r/v Gunnar Thorson

Monitoring Cruise Report

Cruise no.: GT 243

Time: 17-21 September 2007

Area: The Sound, the Arkona Sea, the Belt Sea and the Kattegat

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Data sheet

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Monitoring cruise report - Cruise no. GT 243, 17-21 September 2007

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Cruise leader:	Gunni Ærtebjerg (Copenhagen to Korsør) Colin A. Stedmon (Korsør to Copenhagen)
Participants:	Jan Damgaard (Korsør-Copenhagen) Dorete Jensen Lars Renvald (Copenhagen to Korsør) Kjeld Sauerberg Colin Stedmon Gunni Ærtebjerg (Copenhagen to Korsør)
Vessel:	R/V Gunnar Thorson
Sampling region:	The Sound, the Arkona Sea, the Belt Sea and the Kattegat
Primary aim:	Monitoring of oxygen deficiency

This report is based on preliminary data, which might later be corrected. Citation permitted only when quoting is evident.

Summary

- The water column in the southern Belt Sea (Fehmarn Belt, Mecklenburg Bight) was well mixed with less stratification than expected for this time of year.
- Nutrient concentrations were in general at levels expected for this time of year. Exceptions were in the bottom waters of the Sound where TN, TP, DIN and DIP concentrations were higher than usual and in the bottom waters of the southern Kattegat P concentrations were elevated.
- Bottom water oxygen concentrations in the southern Belt Sea were generally much higher than normally observed at this time of year. Oxygen depletion persists in the bottom waters of the Great Belt and the southern Kattegat and concentrations are amongst the lowest recorded for September since 2000.

Introduction

The cruise is part of the Danish national monitoring programme (NOVANA), the HELCOM monitoring programme (COMBINE) for the Baltic Sea area, and the OSPARCOM monitoring programme (JAMP) for the Greater North Sea (the Kattegat). The primary aim of the cruise is to provide measurements of hydrography and oxygen concentrations. Nutrient and chlorophyll a measurements were also undertaken. In addition samples were taken for a research project on the biogeochemistry of dis-

solved organic matter in these waters. *Figure 1* shows the locations of the monitoring sampling stations.

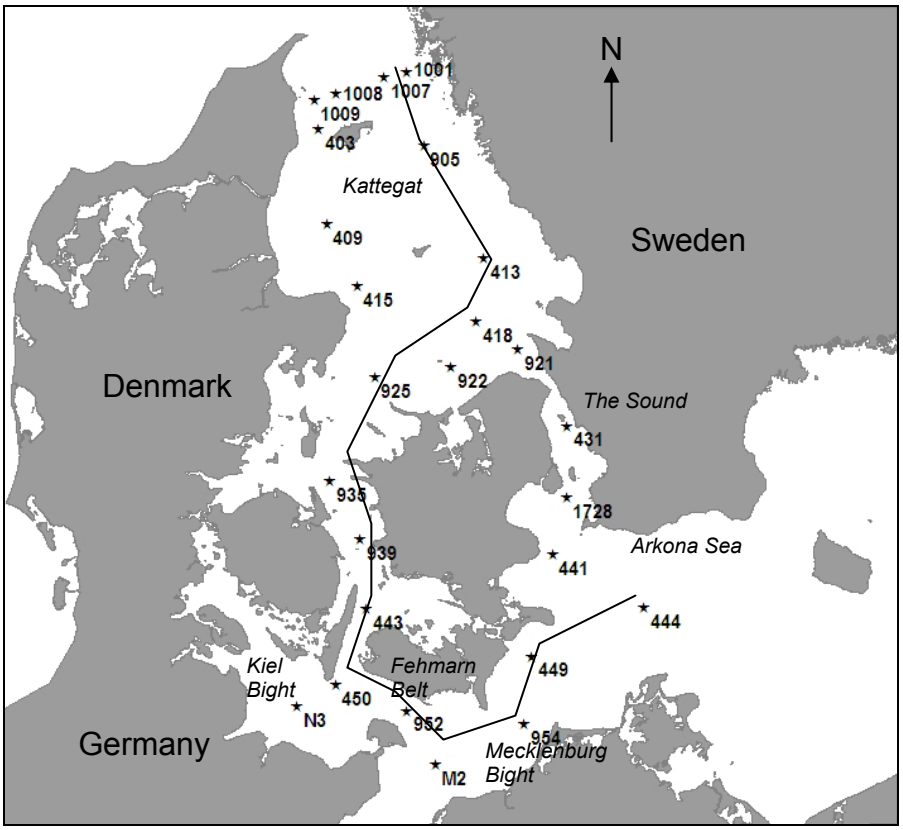


Figure 1 Map showing the stations sampled by the monitoring cruise, region sea names and the location of the transects plotted in the following figures.

Meteorology

Up until September average monthly air temperatures in 2007 have been above average (*Figure 2*). Precipitation has also deviated from the long-term averages with approximately twice as much precipitation in January and February, and June and July, than normally expected. The month of September was, however, not notably different from average values.

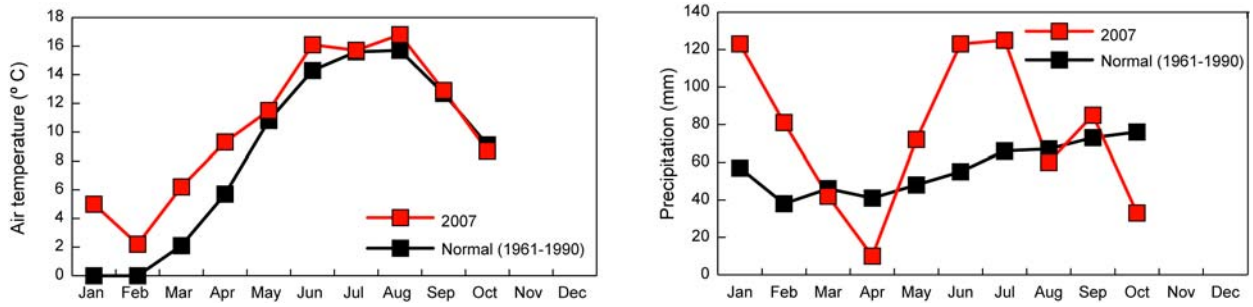


Figure 2 Monthly average air temperature and monthly total precipitation data for 2007 compared with long term averages (1961-1990). Data retrieved from Danish Meteorological Institute (www.DMI.dk).

