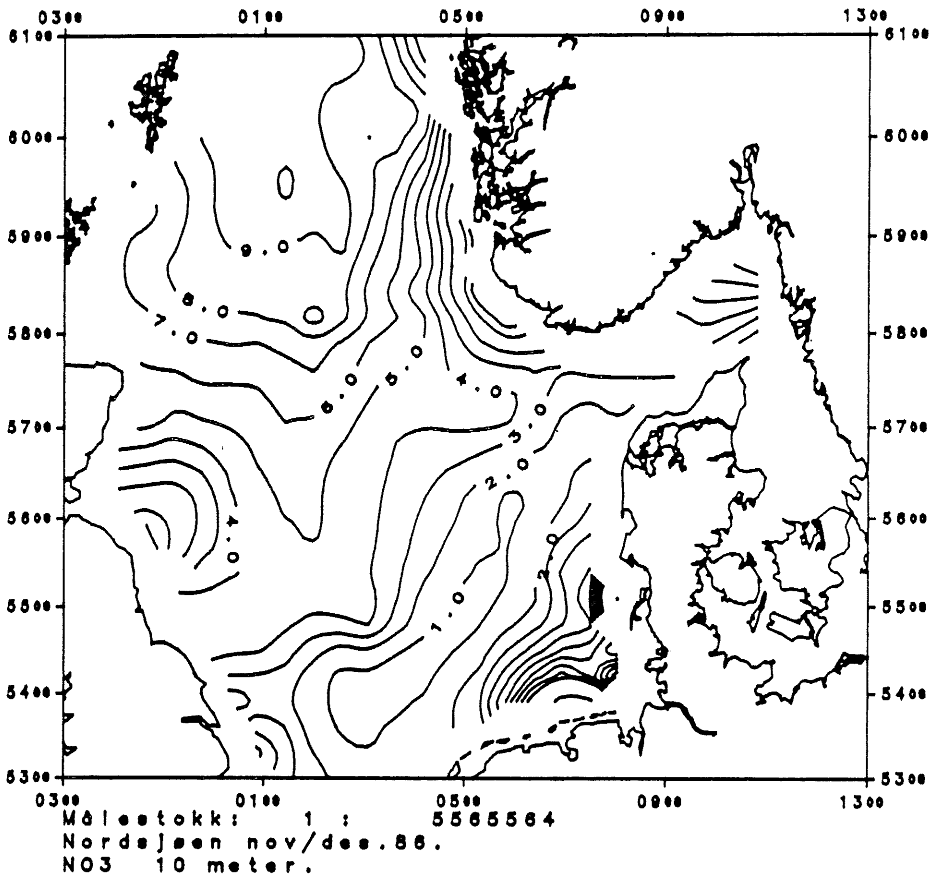

Fig. 2. Nitrate distribution in 10 m depth, in november-december 1986. Isolines are presenting the values in µM NO_3.

The picture presents the main distribution of nitrate as have been observed, in november - december, both in 1983 and 1985, Figs.3 and 4, (FØYN,1986). As Fig.1 indicates the North Sea is fairly well covered in november 1986 and it is possible to distinguish some clearly different regimes. North of 57^0 N the influence of nutrient rich Atlantic water is shown, while south of 57^0 N there is a very pronounced nutrient minimum in the central part. Furtheron the influence from sources on land (rivers) is dominating in the German Bight, but only extended to a fairly restricted area. The northbond Jutland current along the western coast of Denmark, do not seem to transport greate amounts of nutrients into the Skagerrak. The nutrients distribution two months later, jan. - feb. 1987, as presented by Brockmann (1987), shows the same main picture.

