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2015-07-27
Dnr: S/Gbg-2015-104

Report from the SMHI monitoring cruise with R/V Aranda

Survey period: 2015-07-20 - 2015-07-27
Survey area: Skagerrak, Kattegat, the Sound, the Baltic Proper and the Gulf of Finland
Principal: SMHI and the Swedish Agency for Marine and Water Management

SUMMARY

The expedition was part of the Swedish regular marine monitoring programme and covered the Skagerrak, the Kattegat, the Sound, the Baltic Proper and the Gulf of Finland. Data presented in this report has been subject to preliminary quality control procedures only.

The water temperature in the surface layer was essentially normal or somewhat lower than normal for the season. In the southern and southeastern Baltic Proper very high concentrations of phosphate and silicate were measured. The large inflow that occurred in December 2014 had now reached the northern parts of the eastern Gotland basin, but the oxygen levels in the inflowing water had now declined to below 2 ml/l. In the northern and western Gotland basin and in the western part of the Gulf of Finland the oxygen situation remains severe as completely oxygen free conditions are found at depths exceeding 70-90 metres. Acute hypoxia was found from 55 metres in the western Gotland basin. In the bottom water in the Arkona and Bornholm basins, and in the Hanö Bight, oxygen levels had declined compared to the previous sampling in June and acute hypoxia was experienced. Phytoplankton analysis showed relatively large amounts of cyanobacteria in the Baltic Proper, which could also be clearly seen in the surface water in the northern parts, as well as in the Bornholm basin. Surface accumulations were only observed in a small area in the eastern Arkona Basin. For a more detailed analysis of the phytoplankton situation, please see the separate report.

The next cruise is planned to start August 31, 2015.

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SMHI

PRELIMINARY RESULTS

The cruise, performed on board the Finnish research vessel Aranda, began in Helsinki on July 20 and ended in the same port on the 27th. The winds during the expedition were mainly weak to moderate. In parts of the Kattegat, the Skagerrak and the northern Baltic Proper however, the wind increased and on a few occasions were at gale force. Air temperatures ranged from 13-19°C.

To monitor the ongoing cyanobacterial bloom in the Baltic Proper extra sampling was performed at all stations and phytoplankton analyses were carried out onboard. The results of these analyses are presented in a separate report.

In the Gulf of Finland and the northern Baltic Proper four stations were visited that usually are sampled by the Finnish Environment Institute (SYKE). This extended monitoring is part of a new collaboration between SYKE and SMHI with the aim to i.e. increase the sampling frequency at Swedish and Finnish monitoring stations.

During the cruise, scientists from the Umeå and the Stockholm University collected water and net samples for analysis of methyl mercury and total mercury. The purpose was to investigate the concentrations and bioaccumulation of mercury in the Baltic and the Kattegat, but also to evaluate suitable monitoring methods. Also, a scientist from Tartu University performed a comparative study of three different analysis methods for pH.

The Skagerrak

The temperature in the surface water was somewhat lower than normal for the season and varied between 14.7 and 16.7°C, highest near the coast. The surface salinity was normal; 25.6 – 31.7 psu, lowest at the coast. The stratification was found at 15-20 metres depth.

The nutrients in the surface waters were now completely depleted both at the coast and offshore, which is normal for the summer period. All nutrients showed concentrations below the reporting limit, or very low concentrations. The offshore phosphate concentrations varied around 0.02 µmol/l, inorganic nitrogen (nitrite+nitrate and ammonia) was below the reporting limit, while silicate varied between 0.1-0.4 µmol/l.

Fluorescence measurements showed that the biological activity was high just below the cline at the offshore stations, but that the activity was low along the coast. For more details see the separate phytoplankton report.

The lowest oxygen concentration in the bottom water was found at Släggö in the mouth of the Gullmar fjord.

The Kattegat and the Sound

In Kattegat, the temperature in the surface water was around 17°C which is somewhat lower than normal. The salinity in the surface layer was normal for the season and varied between 20.1 and 22.9 psu. In the Sound the salinity was higher than normal, ~16 psu. The halocline and the thermocline were found at 15-20 metres depth.

The concentration of nutrients in the surface water was low or almost exhausted, which is normal for the season. The phosphate concentrations varied between 0.02-0.05 µmol/l and the inorganic nitrogen was below the reporting limit. Silicate also showed low concentrations around 0.6-0.9

µmol/l. In the Sound, the concentrations of nutrients were normal except for silicate which showed lower concentrations the normal, 1.6 µmol/l. Phosphate was 0.14 µmol/l and inorganic nitrogen was below the detection limit.

De lowest oxygen concentrations in the bottom water were measured at Anholt E, 3.7 ml/l in Kattegat and 3.5 ml/l at W Landskrona in the Sound.

The plankton activity was low in the surface water, but at Anholt E a distinct fluorescence peak, dominated by dinoflagellates *Ceratium macroceros*. This spices are an indicator of North Sea water. For more details see the separate phytoplankton report.

The Baltic Proper

The temperature in the surface water was normal or somewhat below normal for the season and varied between 15.2 and 17.1°C. The surface salinity was higher than normal in the south western Baltic Proper and below normal in the north eastern parts. The salinity varied between 5.6 psu in the central Gulf of Finland to 8.3 psu in the Arkona basin. The halocline was found at 60-80 metres depth in the western and eastern Gotland basin, while it was shallower in the southern parts. In the Arkona basin it was found at 30-40 metres depth. The thermocline was found at 15-25 metres depth and was well developed.

The concentration of phosphate and silicate in the surface water was still over normal in the southern and in the south eastern Baltic Proper. At some stations the concentration had increased further. The high concentrations of phosphate and silicate in the surface waters could be attributed to the inflow, and nutrient rich bottom water consequently reaching the surface water. Another plausible cause to the high phosphate concentration is that the cyanobacterial bloom had not yet started. In the remaining parts the concentrations had declined and were now normal for the season. Phosphate concentrations varied between 0.10-0.47 µmol/l and silicate between 8.8-17.4. The high concentrations were observed at BCSIII-10 in the south eastern Baltic Proper. The inorganic nitrogen was completely consumed down to 20 metres depth in the whole area.

To monitor the inflow to the Baltic Sea that occurred during December 2014 extra sampling points were visited in the eastern Gotland basin. Weak signs of the inflow were found at the Fårö Deep (BY20). The inflow was more clearly seen between the Fårö Deep and the Gotland Deep (BY15) as a thin bottom layer, where the maximum oxygen concentration had increased from about 0.9 ml/l to 1.4 ml/l.

In the western and northern Baltic Proper, and in the western Gulf of Finland, the oxygen situation was still severe. Completely oxygen free conditions were found at depths exceeding 70-80 metres. In the Gotland Deep, in the eastern Gotland basin, acute hypoxia was found at depths exceeding 70 metres and hydrogen sulphide was found at intermediate depths in a narrow layer at about 110-120 metres. Below the oxygen free layer, the deep water was still oxygenated, but the concentrations had declined to below 2 ml/l.

Acute hypoxia was found in the western Gotland basin from 55 metres depth. In the northern and eastern Gotland basin, the western Gulf of Finland and in the Bornholm basin, hypoxia was found from 70-80 metres depth. The oxygen content in the bottom water in the Arkona basin and the Hanö bight had declined further compared to the last measurements in June, and also here acute hypoxia was observed.

The phytoplankton analyses during the cruise shows that relatively high amounts of cyanobacteria were present throughout the investigated area. Cyanobacteria were visible in the surface water in the northern Baltic Proper and in the Bornholm Basin. Surface accumulations were only observed in a small area in the eastern part of the Arkona Basin. For more information about the algal situation, please see the separate phytoplankton report.

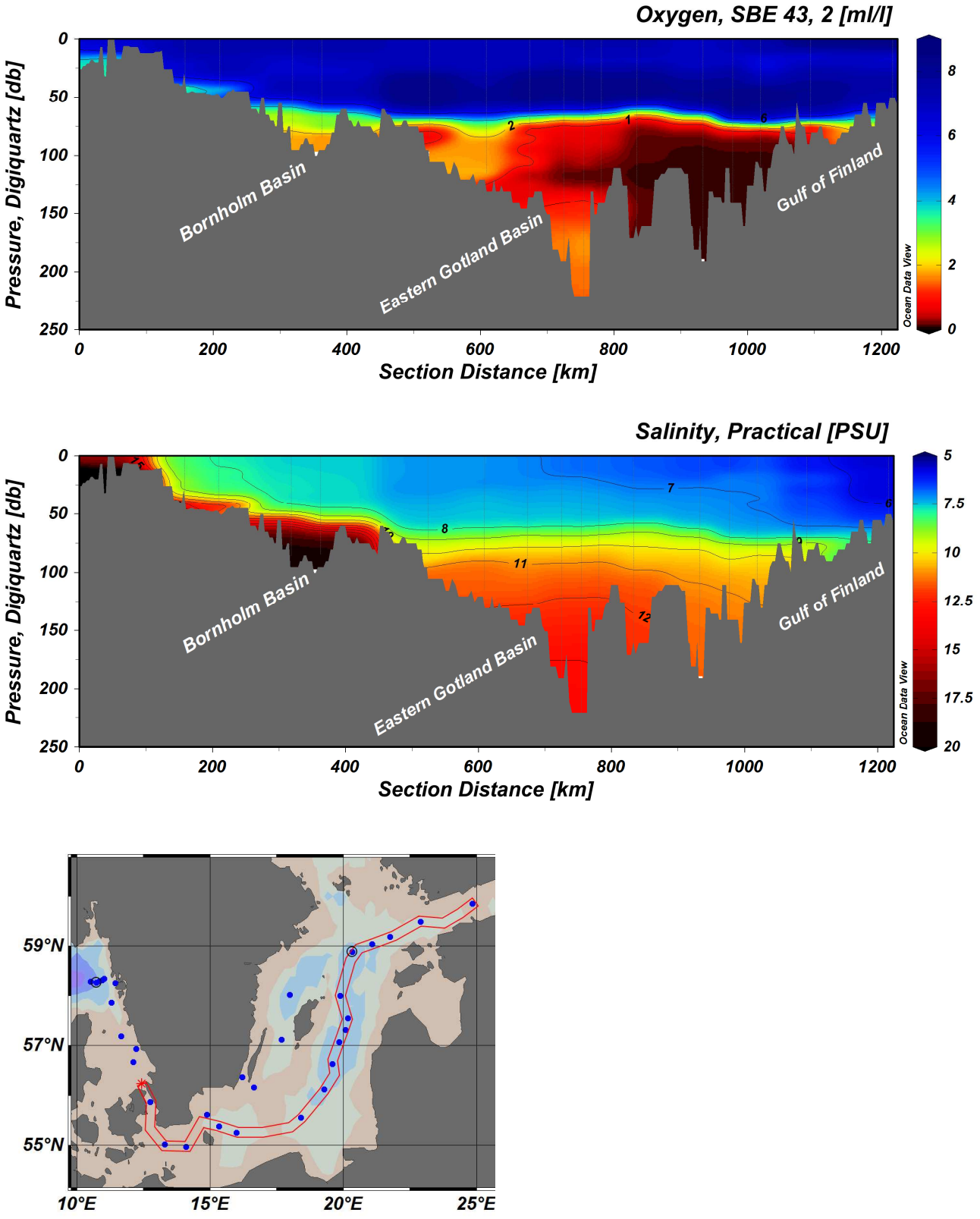

Figure 1. Transect showing the oxygen and salinity from the Sound to the Gulf of Finland.

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PARTICIPANTS

Name		**Institute**
Martin Hansson	Chief scientist	SMHI
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Daniel Simonsson		SMHI
Jenny Lycken		SMHI
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Mikael Krysell	(Lysekil-Helsinki)	SMHI
Erik Björn		Umeå University
Anne Soerensen		Stockholm University
Silvie Lainela		Tartu University

APPENDICES

- Track chart
- Table over stations, parameters and sampling depths
- Map showing bottom oxygen concentrations
- Monthly average surface water plots for selected stations
- Vertical profiles for selected stations

TRACKCHART
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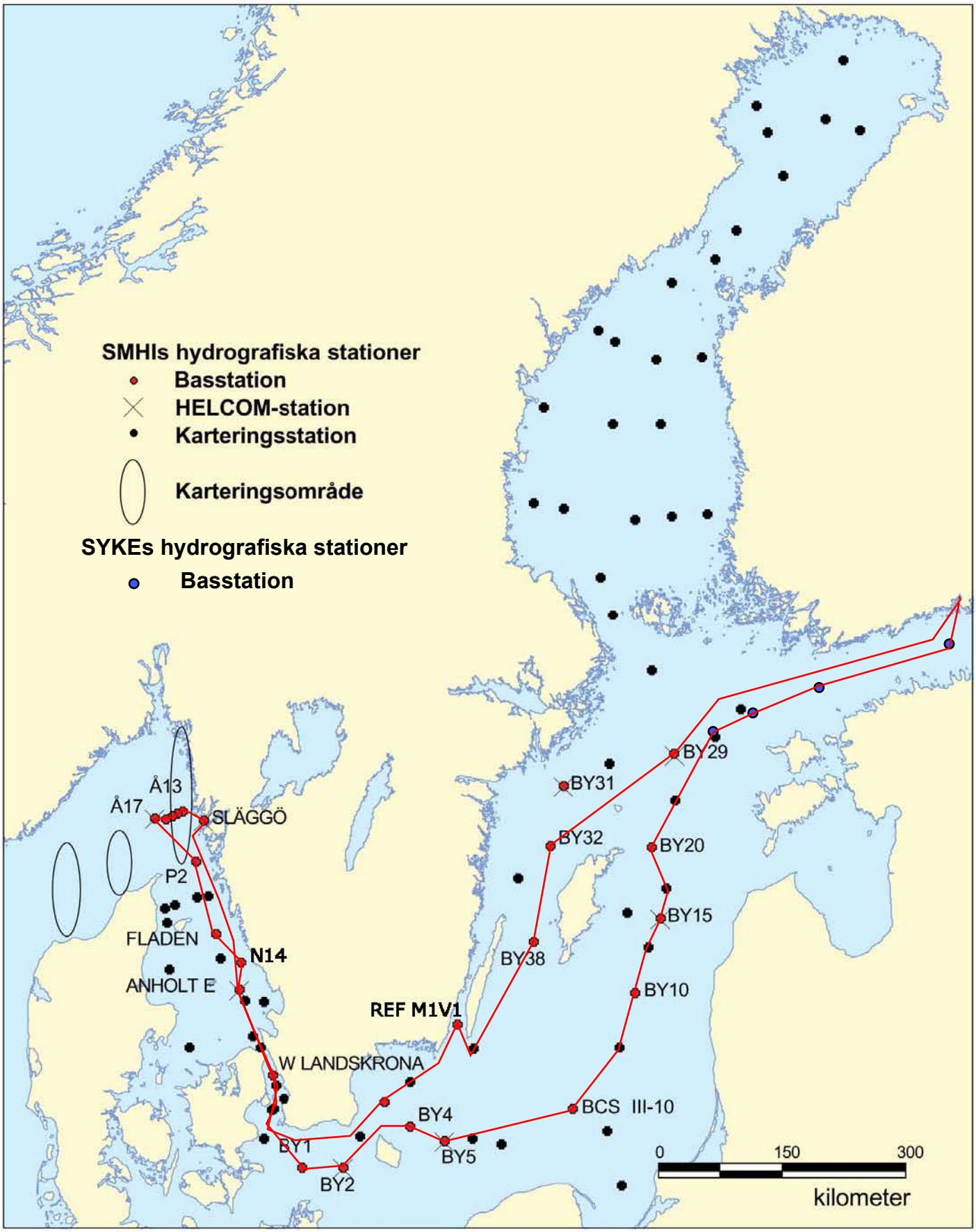
Ship: R/V ARANDA
Date: 20150720-20150727
Series: 0460-0493



SMHI ***** Hydrographic Ship: 01-Aranda ****** Date: 2015-07-27
Ocean enh ***** series Year: 2015 ****** Time: 17:35

Ser no	Stat code	Proj	Station	Lat-----	Lon-----	Date yyyymmdd	Time hhmm utc	Bottom depth m	Secchi depth m	Wind dir	Wind vel	Air temp C	Air pres hPa	WCSI aoahd	Ct	PPCPZZT Hrhhoor Cilyooa motPBw PrP l	No de	Tem p	Sal in	pH	Oxy g	H2S	PO4P	Too t P	NO2N	NO3N	NOxN	Tot N	Alk a l	Sium s	Hum g	Lui n	PON	POC	TOC	Comm
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0462	BPNX00EXT	LL15		N5911.00	E2144.81	20150720	2345	132		32	7	16.0	1007	9990	x	-------	15	x	x	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	x
0463	BPNX00EXT	LL17		N5902.00	E2104.77	20150721	0207	169		32	3	15.6	1008	1130	x	-------	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x
0464	BPEX26BAS	BY20	FÅRÖDJ	N5800	E1953	20150721	0845	197	5	20	4	16.1	1009	1530	x	--x----	17	x	x	-	x	x	x	x	x	x	x	x	-	x	-	-	-	-	x
0465	BPEX25EXT	BY19		N5737	E2010	20150721	1210	161	5	21	7	16.1	1009	2730	x	-------	17	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x
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0468	BPEX14EXT	BY11		N5704	E1950	20150721	1750	205		19	9	15.8	1006	2830	x	-------	17	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x
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0493	BPNX35BAS	BY29		N5853	E2019	20150727	0208	170		22	15	14.8	999	2850	x	-------	16	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x