Average weekly wind speeds for 2007 are shown in *figure 3*. The data show that for the two months before the cruise wind speeds have been above average and in the week before the cruise the winds were unusually calm.

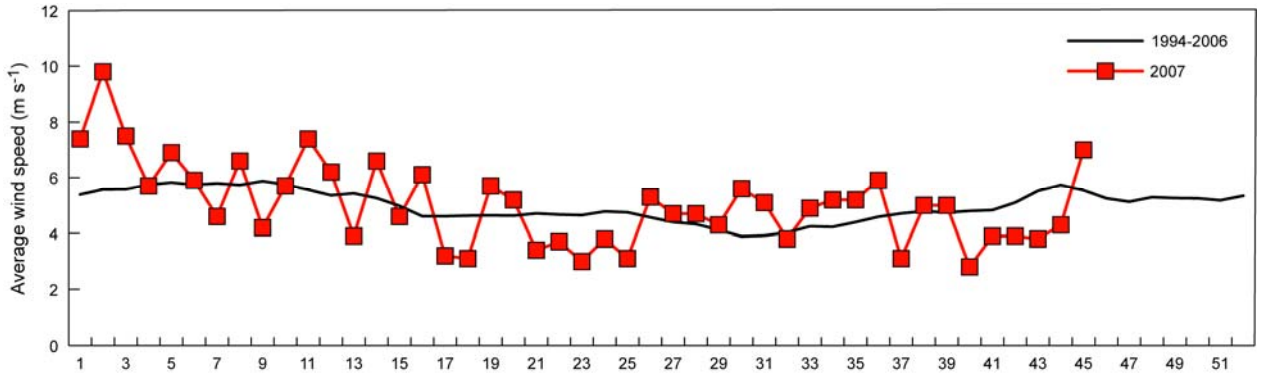


Figure 3 Weekly average wind speed for 2007 compared with long-term average. This cruise was in week 38.

Hydrography

The hydrographic and nutrient measurements for a transect through the sampling region are presented in *figure 4* and the locations of the transect is marked on *figure 1*. The plots summarise the horizontal gradients in the measured parameters. Surface water temperatures (≤5 m) did not vary considerably, ranging between 13.9-14.8° C. Bottom water temperatures ranged between 9.5° C at St. 413 (54 m) and 15.4° C in the Arkona Sea (St. 444, at 44 m). Surface and bottom water salinities increased from southeast to northwest reflecting the brackish surface outflow from the Baltic Sea and the saline inflow from the North Sea. At the majority of the stations the water column was stratified with warmer and less saline water at the surface. Few stations, however, were well mixed vertically, which is to be expected for the shallow stations (e.g. St. 1728, 10 m, St. 409, 13 m) however noteworthy for deeper stations such as St. 450 (31 m) (see *figure 4*) and St. 1009 (25 m).

Nutrients

Total nitrogen (TN) concentrations in surface waters generally decreased from southeast to northwest. Lowest TN concentrations in surface waters were measured in the north-western Kattegat ~10 µM (St. 1009) and highest concentrations ~20 µM in the Mecklenburg Bight (St. M2, *figure 4*). TN concentrations in bottom waters did not decrease in a similar fashion but increased in the Great Belt and southern Kattegat (*figure 4*). DIN was very low if not absent from surface waters in the whole region. In the bottom waters of the Arkona and Belt seas DIN concentrations were <4 µM. In the Sound, the Great Belt, the central and north-western Kattegat, however, concentrations were between 5 and 14 µM. TN and DIN concentrations in the bottom waters of the Sound are higher than they usually are at this time for year (see St. 431 in the Appendix).

Total phosphorous (TP) in surface waters exhibited a similar trend to that observed for TN with concentrations generally decreasing from southeast to northwest. Surface water concentrations varied between 0.38-1.16 µM. DIP concentrations in surface waters followed TP concentrations and constituted on average 38% of TP (range 13-61%, 5 m). The distribution of TP and DIP concentrations in the bottom waters followed the pattern seen for TN and DIN respectively with elevated concentrations (>1 µM TP and >0.5 µM DIP) in the Great Belt and southern Kattegat (see profiles for TP and DIP at station 925 in the Appendix).

Silicate concentrations in surface waters decreased from 12.3 to 0.83 µM as the Baltic outflow mixed with North Sea water. Bottom water concentrations at the deeper stratified stations were higher ranging between 14.5 and 32.6 µM with highest concentrations in the southern Kattegat (St. 925).