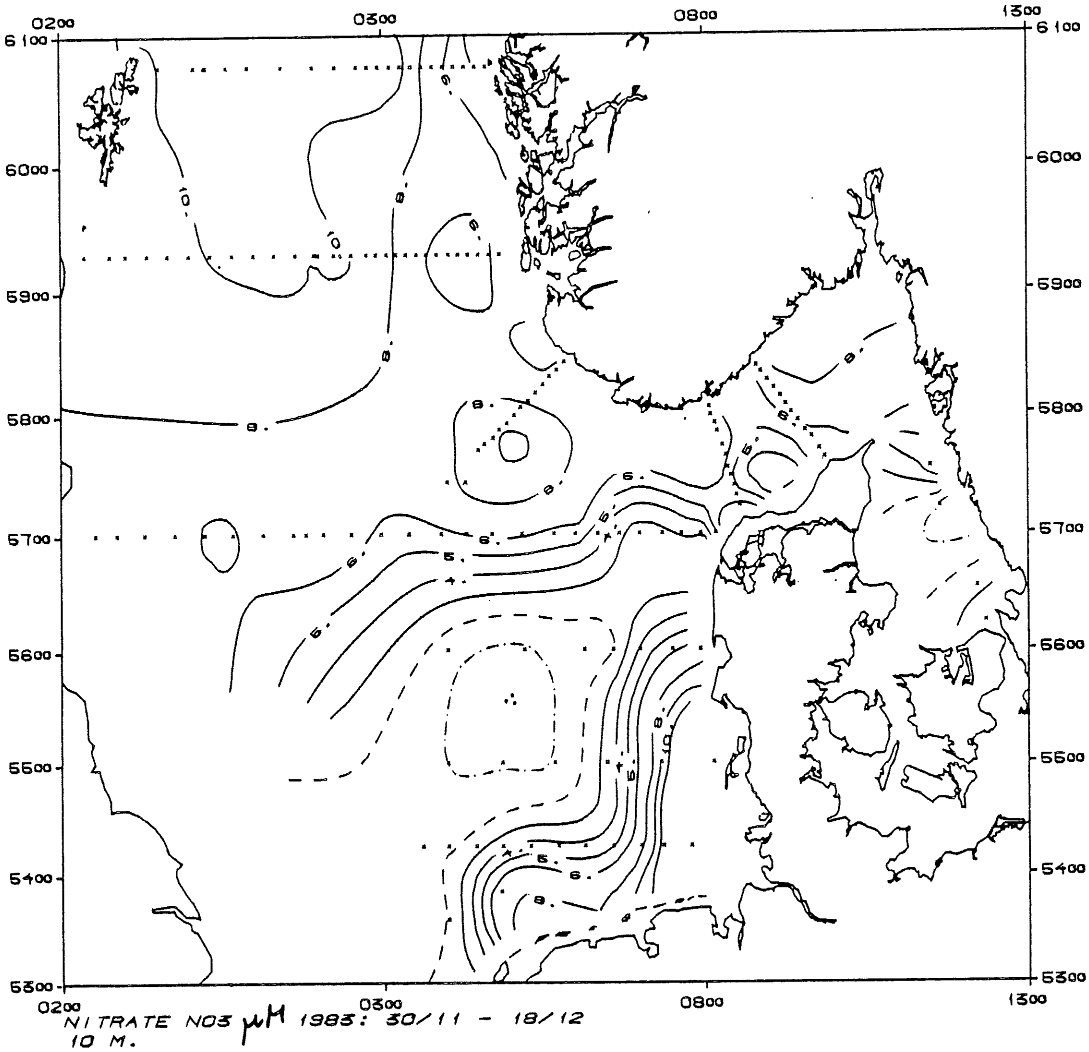

Fig. 3. Nitrate distribution in 10 m depth in november-december 1983. Isolines presenting the values in µM NO_3.