Bottom water oxygen concentration (ml/l)

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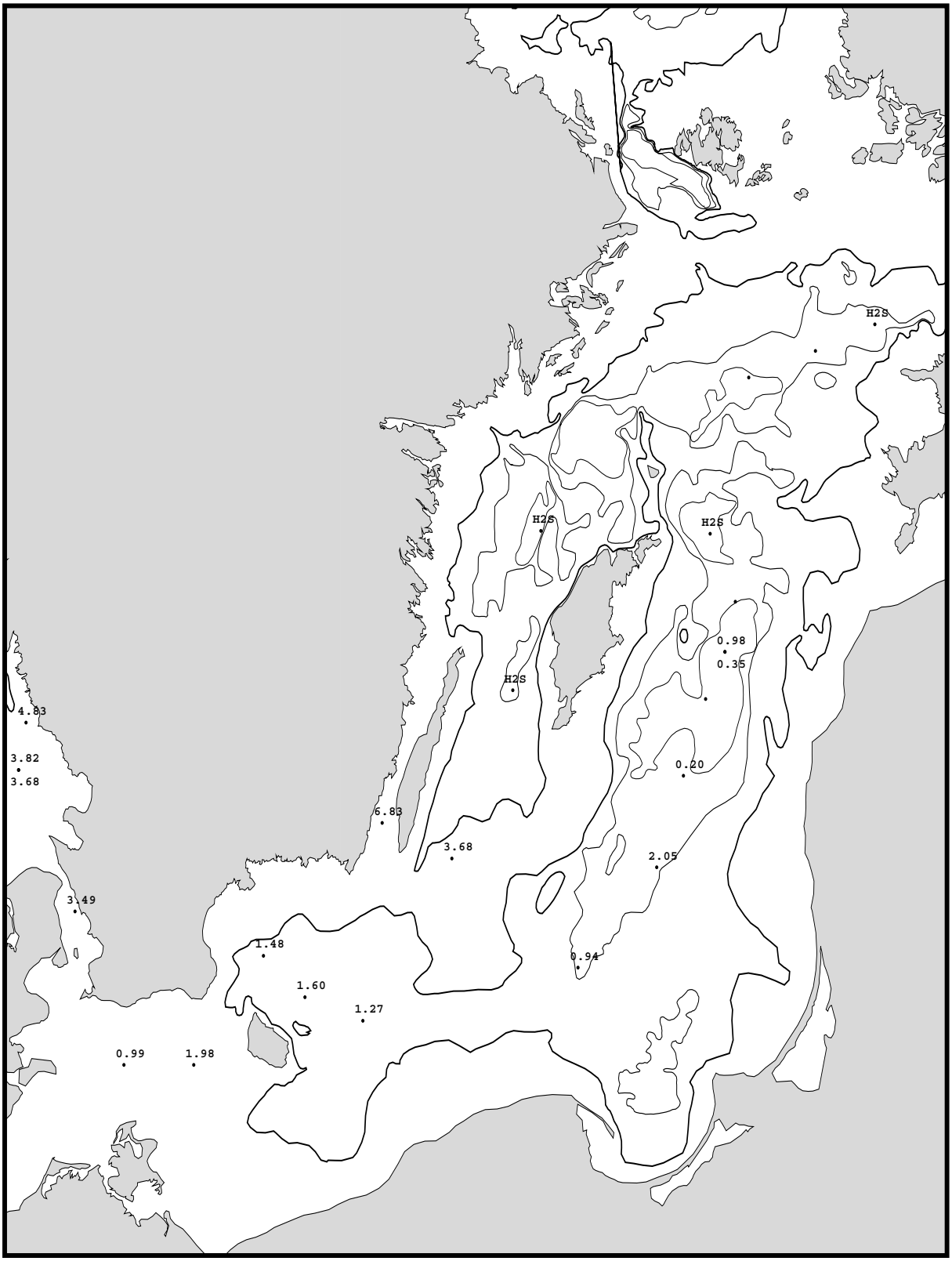
Ship : Aranda
Date : 20150720-20150727
Series : 0460-0493

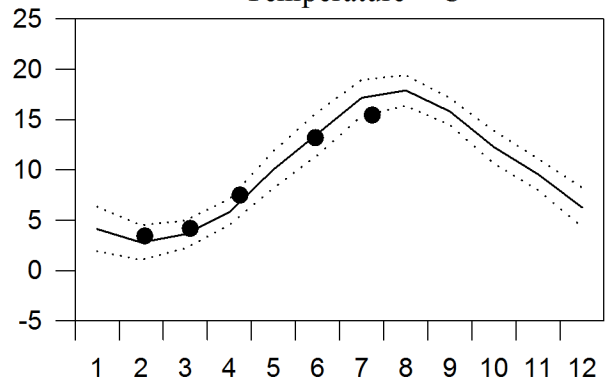


STATION P2 SURFACE WATER

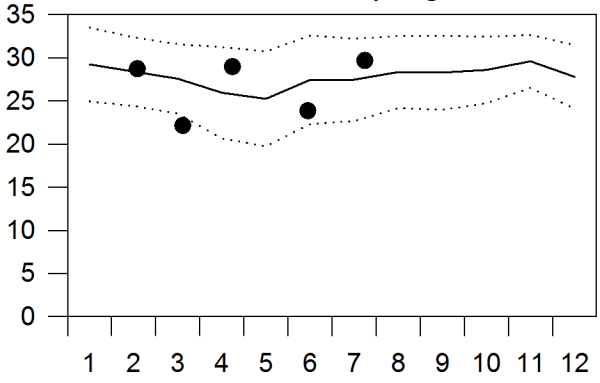
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

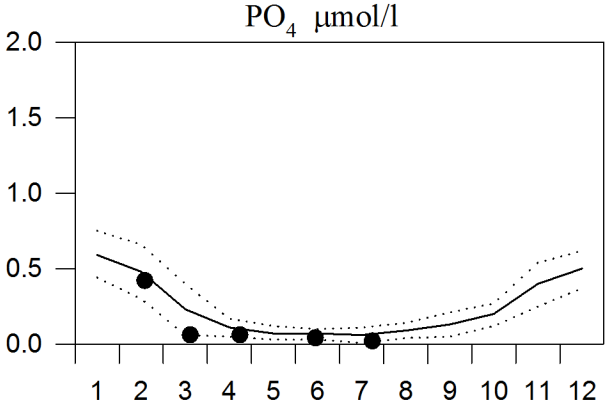
Temperature °C



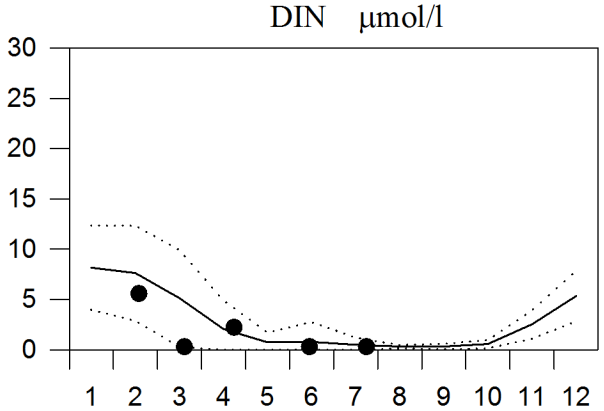
Salinity psu



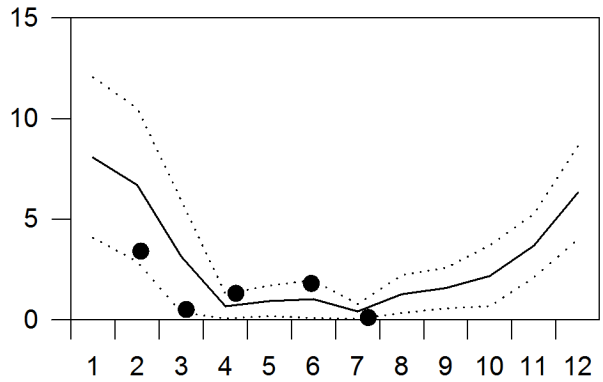
PO_4 µmol/l



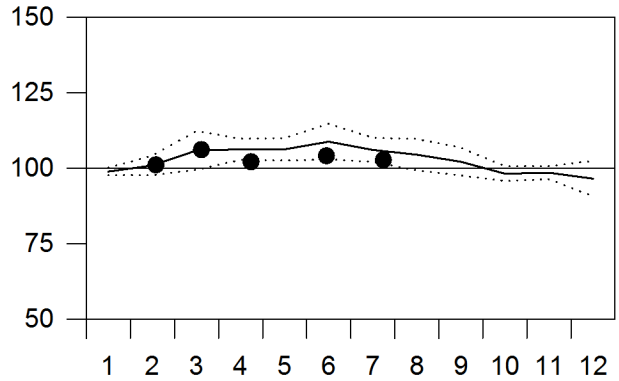
DIN µmol/l



SiO_3 µmol/l

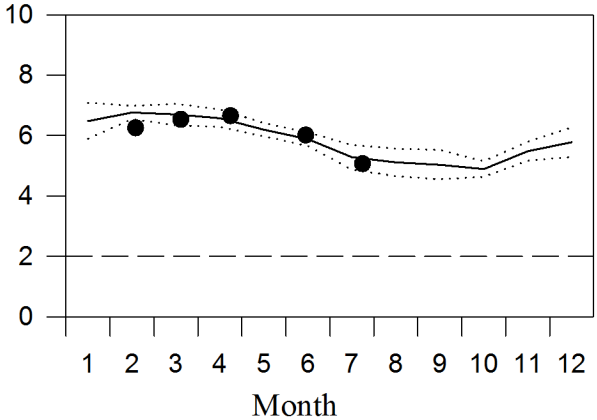


O_2 saturation %



OXYGEN IN BOTTOM WATER (depth >75m)

O_2 ml/l



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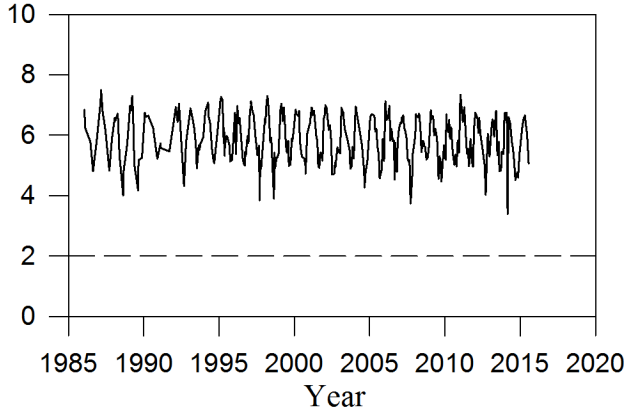

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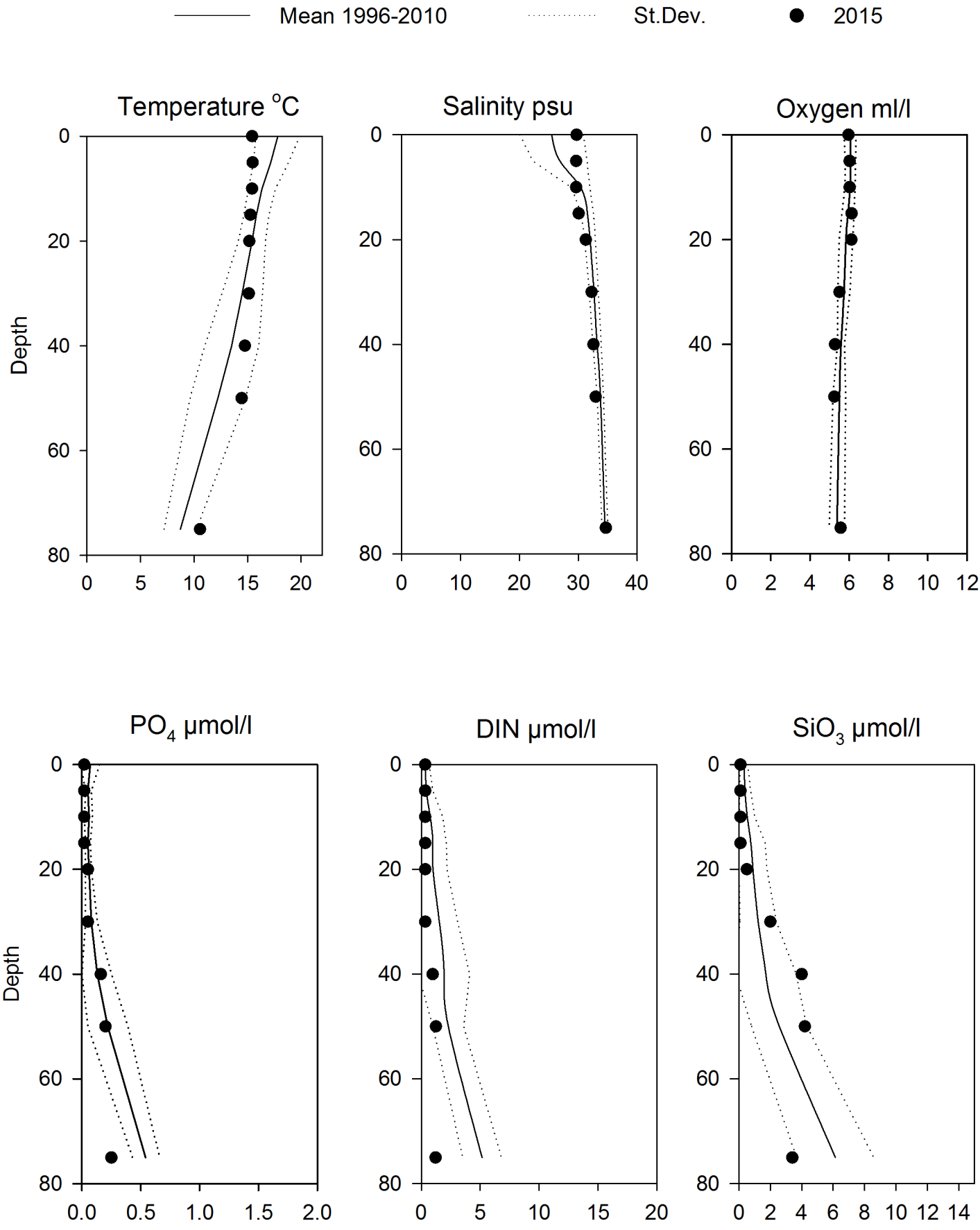
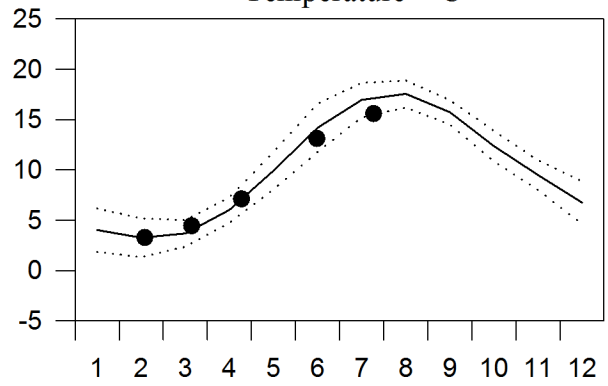


STATION Å13 SURFACE WATER

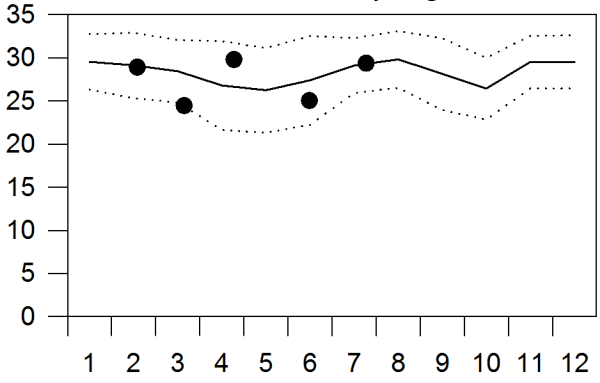
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