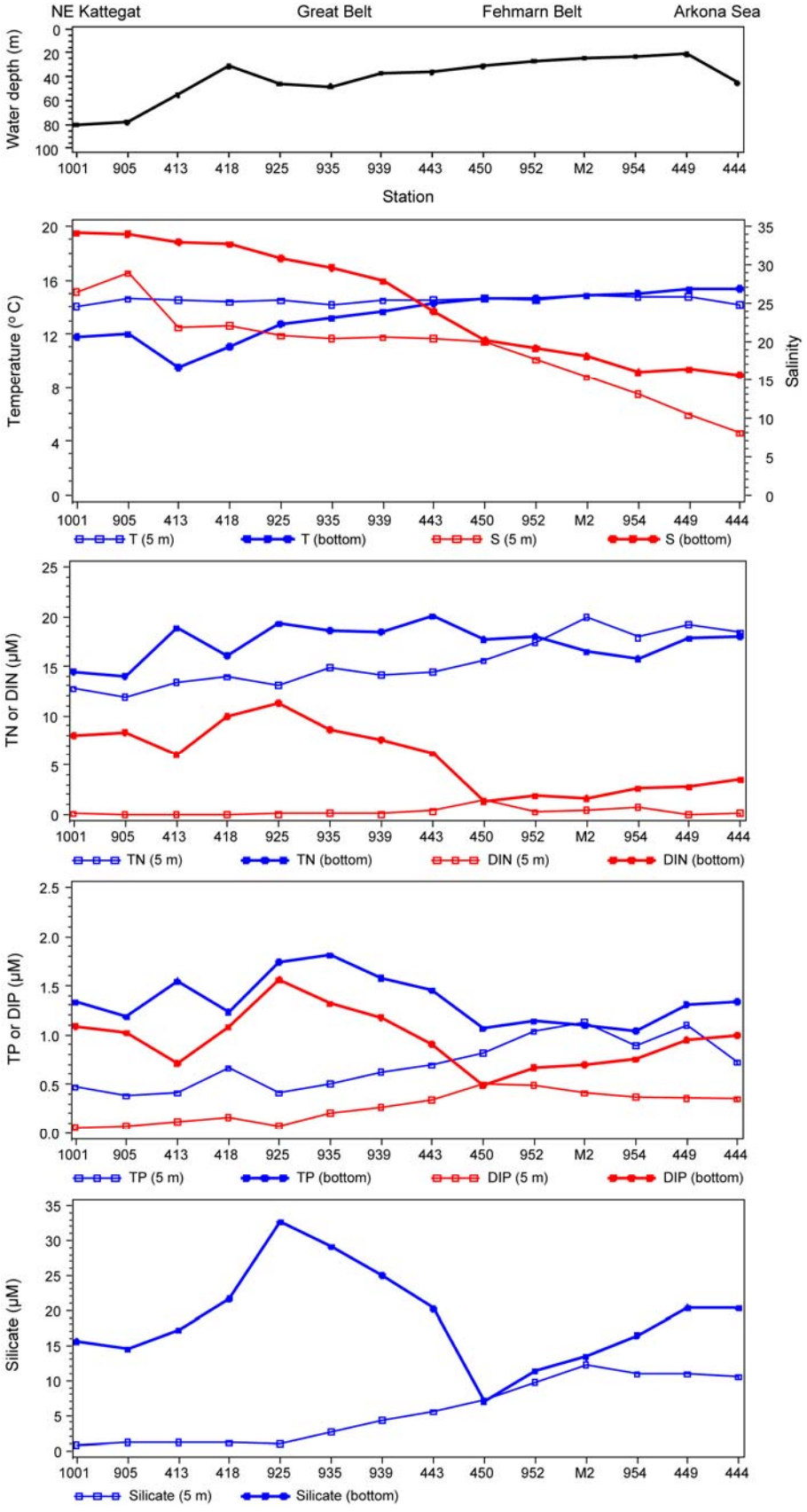


Figure 4 Transects of surface and bottom water temperature, salinity and nutrient concentrations. Position of the transect is indicated in *figure 1*.

Chlorophyll a

Chlorophyll a concentrations in the surface 20 m varied between 0.17 to 7.9 µg/l with the highest concentrations measured in the surface waters of the southern Belt Sea (St. M2, 952) (*figure 5*). In the Kattegat maximum concentrations were on average at 10 m's depth.

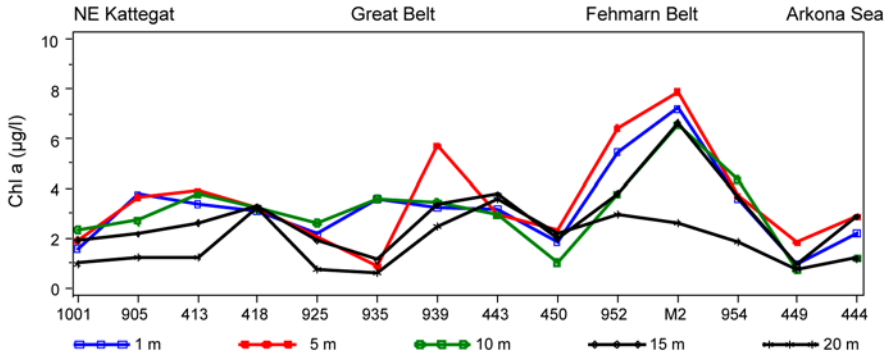


Figure 5 Chlorophyll a concentrations in surface waters along the two transects shown in *figure 1*.

Oxygen conditions in bottom waters

Bottom water oxygen concentrations varied between 0.61 and 6.45 ml/l. The transect is shown in *figure 6*. Lowest concentrations were measured in the southern Kattegat, Great Belt and the Sound (<3 ml/l or 2.1 mg/l). Also shown are the apparent oxygen utilisation (AOU) values which reflect the amounts of oxygen respired since the water body was last in contact with the atmosphere and takes into account possible temperature gradients. From these plots it is clear that vertical mixing has recently replenished oxygen concentrations in the bottom waters of much of the southern Belt Sea. *Figure 7* shows the bottom water oxygen concentrations from the transect plotted with the minimum and maximum concentrations recorded for the same time of year during the period 2000-2006. In general oxygen conditions were either within or greater than those seen in earlier years. The southern Kattegat and Great Belt bottom waters are experiencing oxygen depletion (*figure 7*). Concentrations in the Kattegat are in fact amongst the lowest that have been measured in September for the last 7 years (also clear from the profiles plotted in the Appendix). In contrast conditions in the Belt Sea are much better than they normally are for this time of year due to wind driven mixing.