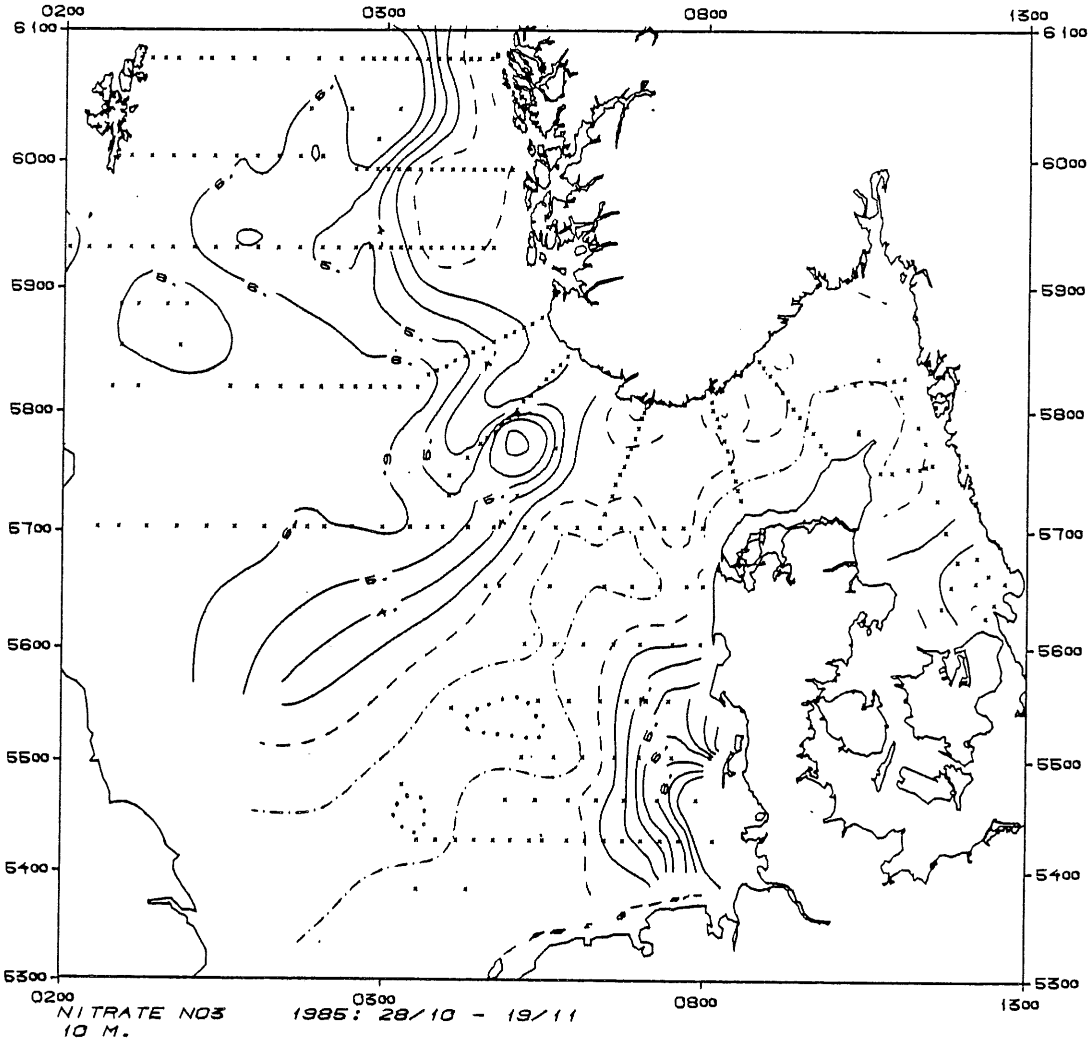

Fig. 4. Nitrate distribution in 10 m depth in november-december 1985. Isolines are presenting the values in µM NO_3.

The cross-section Oksøy - Hanstholmen may represent boarderline to the Skagerrak. Fig. 5 presents the vertical nitrate distribution in december 1986.