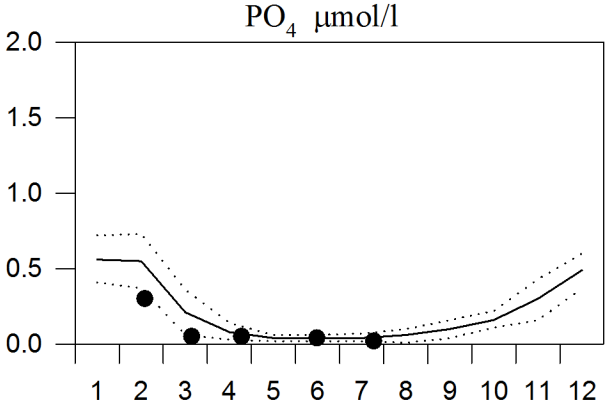
Temperature °C



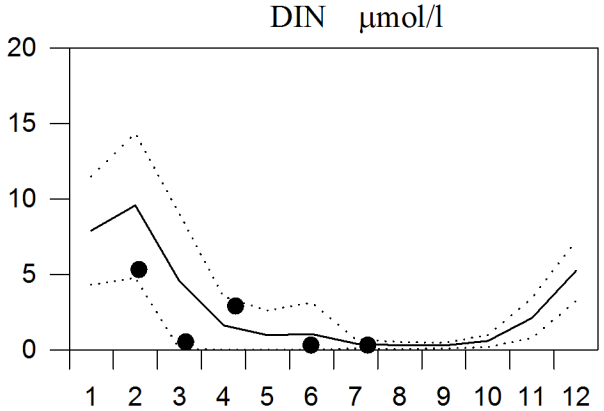
Salinity psu



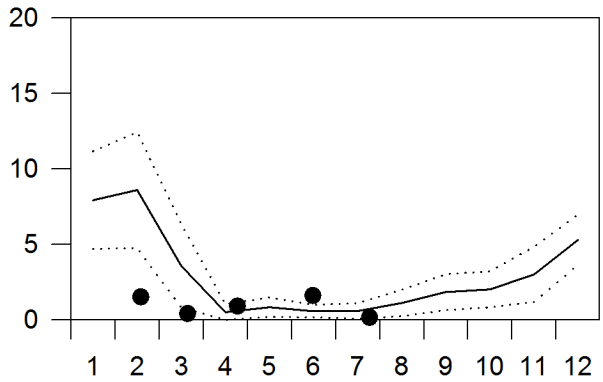
PO_4 µmol/l



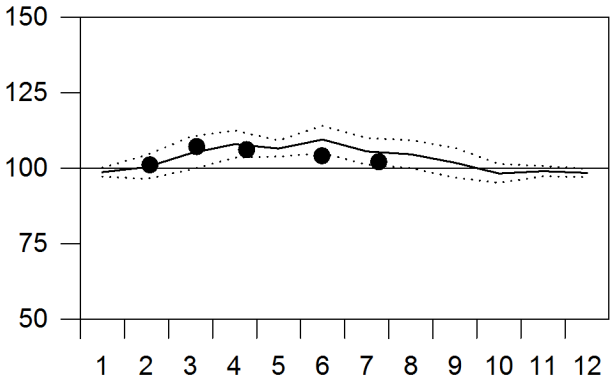
DIN µmol/l



SiO_3 µmol/l

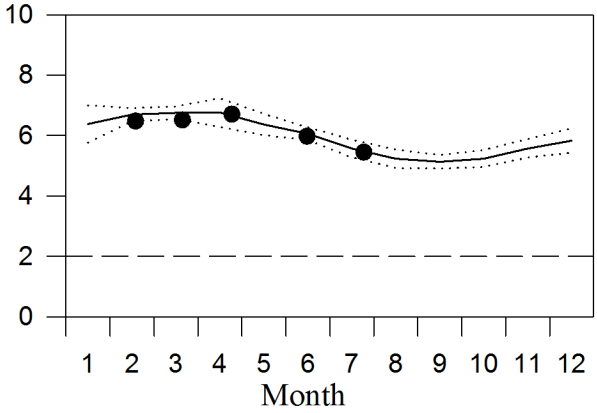


O_2 saturation %

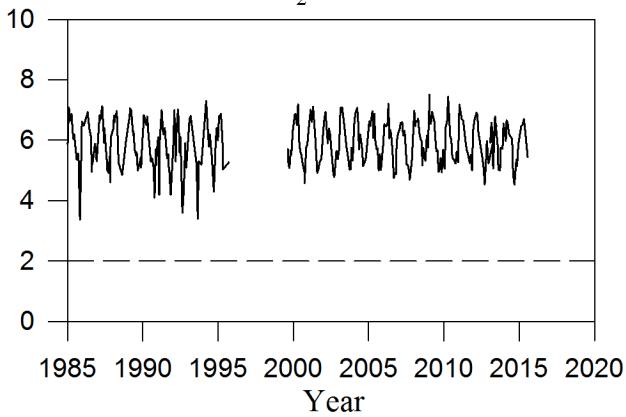


OXYGEN IN BOTTOM WATER (depth >=75m)

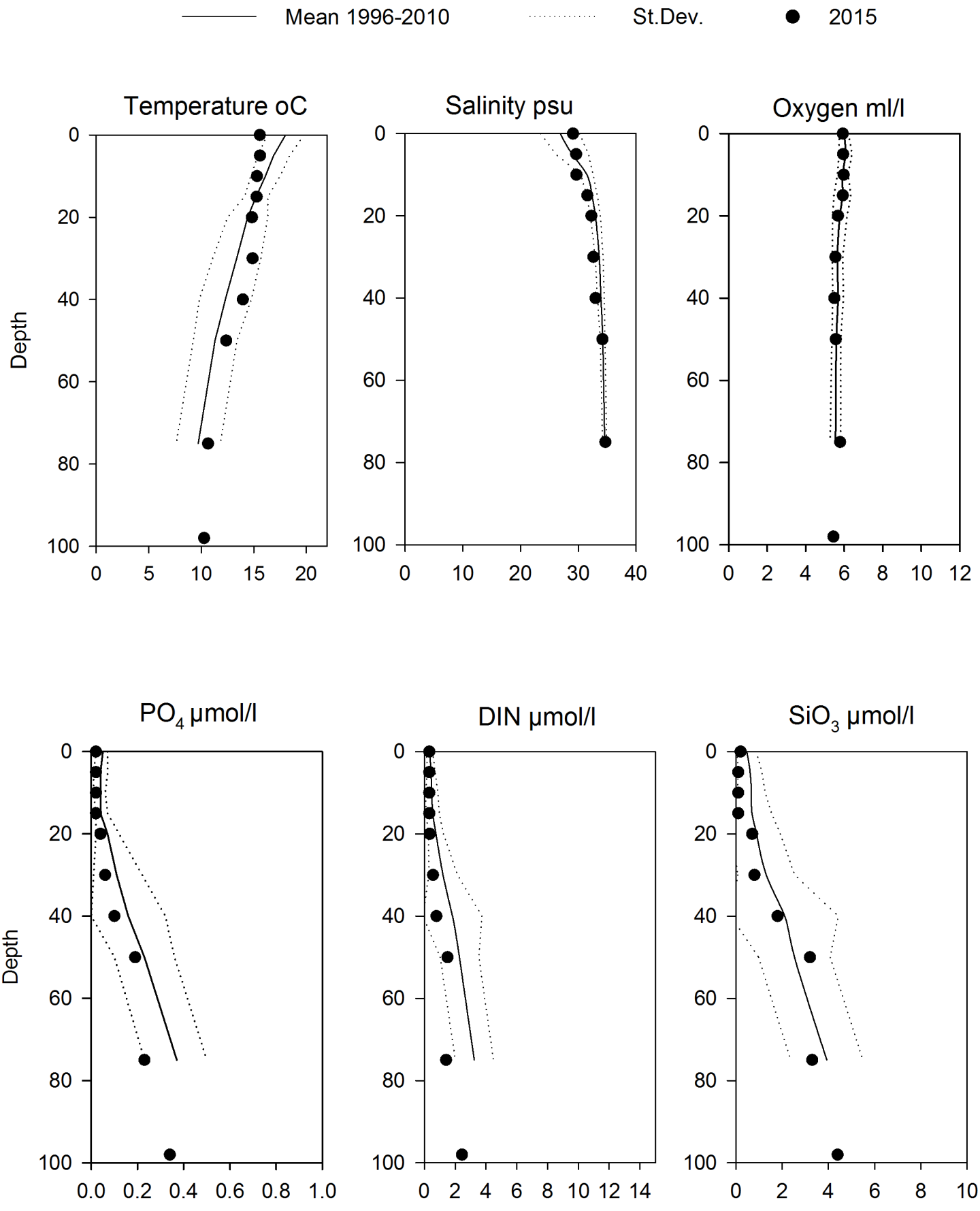
O_2 ml/l



O_2 ml/l



Vertical profiles Å13 July

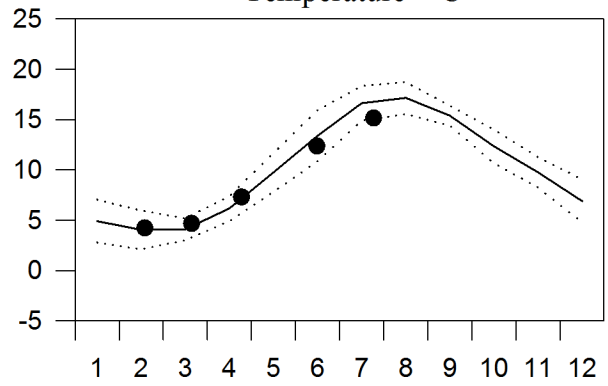


STATION Å15 SURFACE WATER

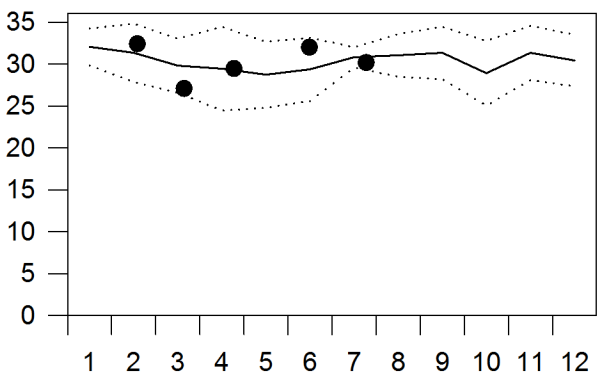
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

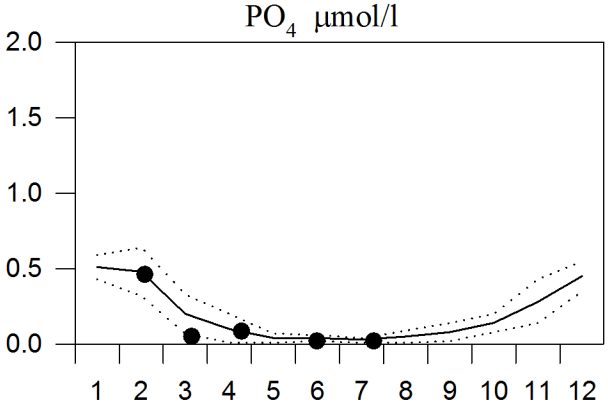
Temperature °C



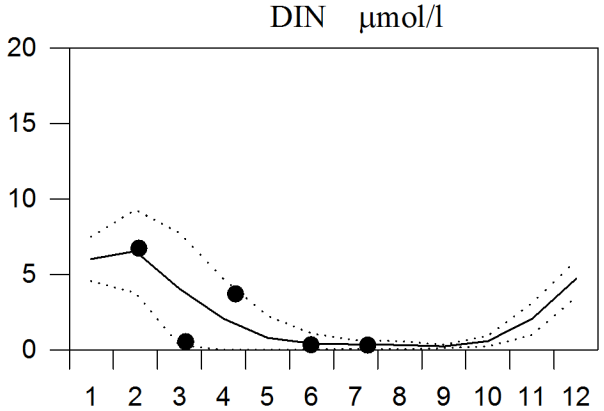
Salinity psu



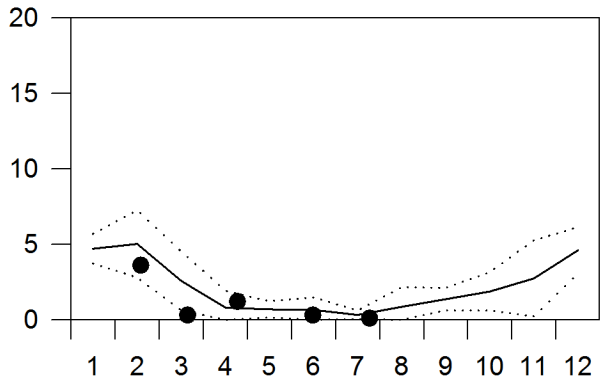
PO_4 µmol/l



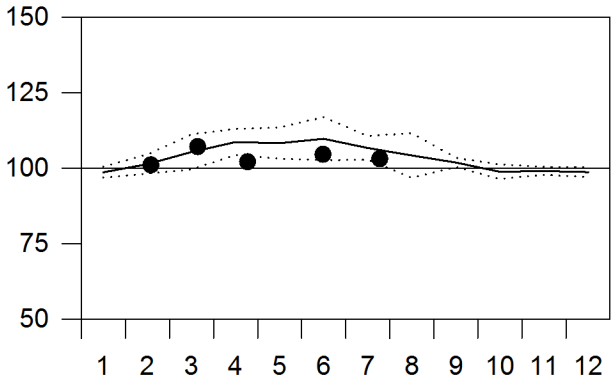
DIN µmol/l



SiO_3 µmol/l

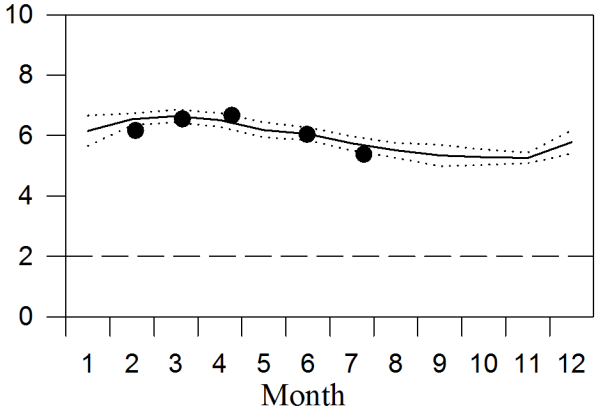


O_2 saturation %

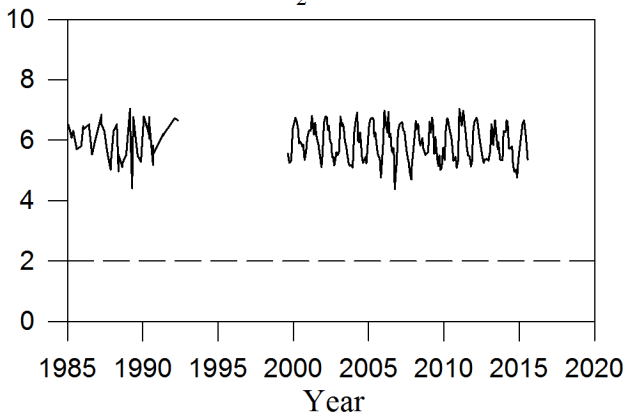


OXYGEN IN BOTTOM WATER (depth >=125m)