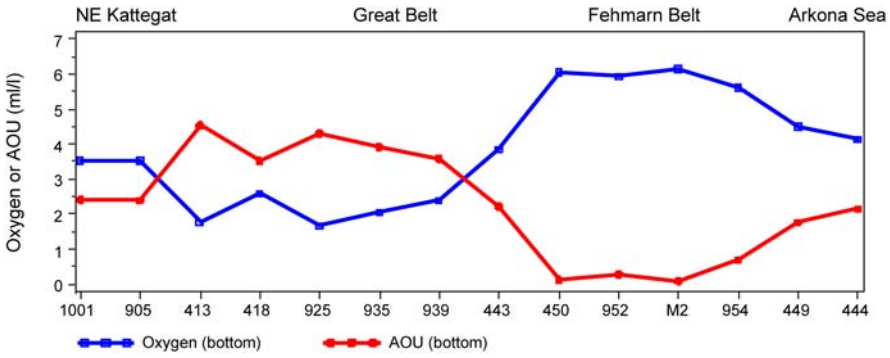


Figure 6 Bottom water oxygen concentrations and apparent oxygen utilisation (AOU) along the transects sampled.

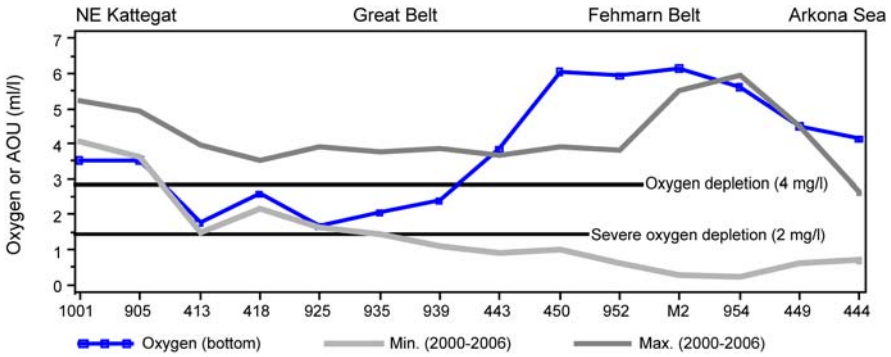
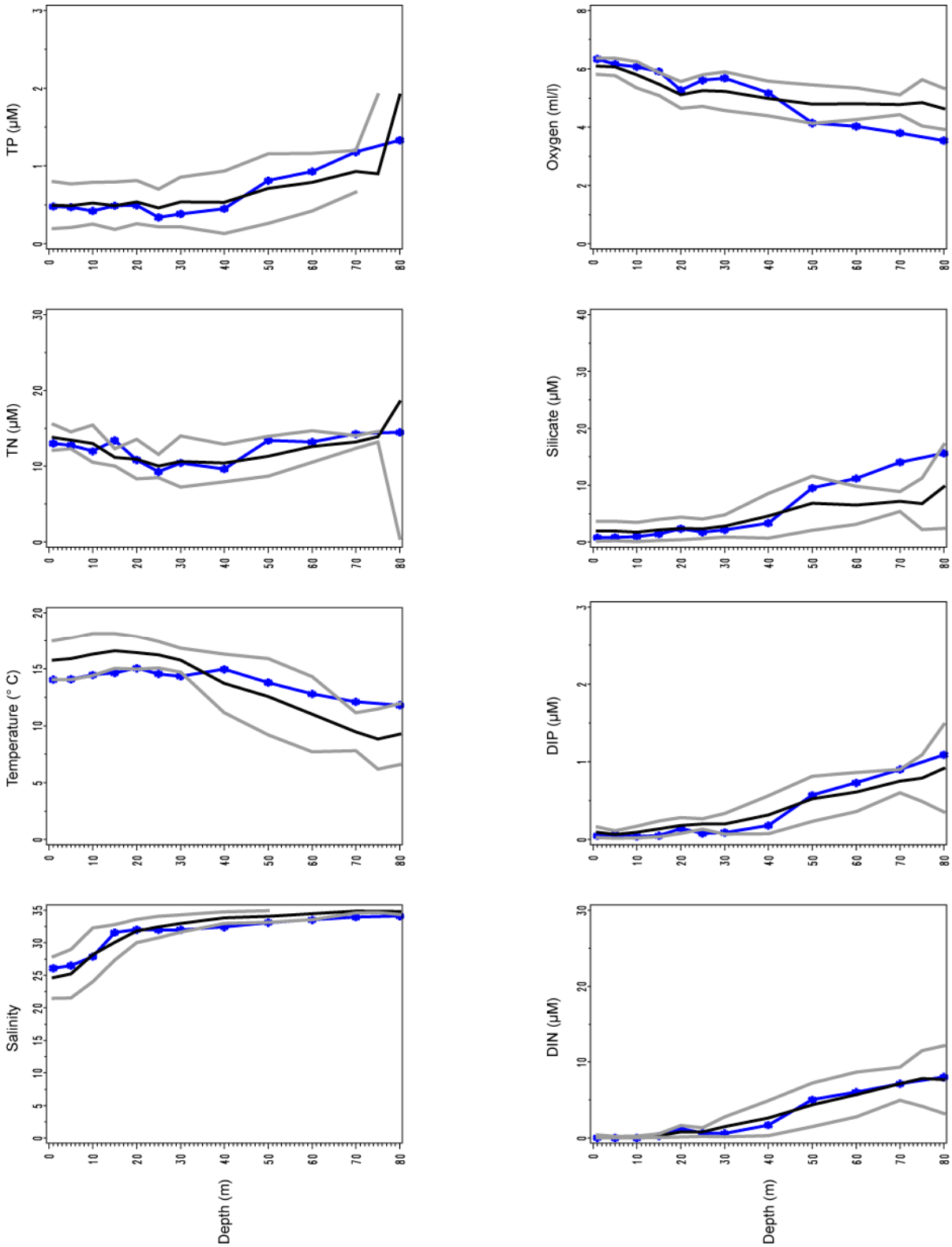