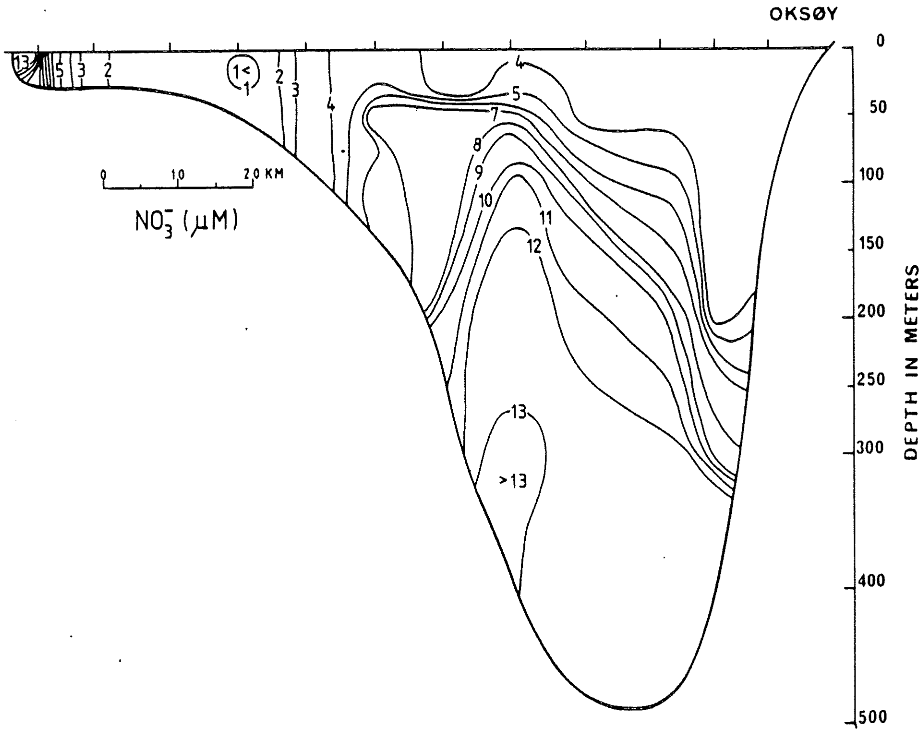

Fig. 5. The vertical distribution of nitrate in the cross-section Oksøy - Hanstholmen 8. december 1986. Isolines represents values in μM NO_3.

This distribution demonstrate the doming of the nutrient rich deep water of Skagerrak which is characteristic throughout the year. The high nutrient concentrations found in the Skagerrak deep water is caused by inflowing nutrient rich Atlantic water. The figure also demonstrates that there is, very close to Hanstholmen on the danish coast, an inflow of nutrient rich water. However, the amount of this inflow, as the figure shows, is small compared to the magnitude of the doming water.

As the Jutland current is said to transport all assumed pollutants from the southern part of the North Sea into the Skagerrak and further north in the norwegian coastal current along the norwegian coast, a better understanding of the magnitude and the impact of this particular current system is highly needed. However, the transport as described by the nutrient distribution indicate that there is little impact from the water in the German Bigth on the open watermasses of the Skagerrak.