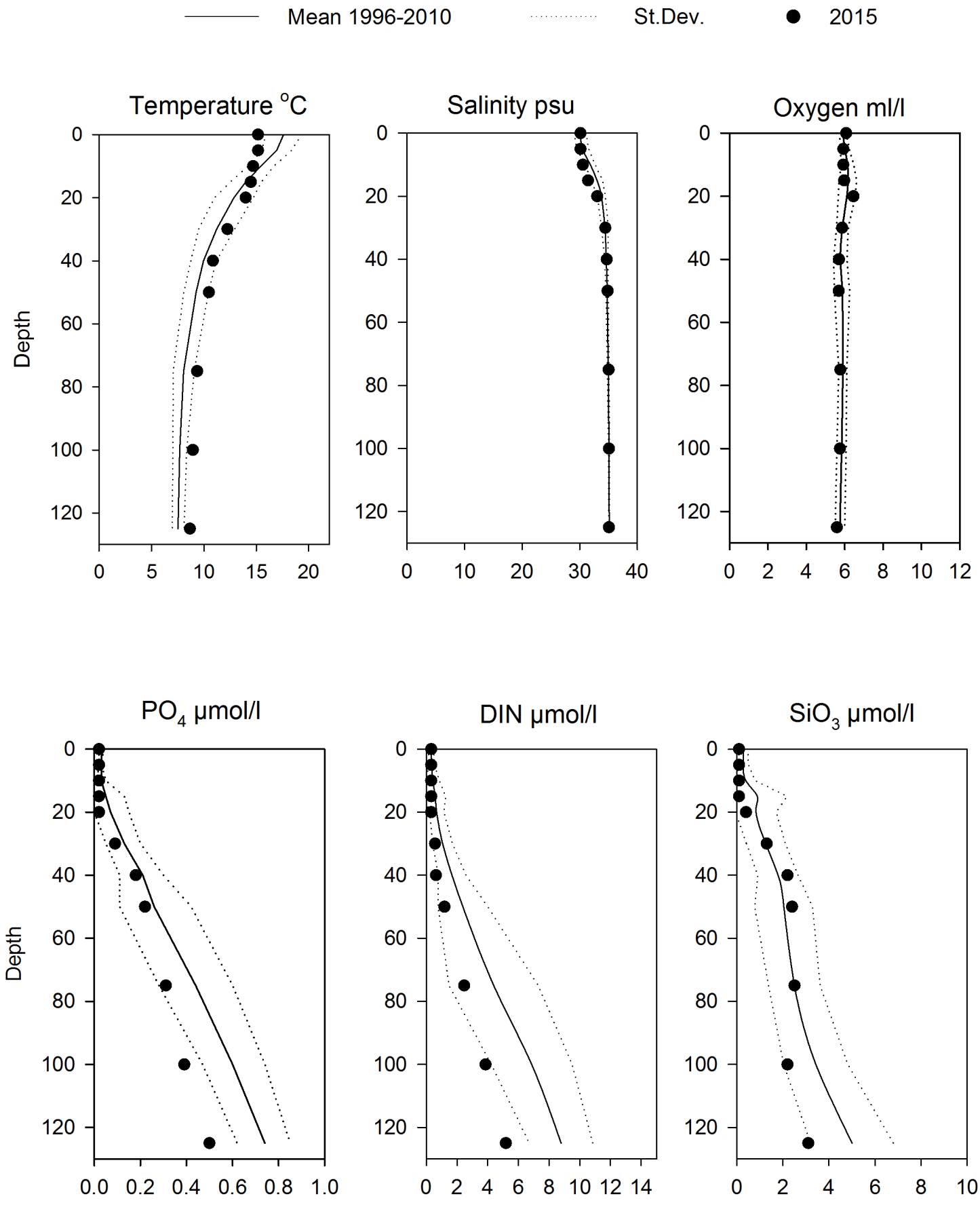
O_2 ml/l



O_2 ml/l



Vertical profiles Å15 July

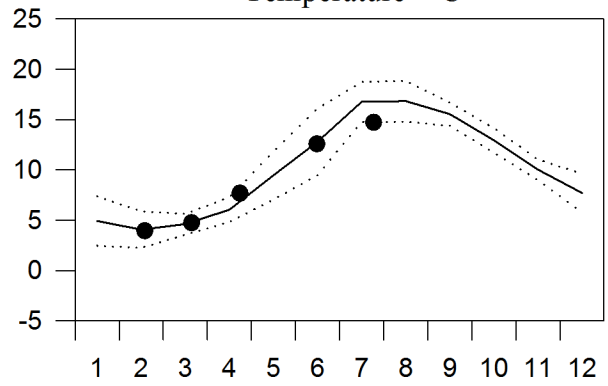


STATION Å17 SURFACE WATER

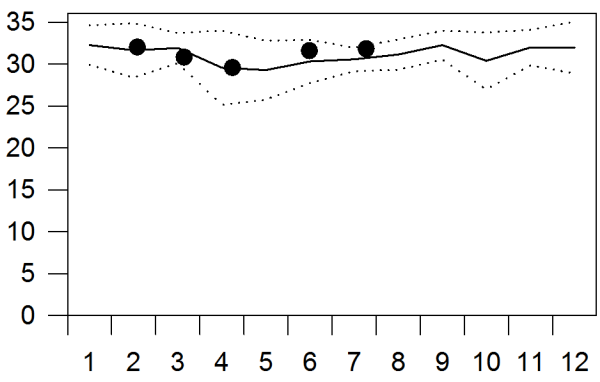
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

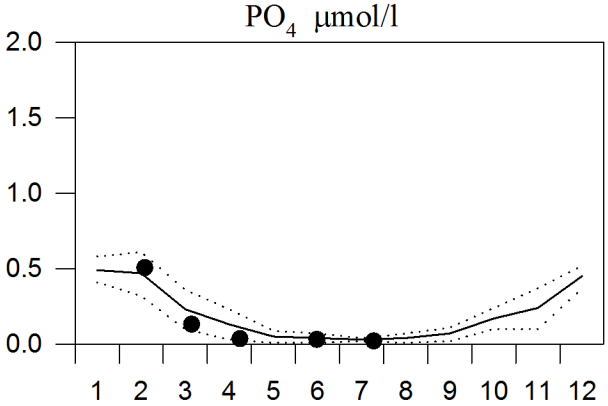
Temperature °C



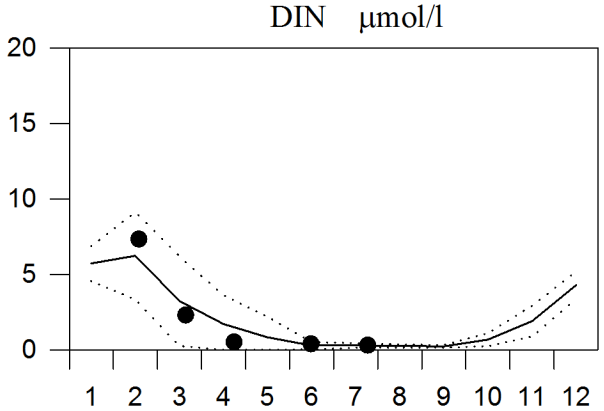
Salinity psu



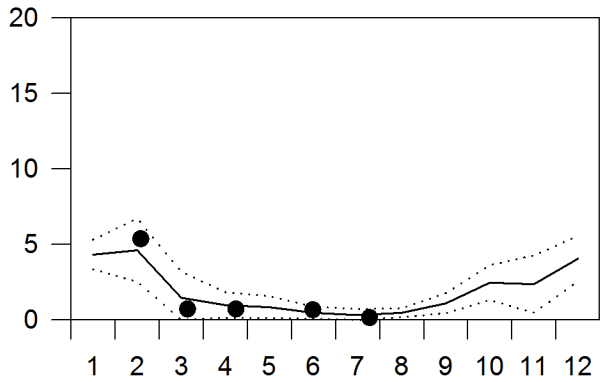
PO_4 µmol/l



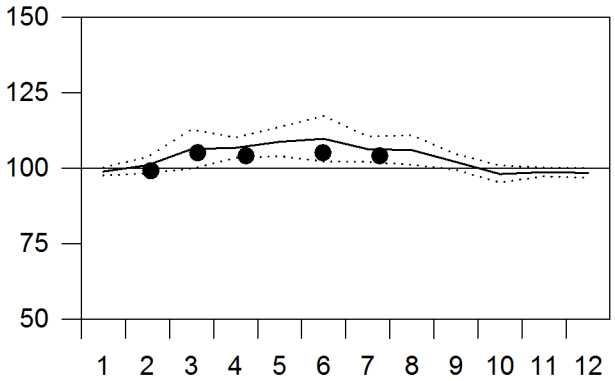
DIN µmol/l



SiO_3 µmol/l

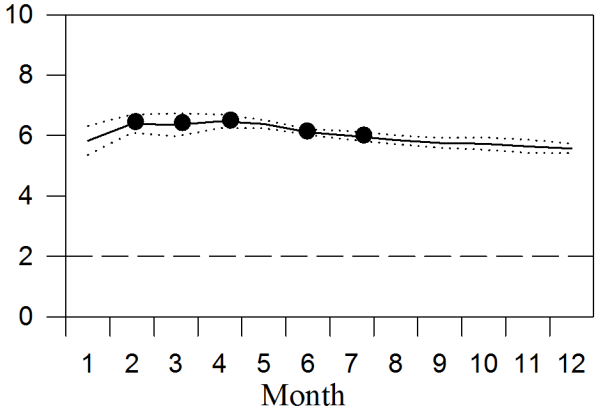


O_2 saturation %

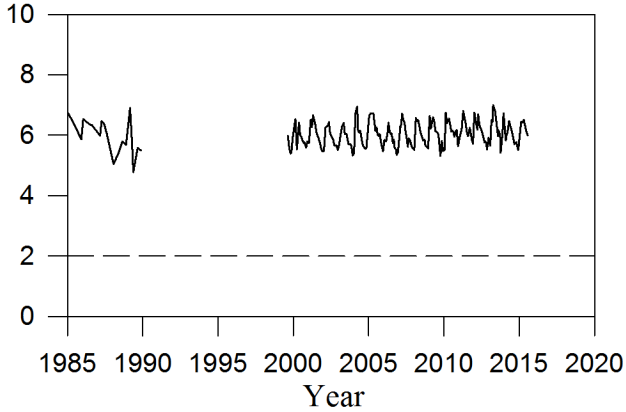


OXYGEN IN BOTTOM WATER (depth = 300m)

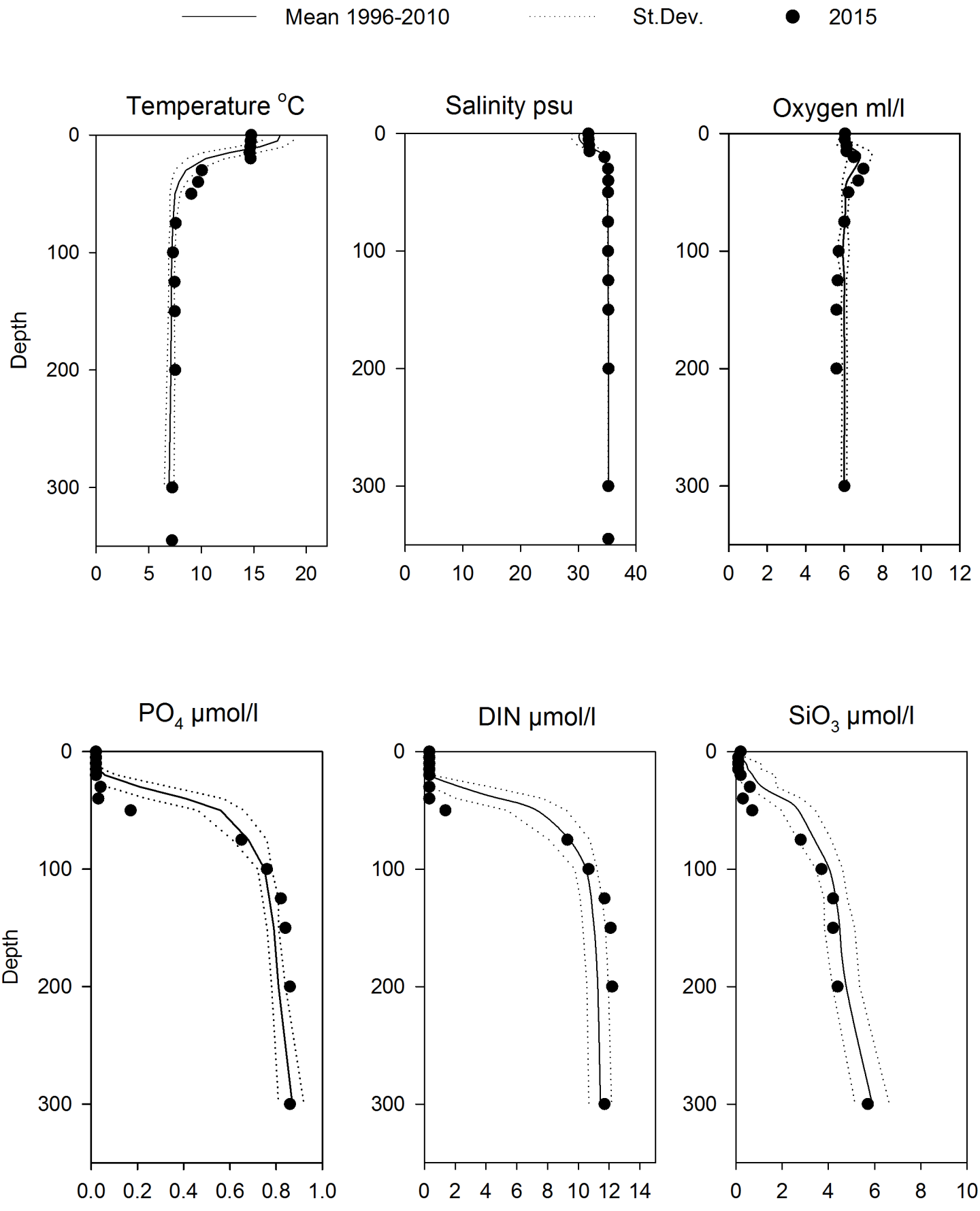
O_2 ml/l



O_2 ml/l



Vertical profiles Å17 July

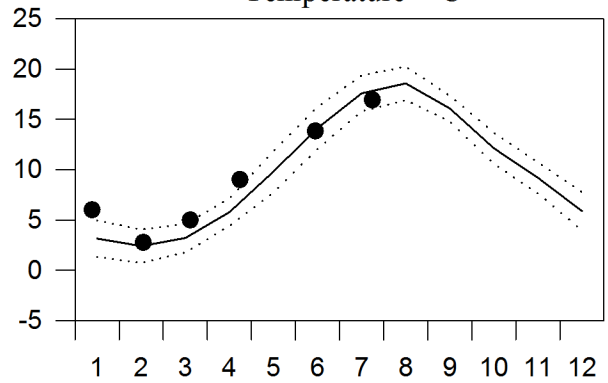


STATION FLADEN SURFACE WATER

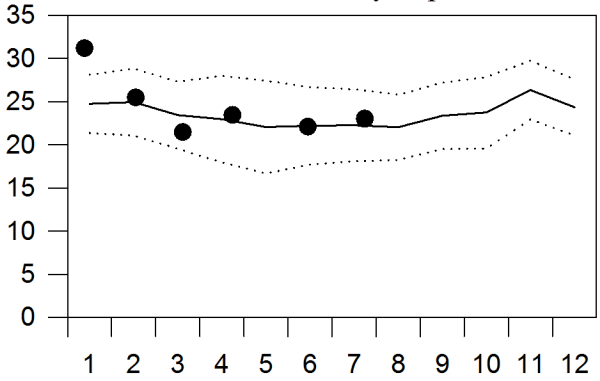
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

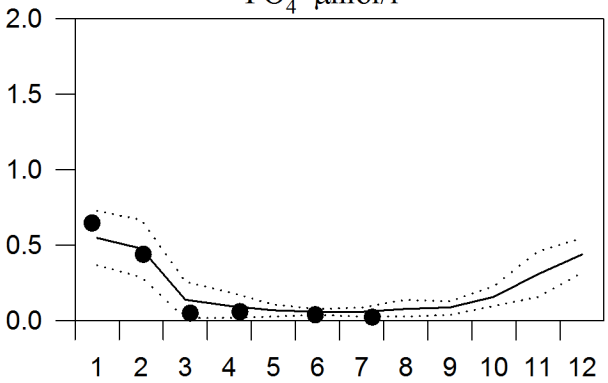
Temperature °C



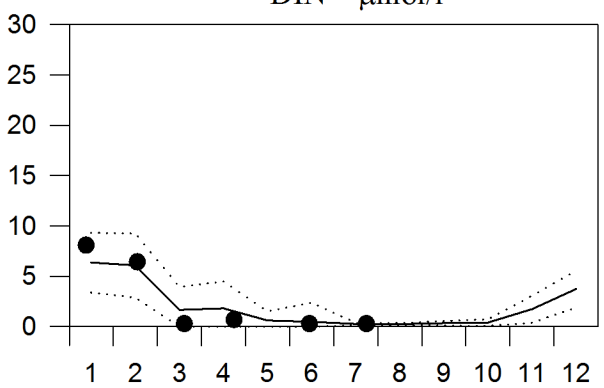
Salinity psu



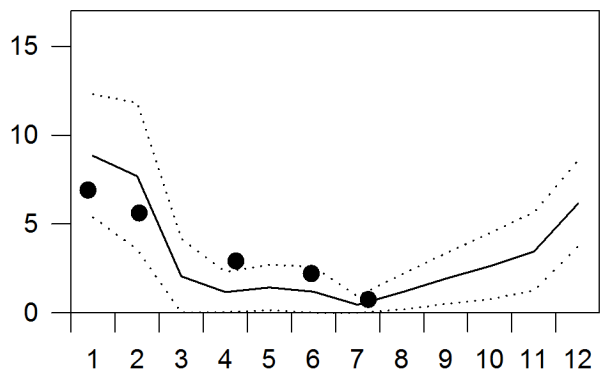
PO_4 µmol/l



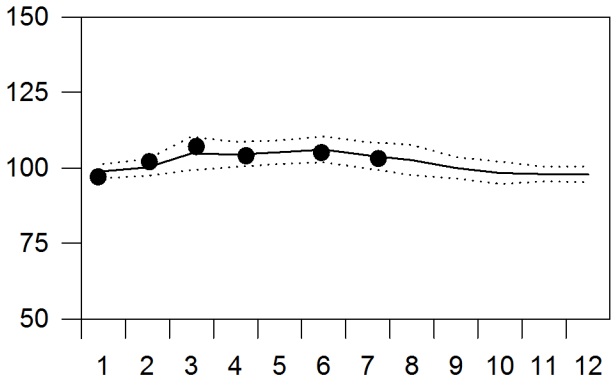
DIN µmol/l



SiO_3 µmol/l

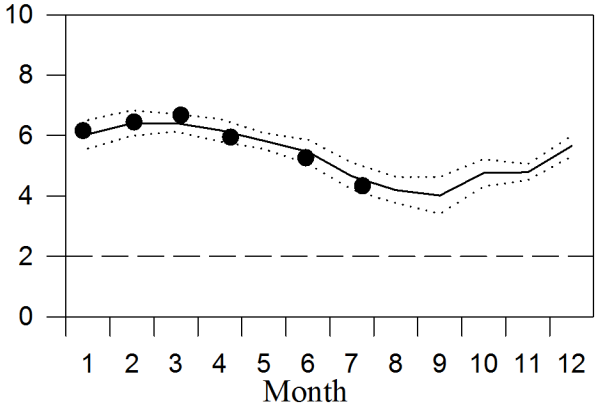


O_2 saturation %

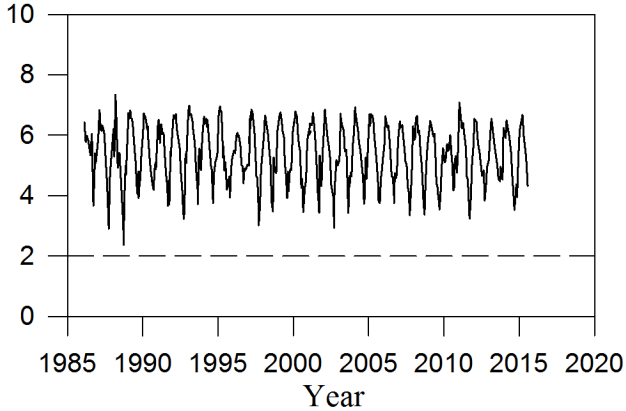


OXYGEN IN BOTTOM WATER (depth > 70m)