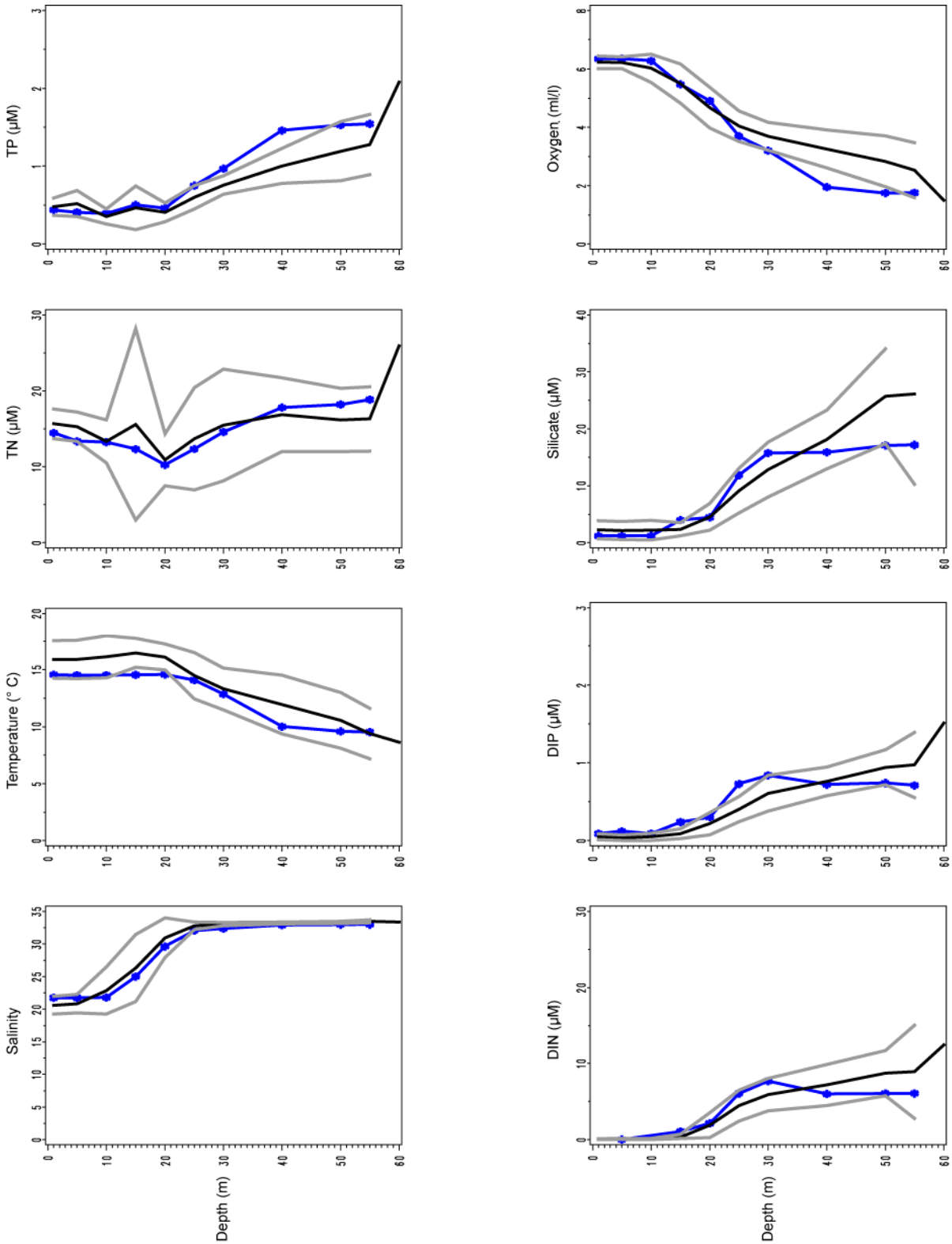
Figure 7 Bottom water concentrations along the NW Kattegat-Belt Sea transect plotted together with the minimum and maximum values recorded for the same September cruise since 2000. Also indicated are the two defined concentration levels for oxygen depletion (4 mg/l) and severe oxygen depletion (2 mg/l). Oxygen concentrations are shown in both mg/l and ml/l.

Appendix

The following graphs show profiles of the measured parameters at seven chosen stations (blue lines). Also plotted are the mean profiles for the station from the same cruise during the period 2000-2006 (black). The grey lines are the upper and lower 95% confidence limits for the mean.