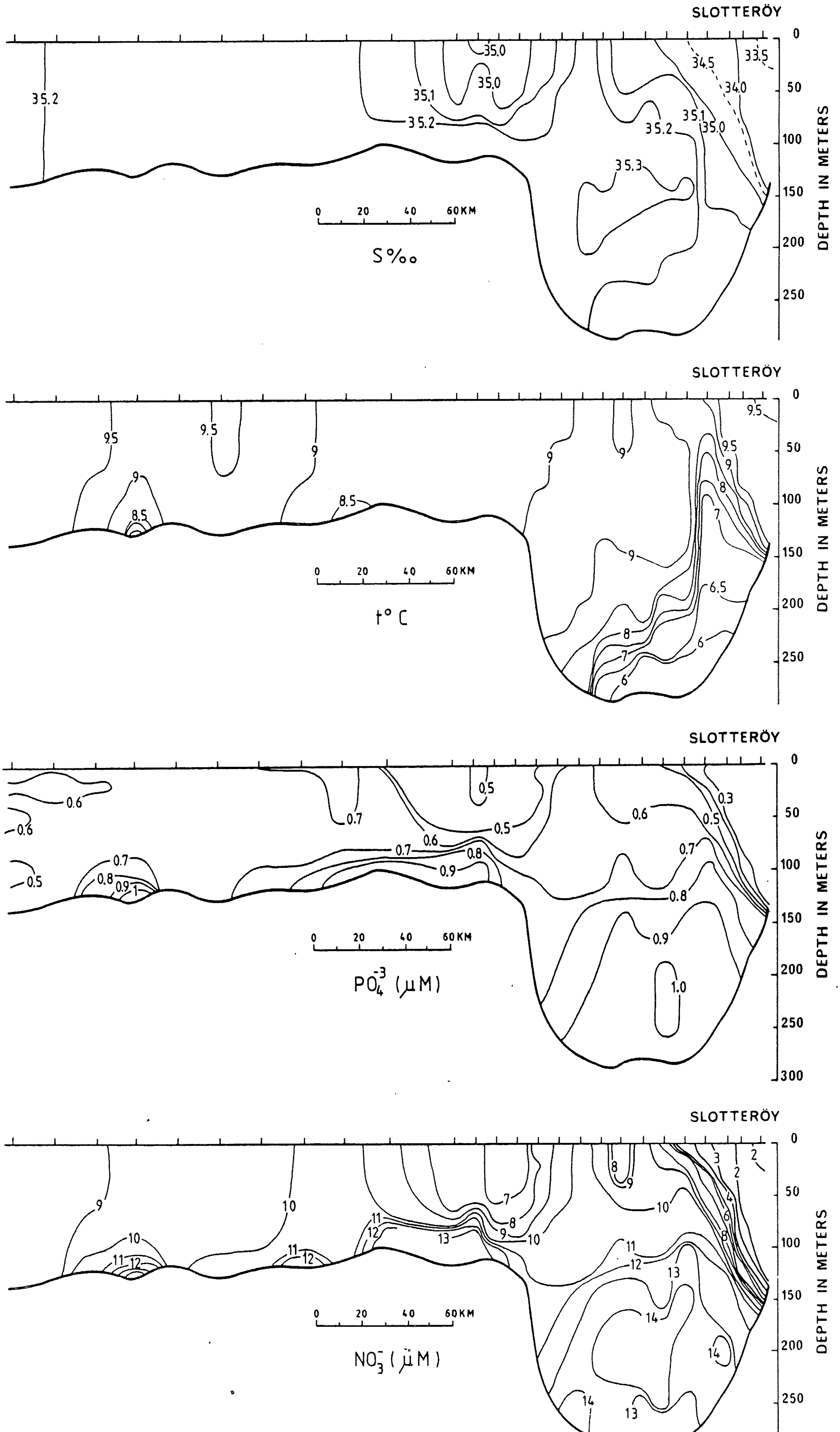

Fig. 6. Salinity, temperature, phosphate and nitrate distributions in the cross-section from Slotterøy to Shetland nov. 1986.

In Fig. 6 data from the cross-section Slotterøy - Shetland are presented as an example where the nutrients may give a somewhat different picture of the watermasses than what is distinguised from the temperature and salinity values. The norwegian coastal current is clearly demonstrated by low salinity values and low nitrate and phosphate values. Inflowing Atlantic deep water may be characterized by salinty values of more than 35,3, phosphate values over 0,8 µM and nitrate values higher than 12 µM, this water is found in the middle and the deeper part of the norwegian trench. The accumulation of both phosphate and nitrate in the bottom water above the beginning of the plateau, Viking bank, of the northern North Sea is not reflected in the temperature and salinity data.

Accumulations of nutrients are a consquence of remineralisation of organic materials. My data from previous years demonstrate the same distribution (FØYN,1986), a distribution which is located from 61^0 N to 58^0 N and 3^0 30´ E to 1^0 30´ E. This particular accumulation which seems to take place every year is broken down later in the winter. To sustain the accumulation of nutrients the watermasses over the area must be kept there whithout moving for several months. This can be explained by the possible existence of a eddy trapping organic material.

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