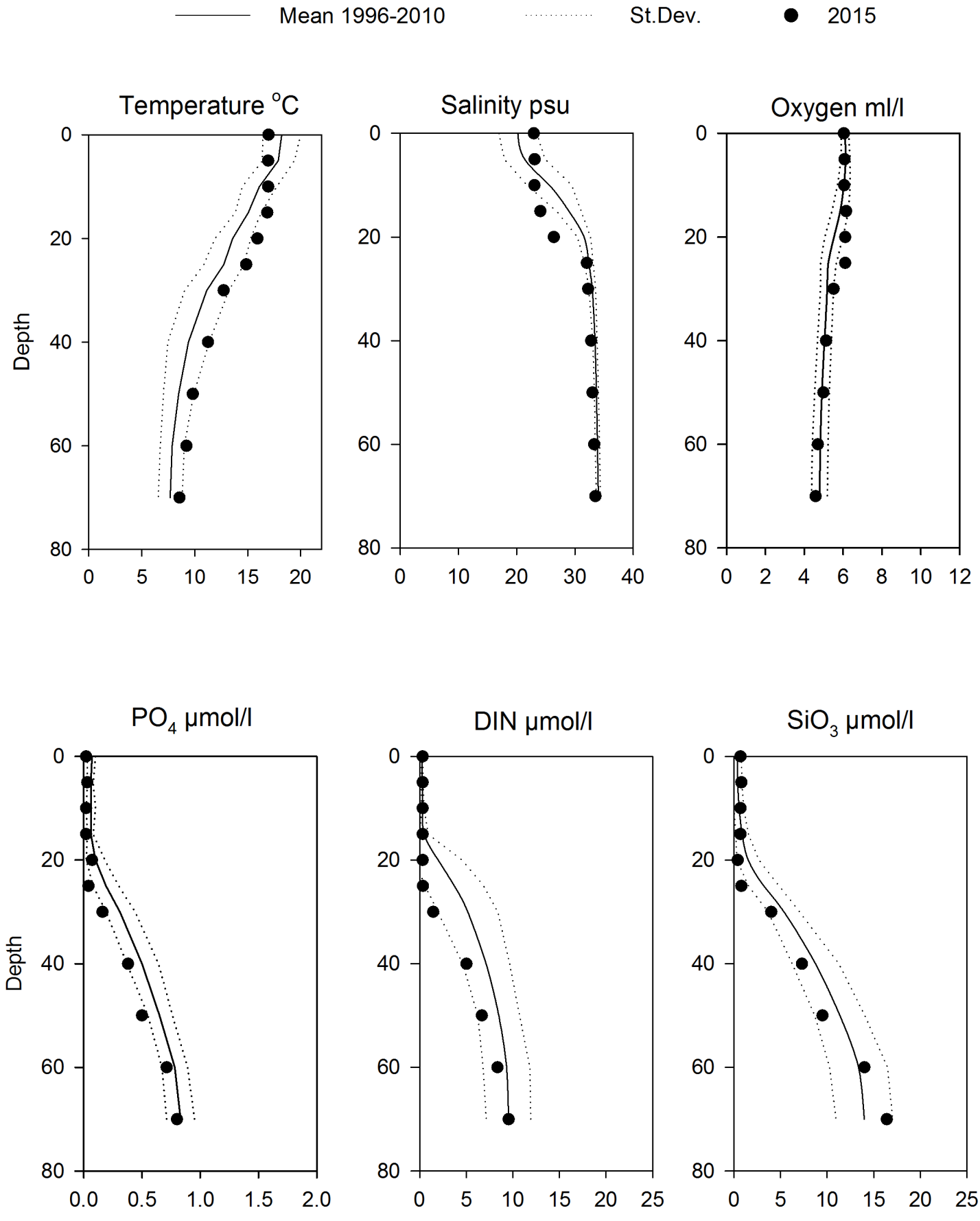
O_2 ml/l



O_2 ml/l

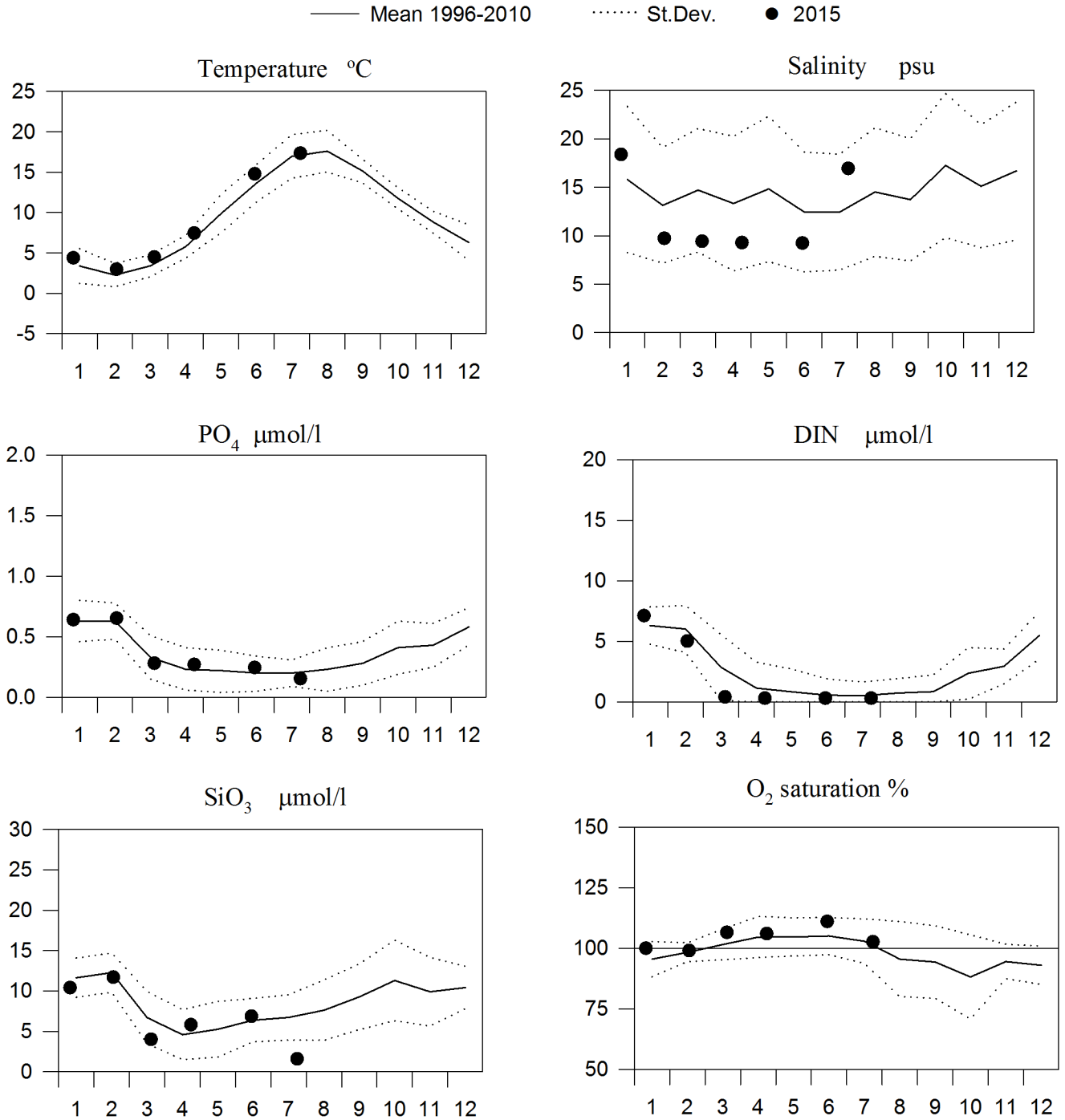


Vertical profiles Fladen July

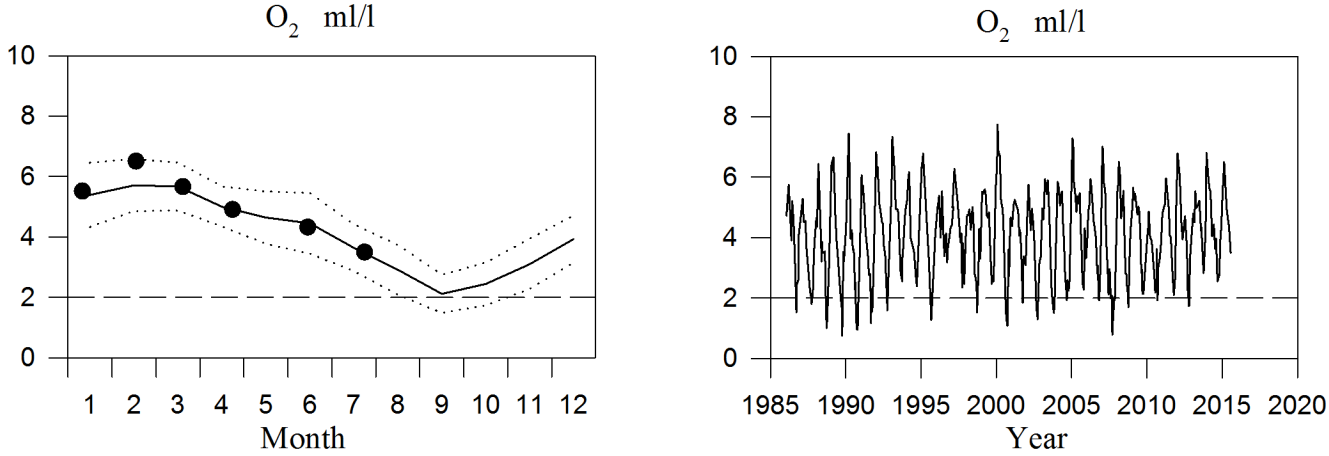


STATION W LANDSKRONA SURFACE WATER

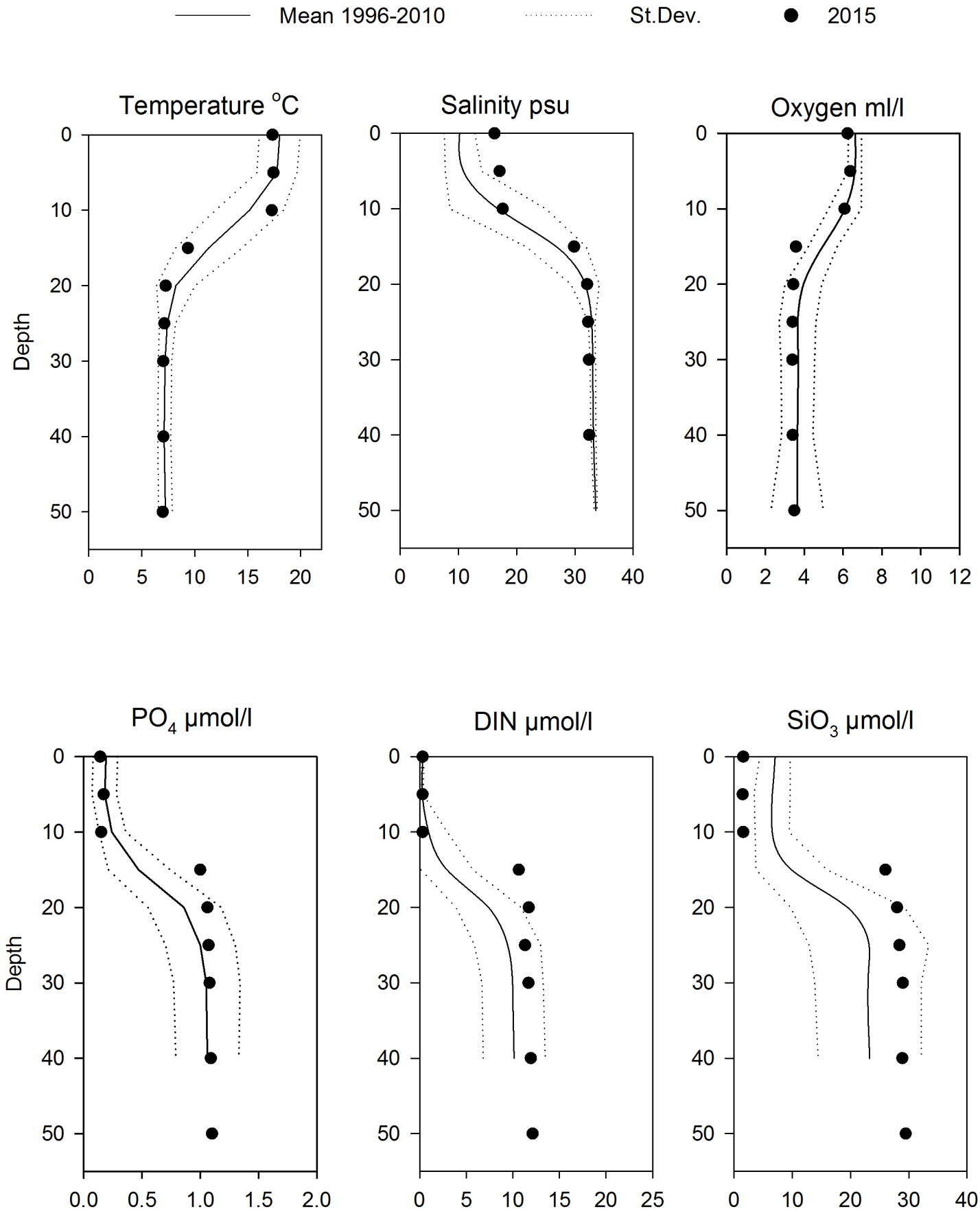
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >40m)



Vertical profiles W Landskrona July

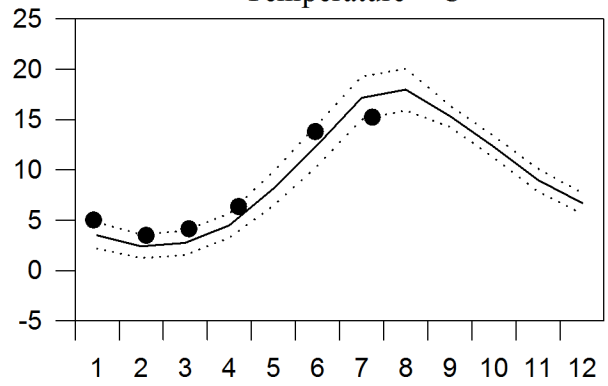


STATION BY1 SURFACE WATER

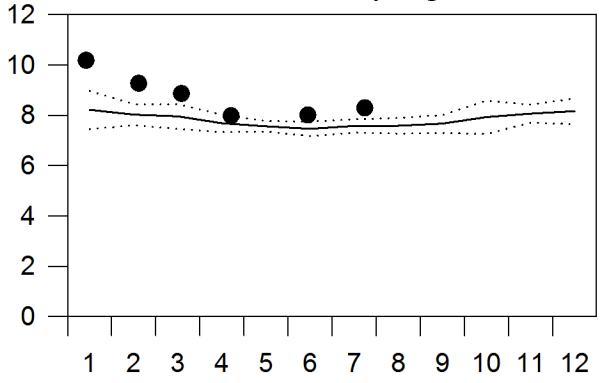
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