St. 1001, GT 243, September 2007



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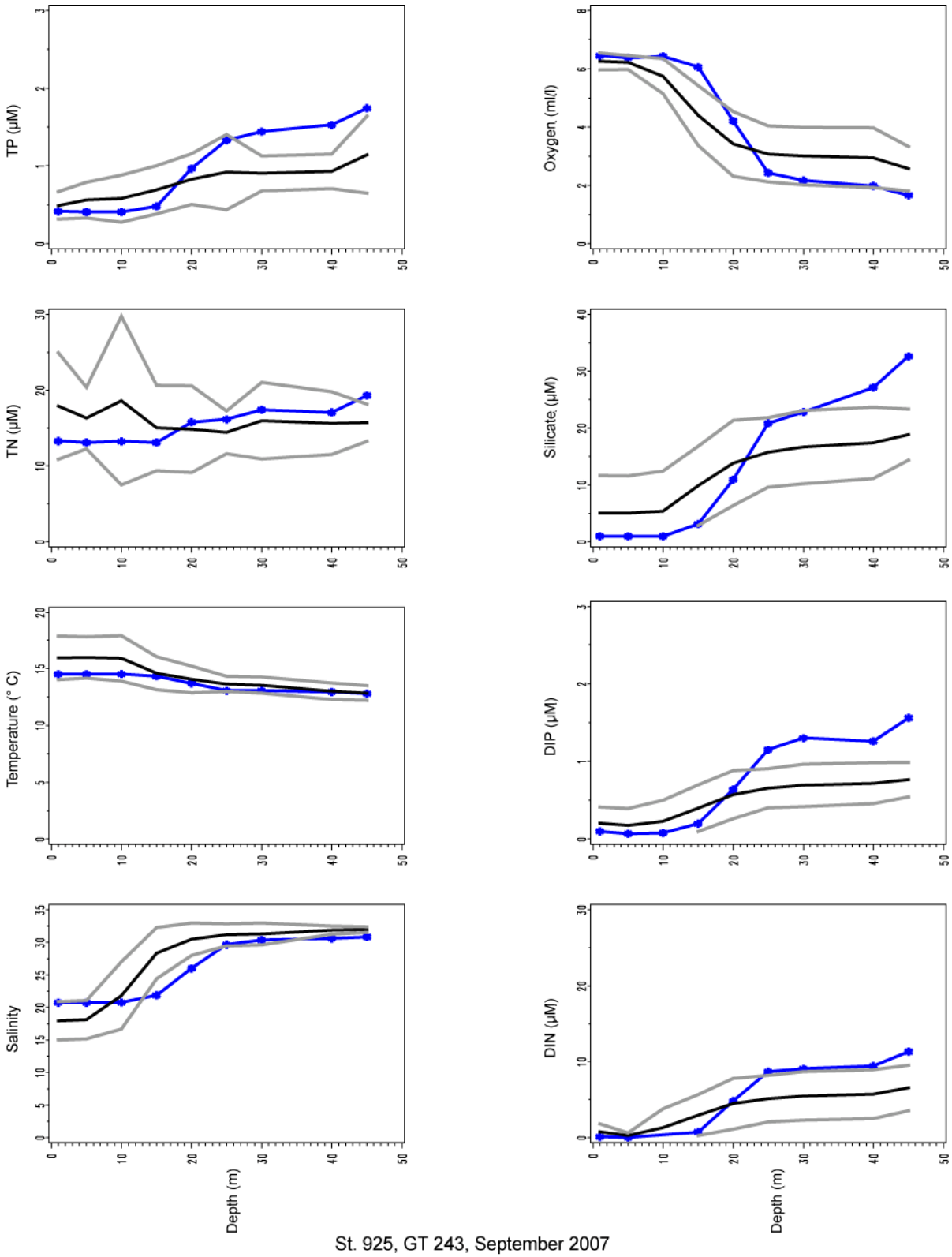
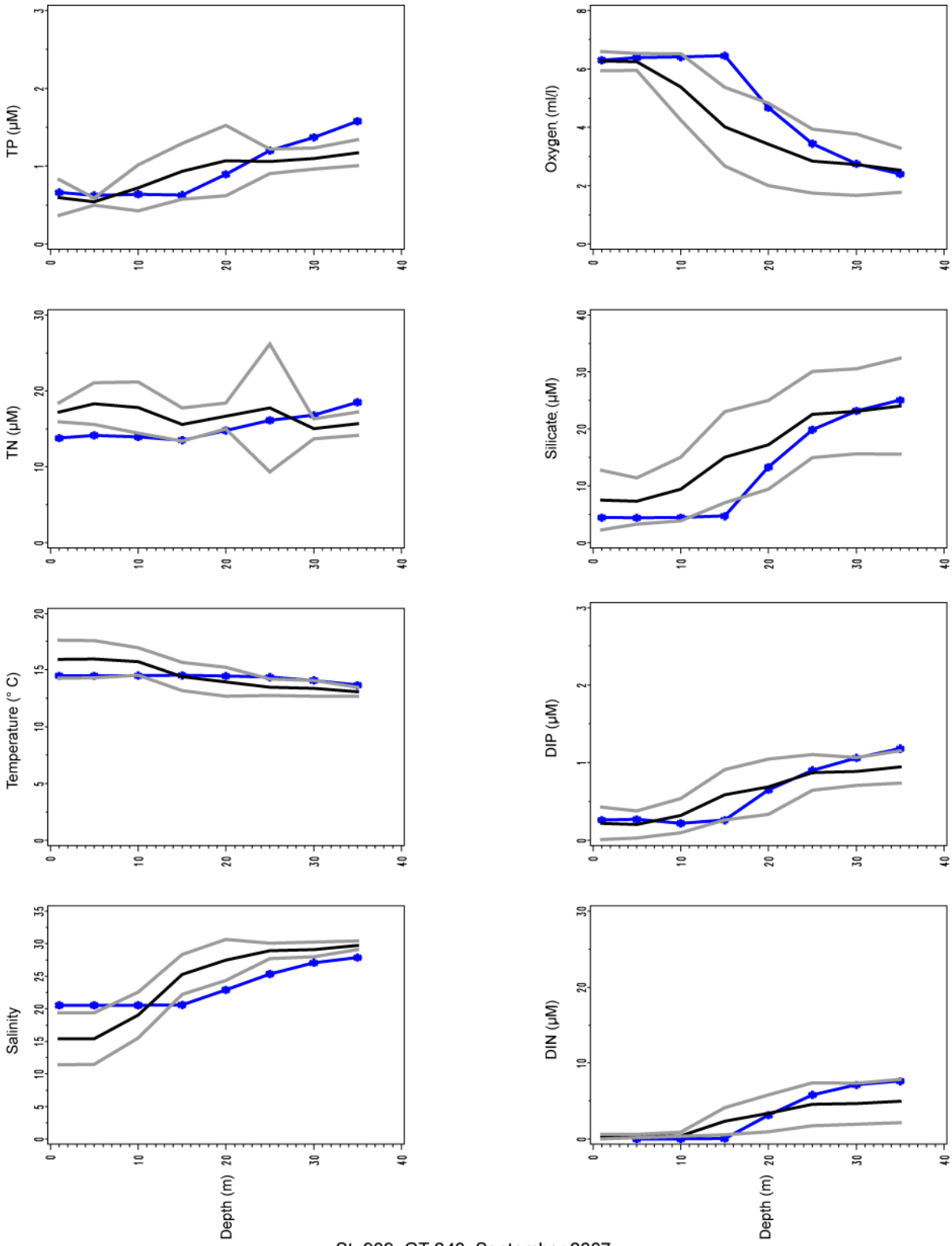
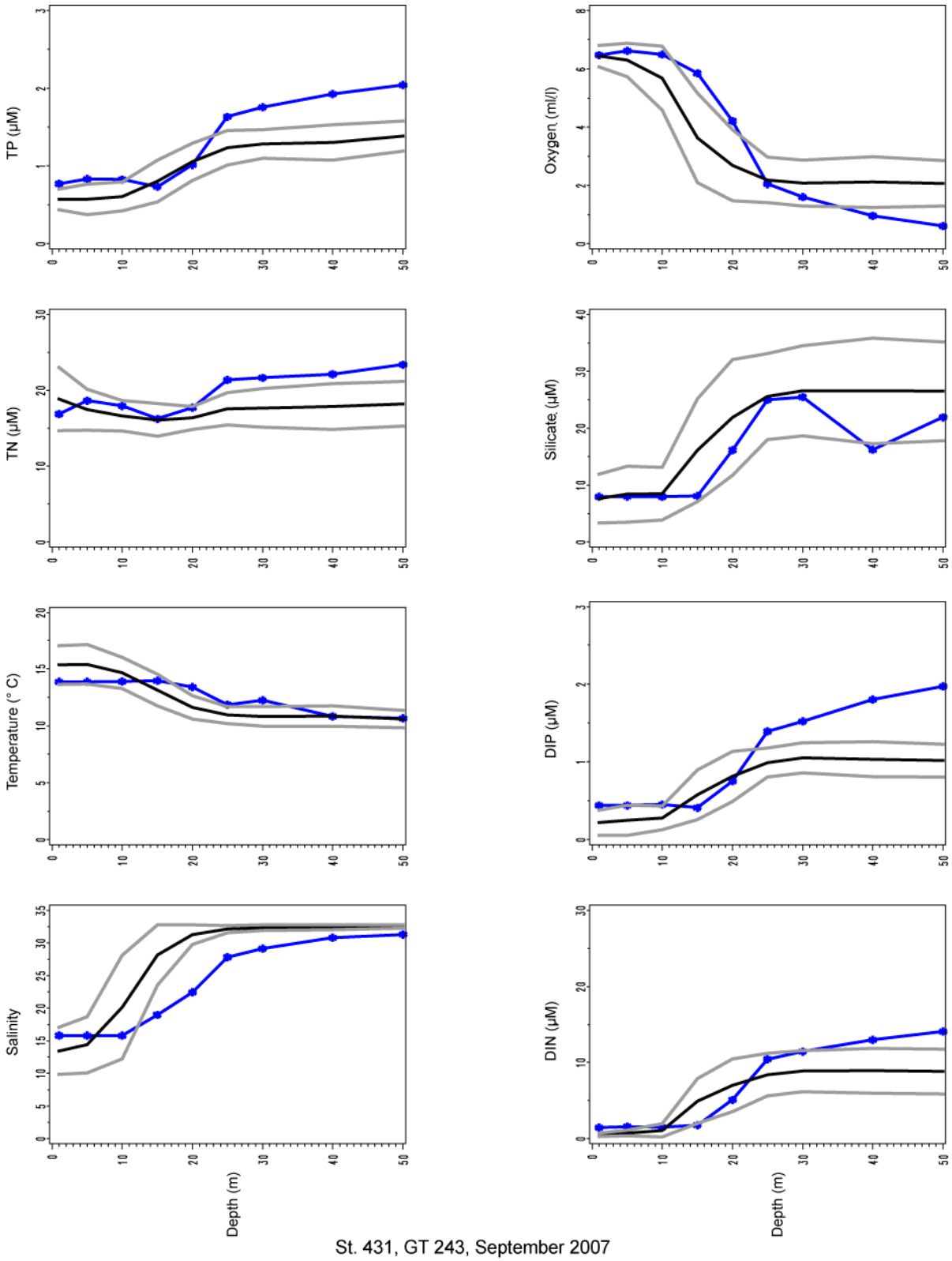


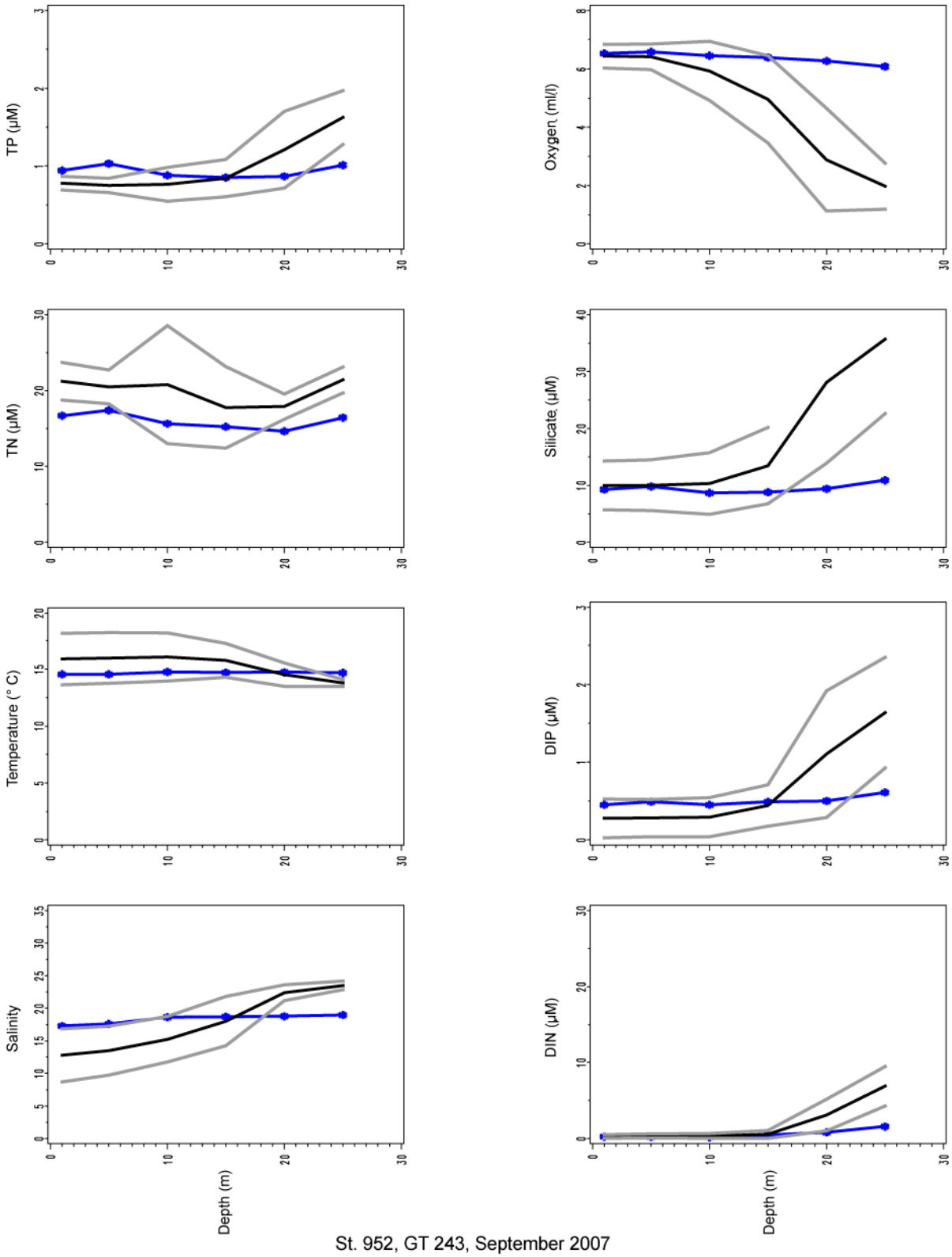
St. 925, GT 243, September 2007



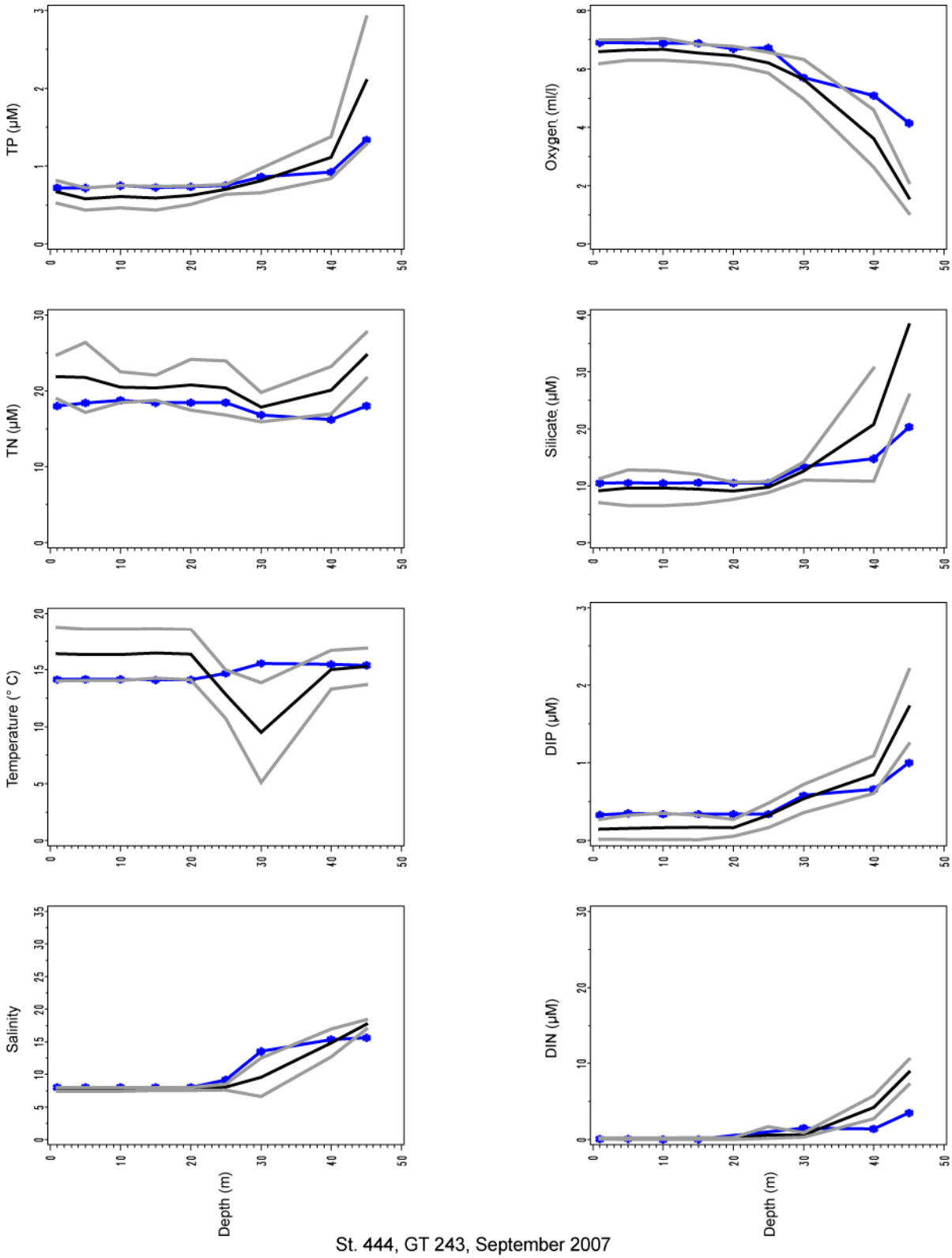
St. 939, GT 243, September 2007



St. 431, GT 243, September 2007



St. 952, GT 243, September 2007



St. 444, GT 243, September 2007