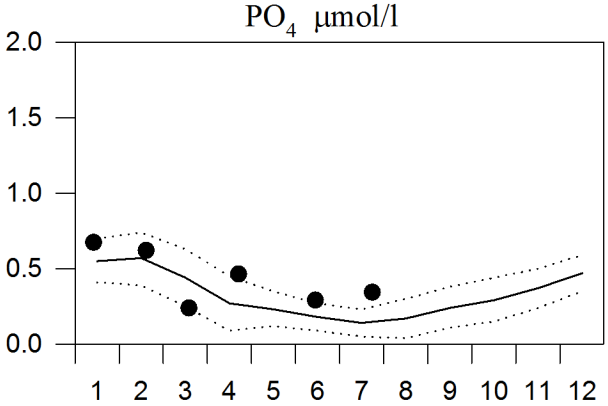
Temperature °C



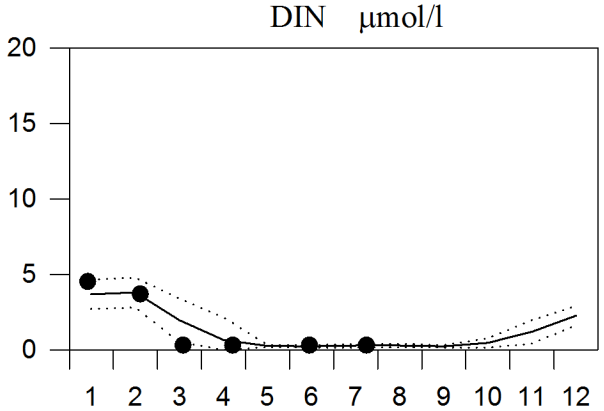
Salinity psu



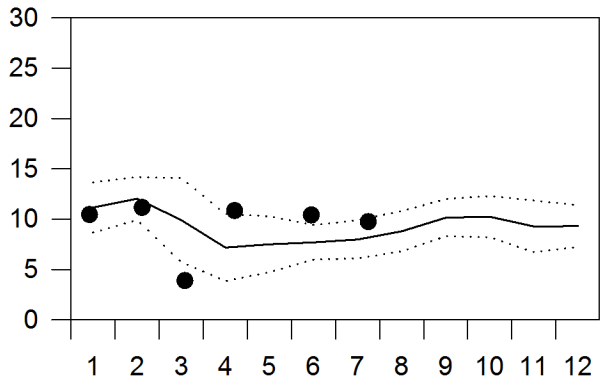
PO_4 µmol/l



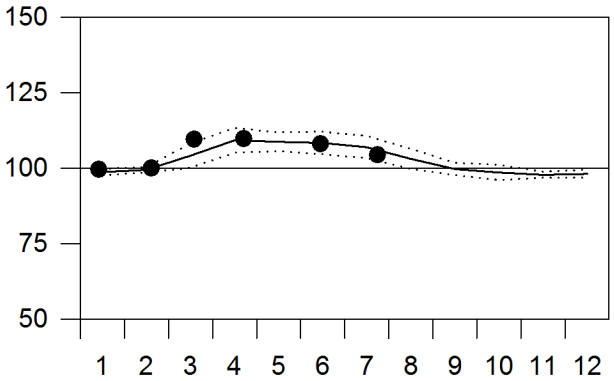
DIN µmol/l



SiO_3 µmol/l

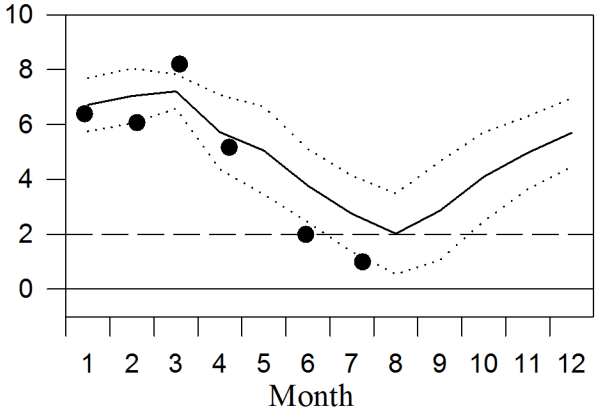


O_2 saturation %

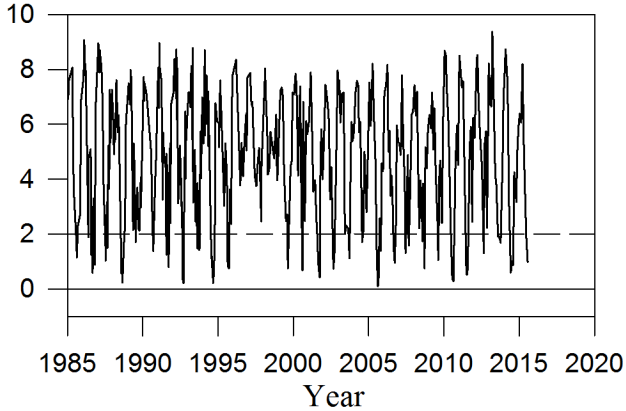


OXYGEN IN BOTTOM WATER (depth >40m)

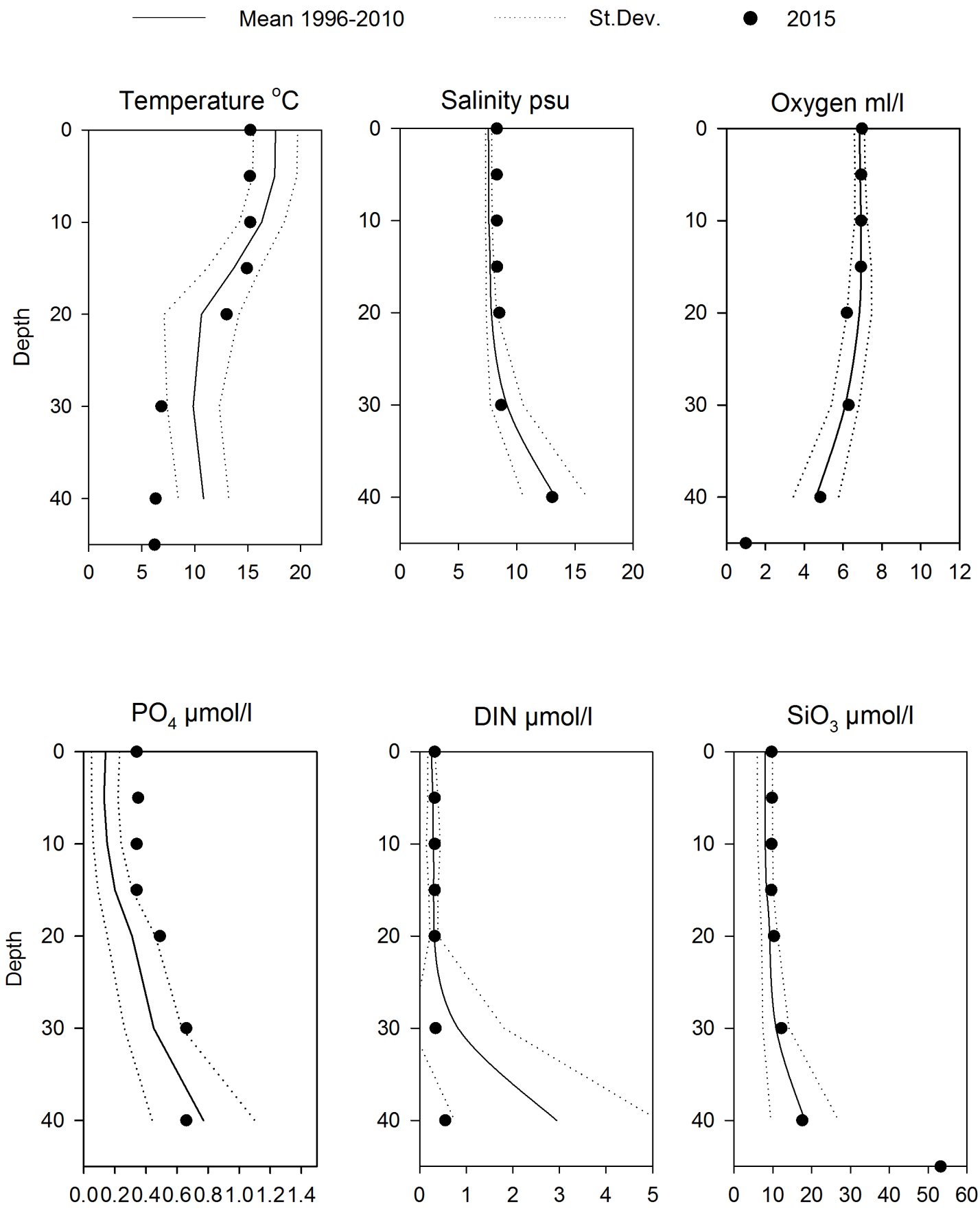
O_2 ml/l



O_2 ml/l



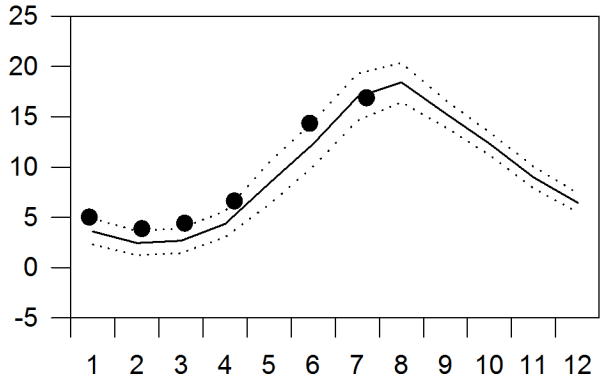
Vertical profiles BY1 July



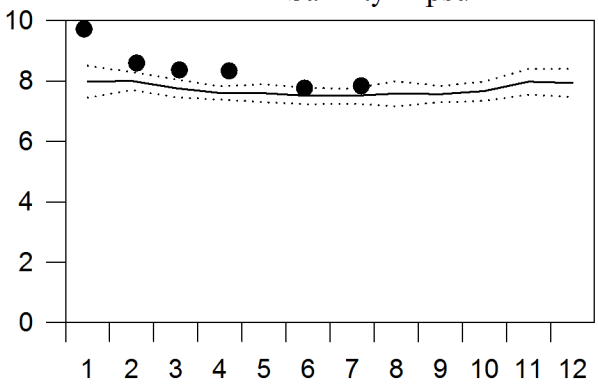
STATION BY2 SURFACE WATER

Annual Cycles

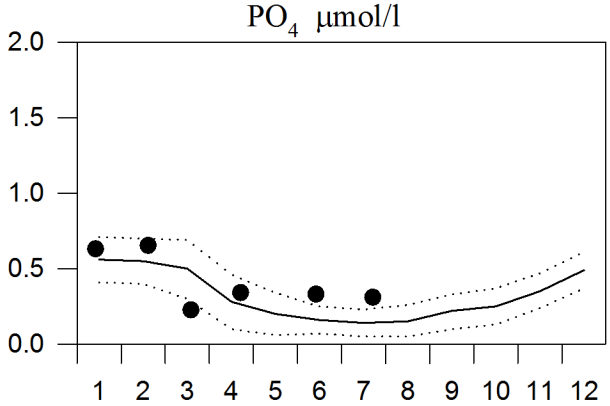
Temperature °C



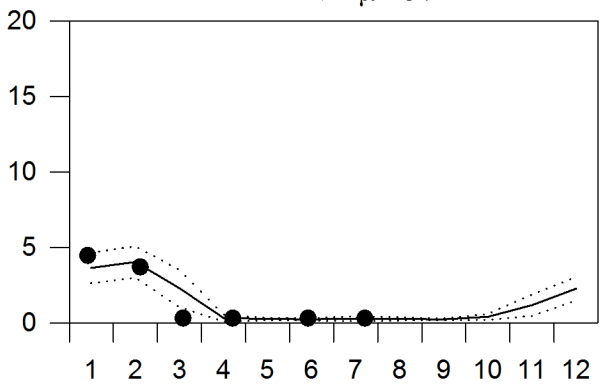
Salinity psu



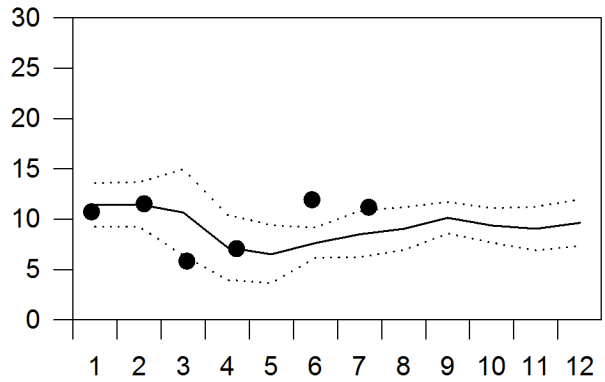
PO_4 µmol/l



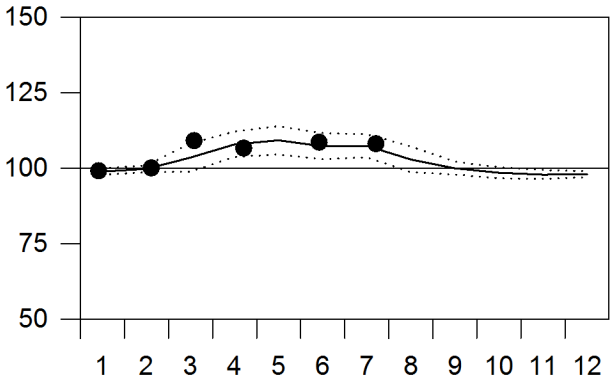
DIN µmol/l



SiO_3 µmol/l

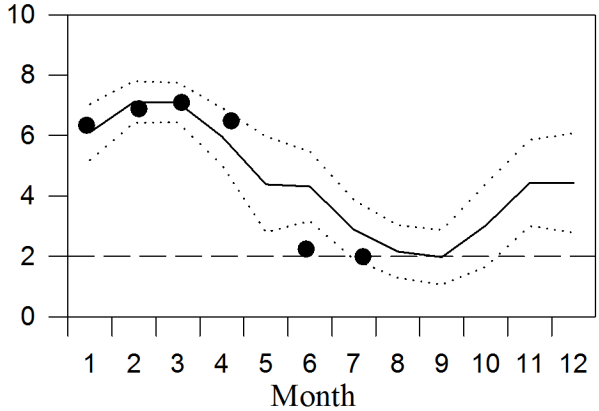


O_2 saturation %

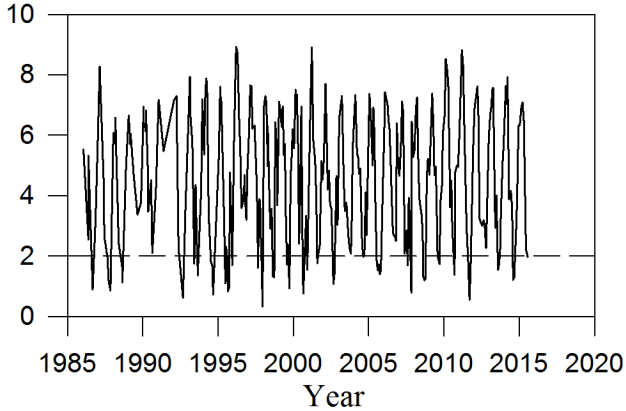


OXYGEN IN BOTTOM WATER (depth >40m)

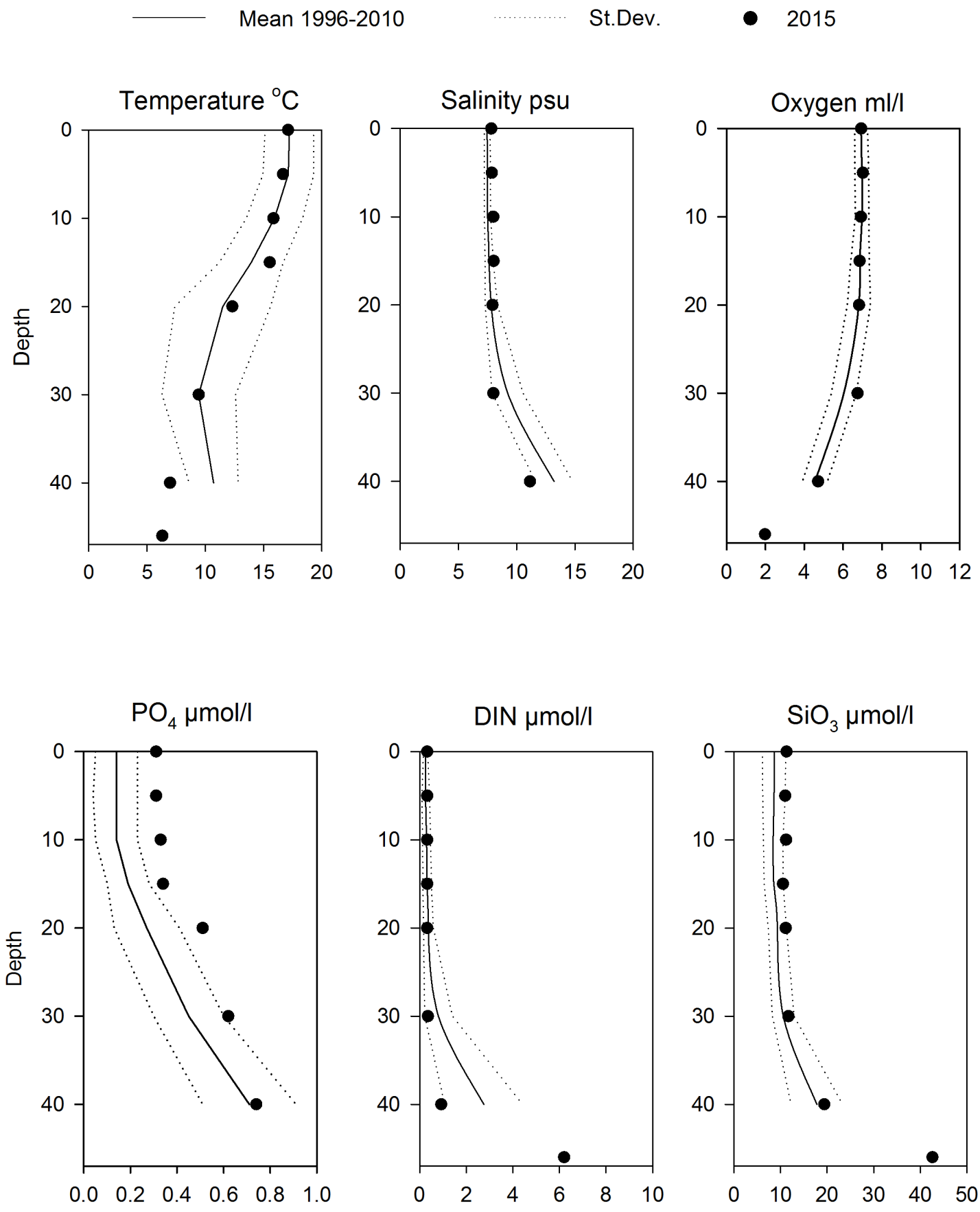
O_2 ml/l



O_2 ml/l



Vertical profiles BY2 July

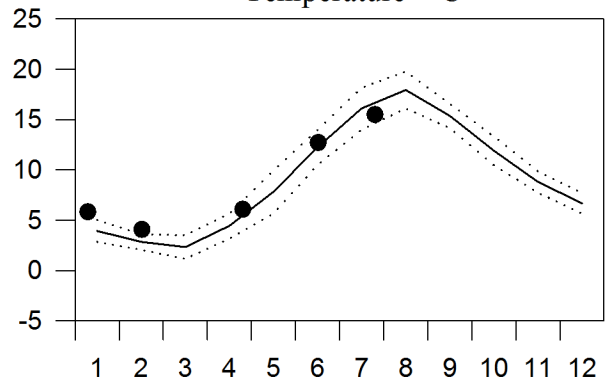


STATION HANÖBUKTEN SURFACE WATER

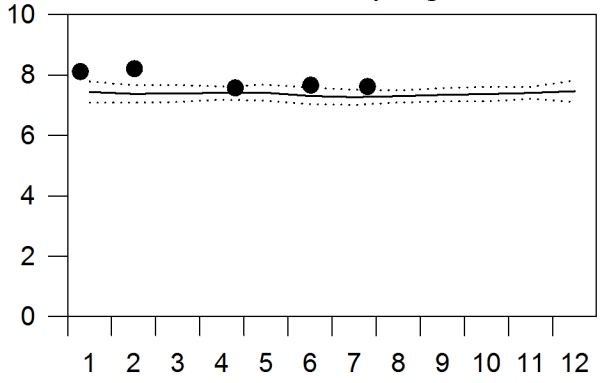
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

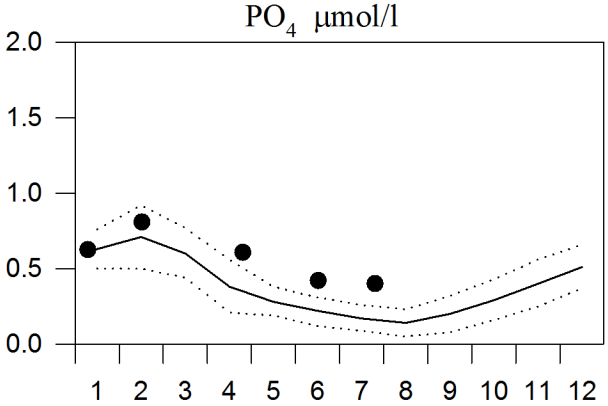
Temperature °C



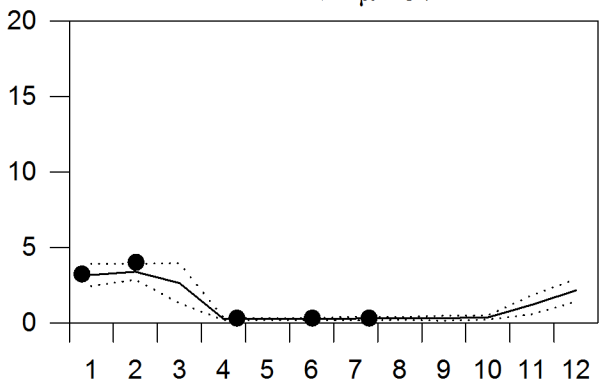
Salinity psu



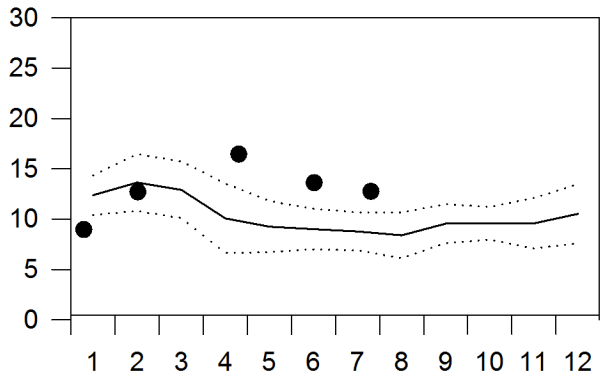
PO_4 µmol/l



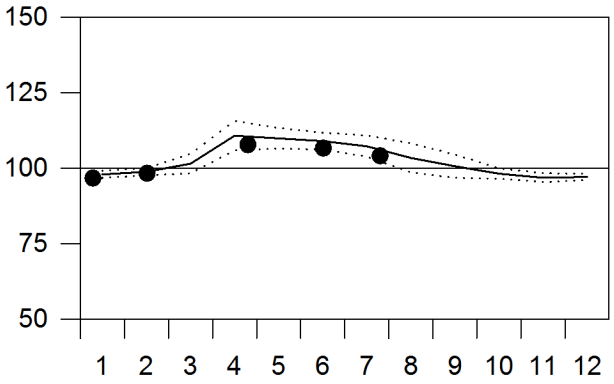
DIN µmol/l



SiO_3 µmol/l

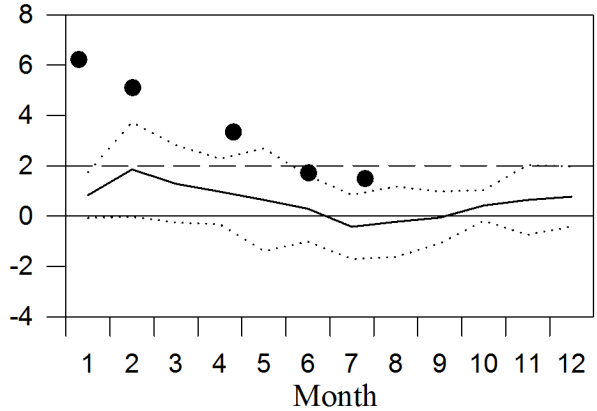


O_2 saturation %

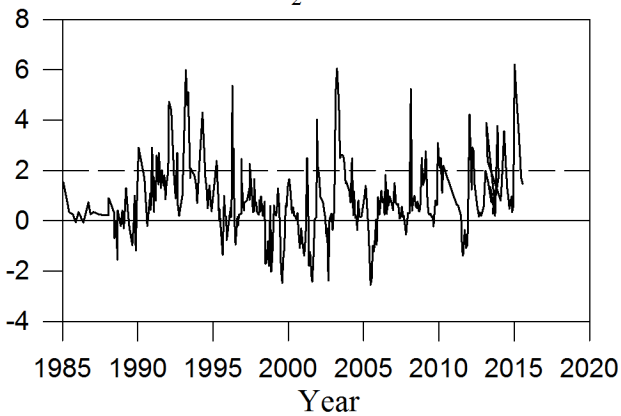


OXYGEN IN BOTTOM WATER (depth > 70m)

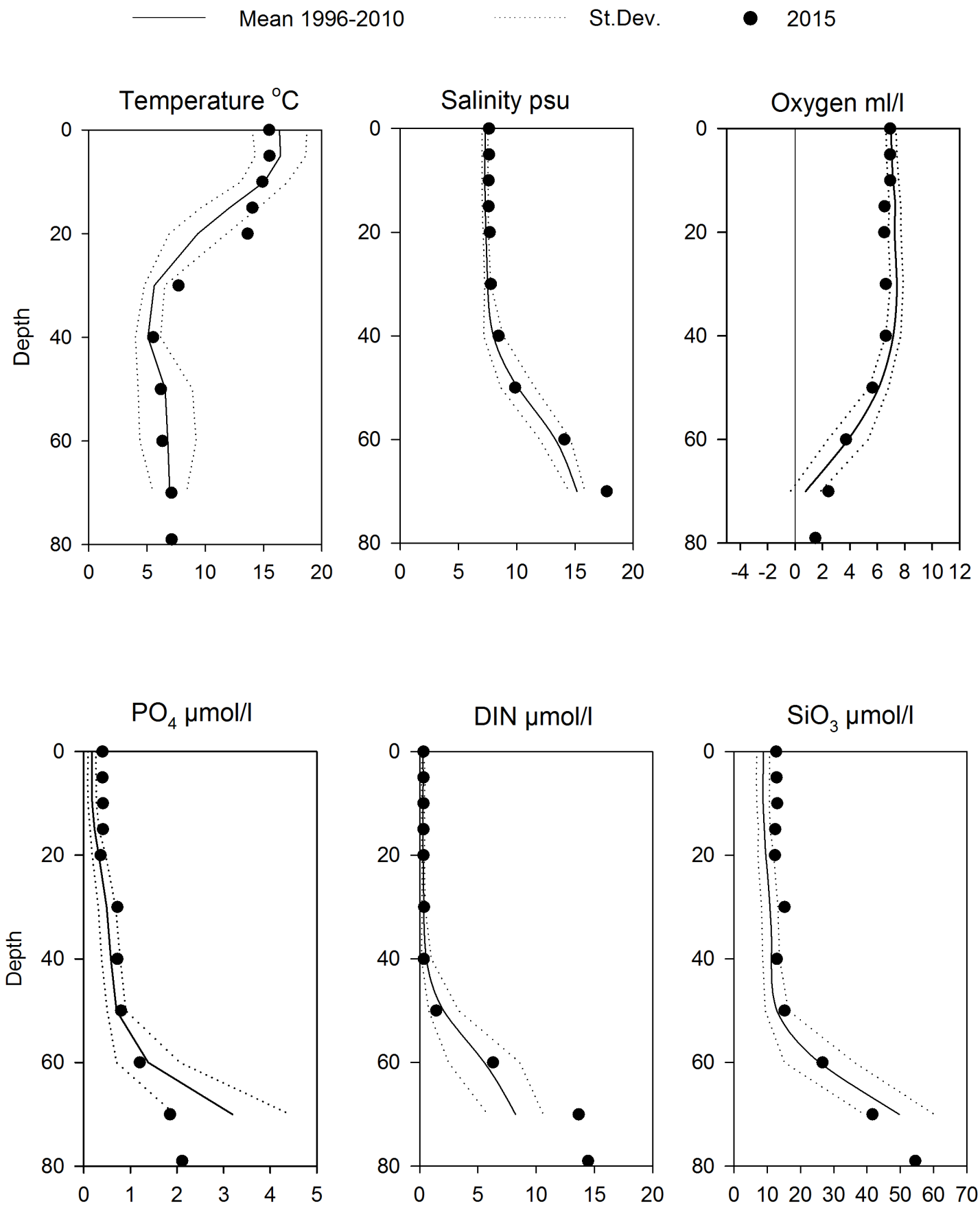
O_2 ml/l



O_2 ml/l



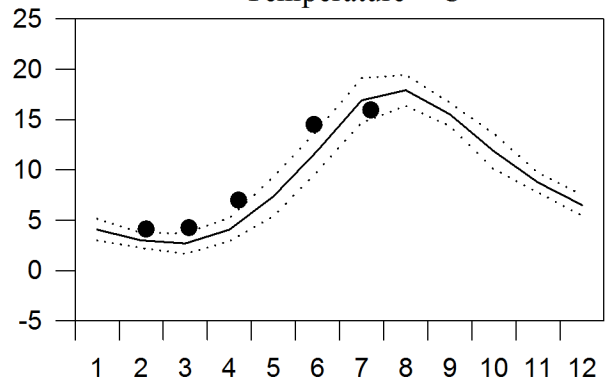
Vertical profiles Hanöbukten July



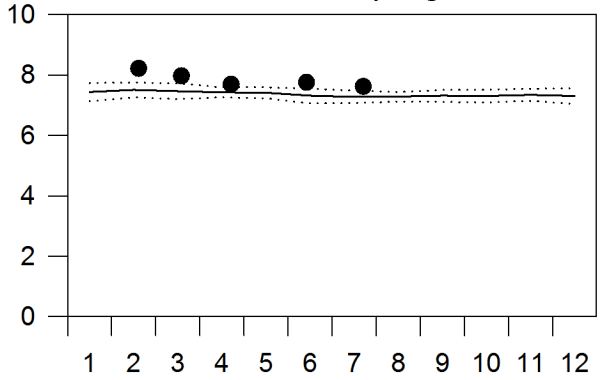
STATION BY4 SURFACE WATER

Annual Cycles

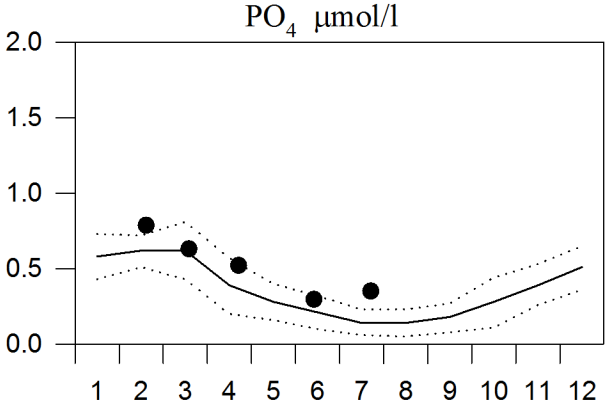
Temperature °C



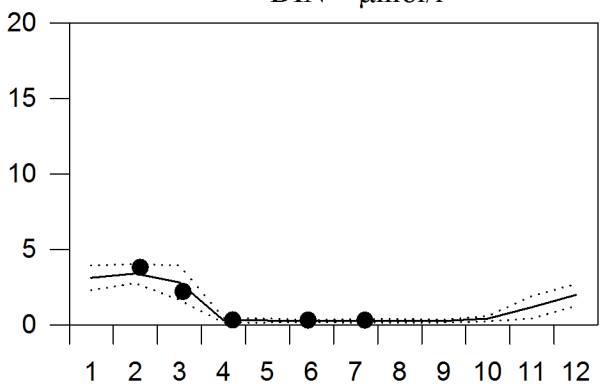
Salinity psu



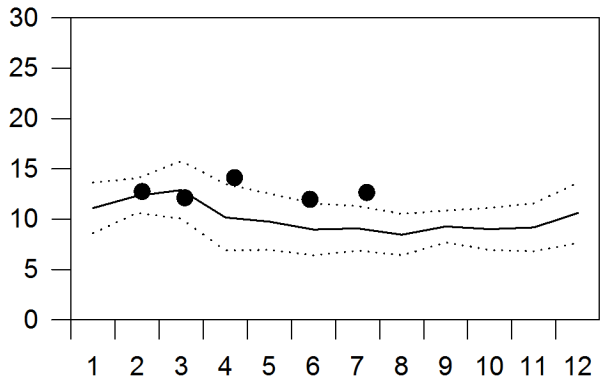
PO_4 µmol/l



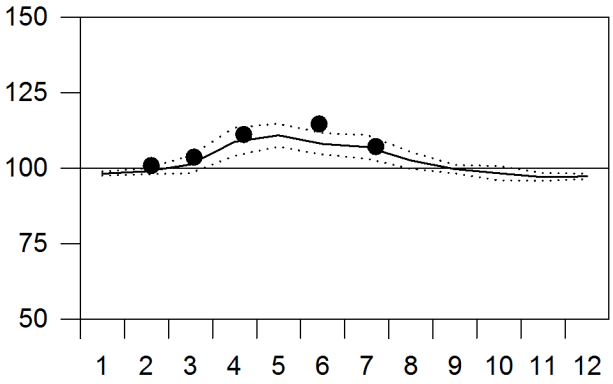
DIN µmol/l



SiO_3 µmol/l

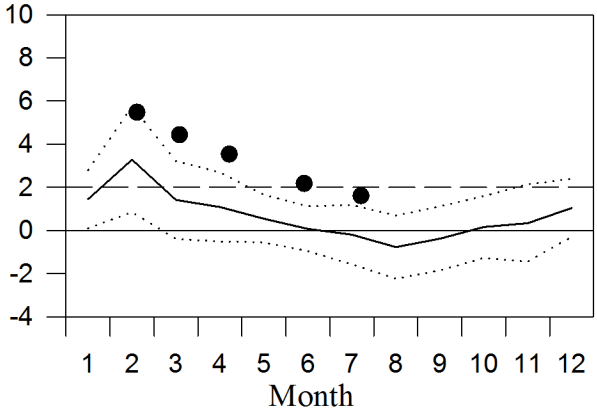


O_2 saturation %

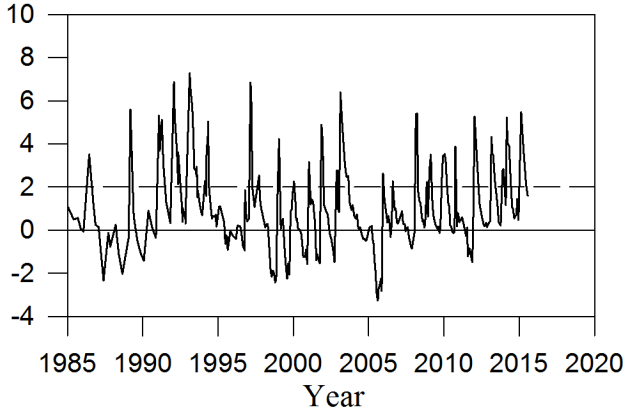


OXYGEN IN BOTTOM WATER (depth >80m)

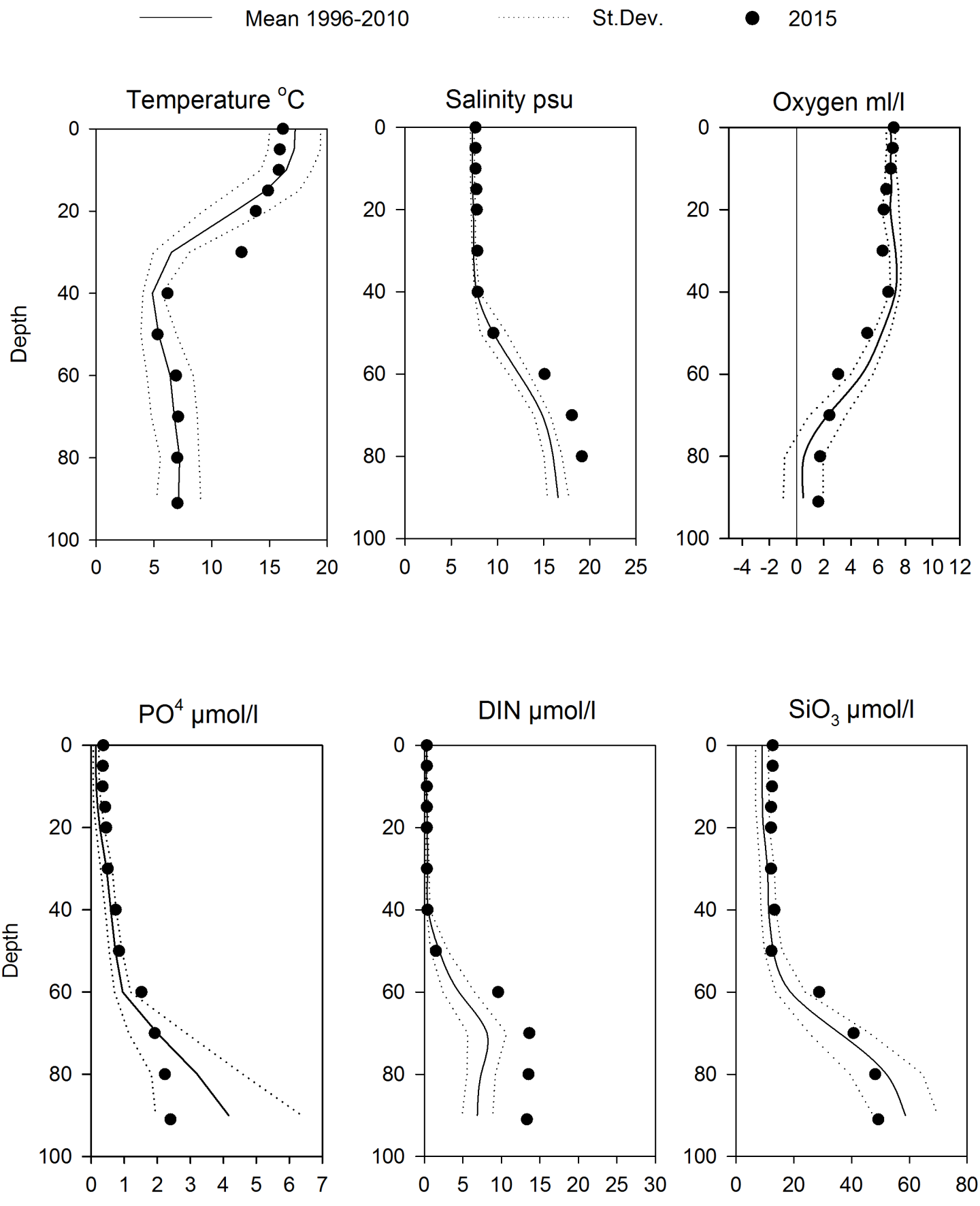
O_2 ml/l



O_2 ml/l



Vertical profiles BY4 July

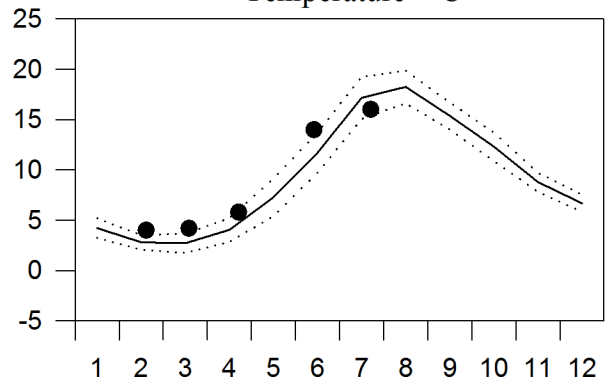


STATION BY5 SURFACE WATER

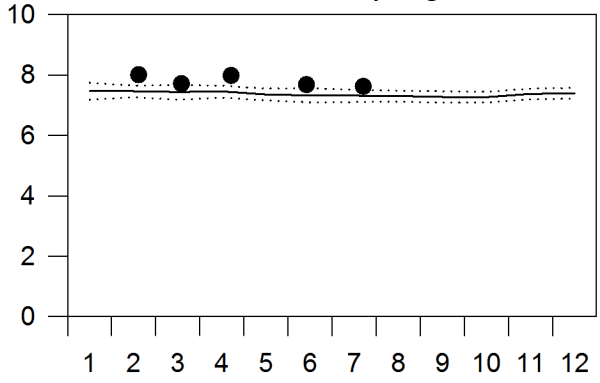
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

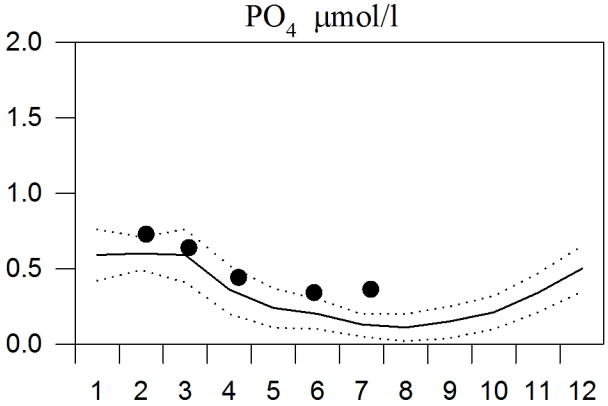
Temperature °C



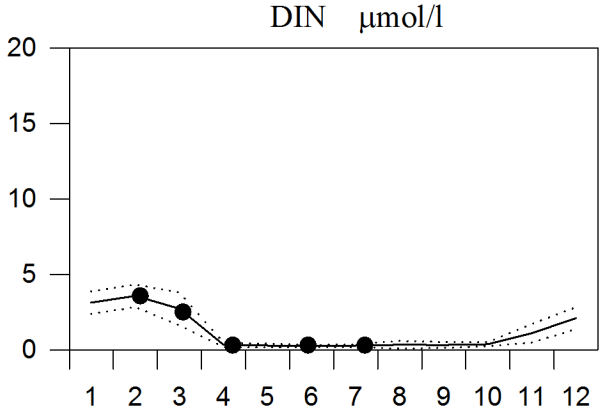
Salinity psu



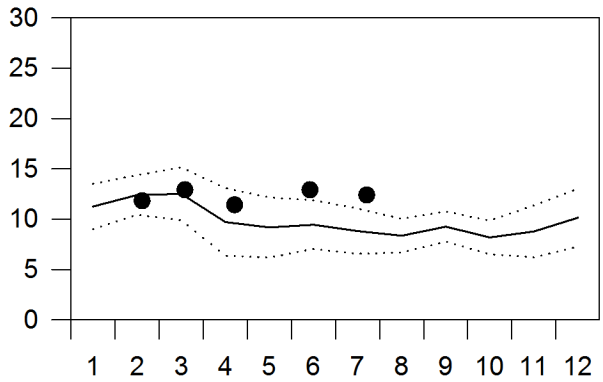
PO_4 µmol/l



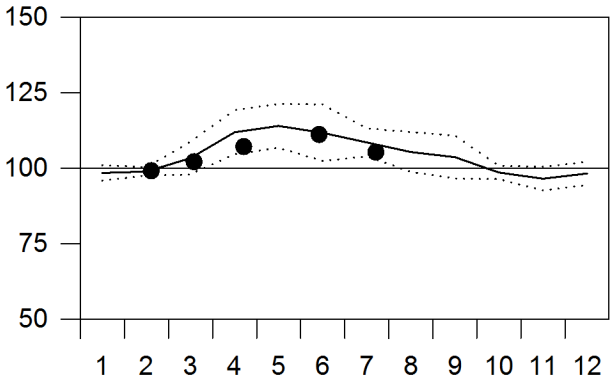
DIN µmol/l



SiO_3 µmol/l

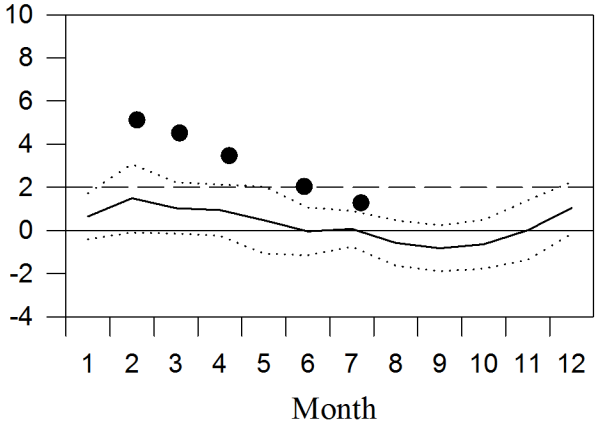


O_2 saturation %

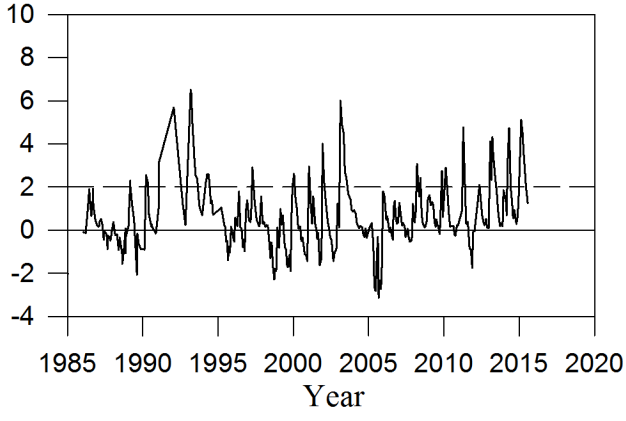


OXYGEN IN BOTTOM WATER (depth >80m)

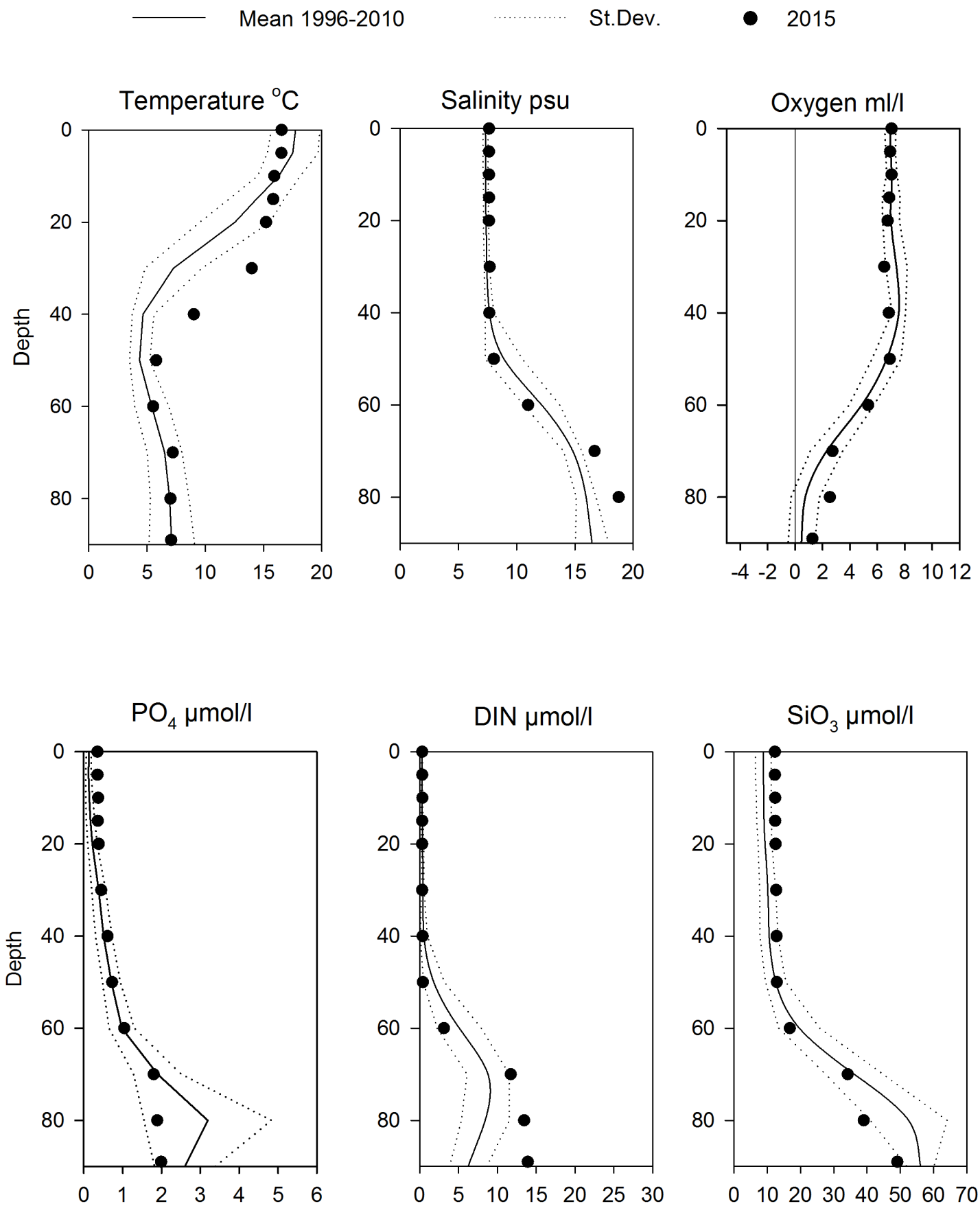
O_2 ml/l



O_2 ml/l



Vertical profiles BY5 July

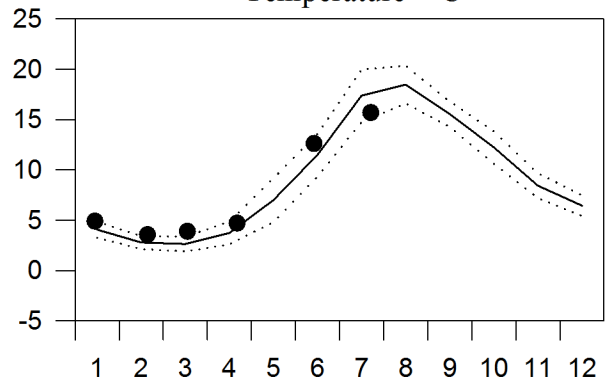


STATION BCS III-10 SURFACE WATER

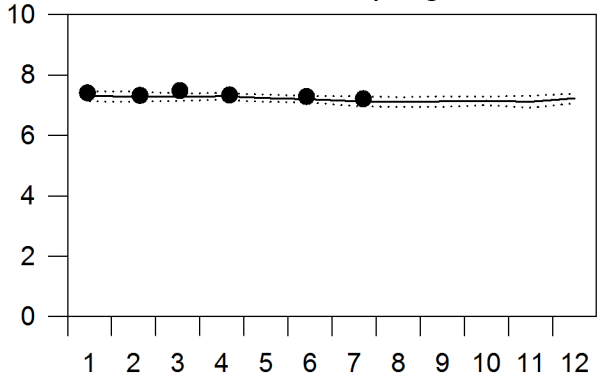
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

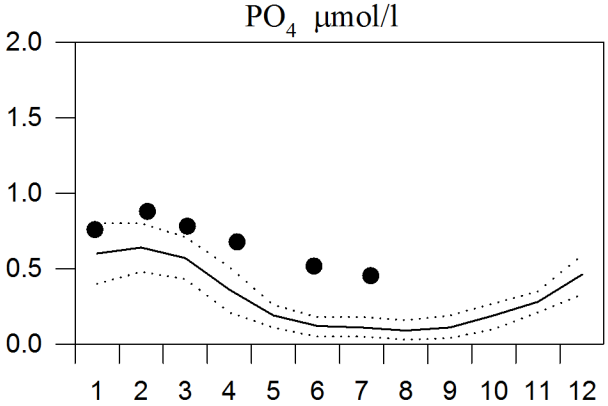
Temperature °C



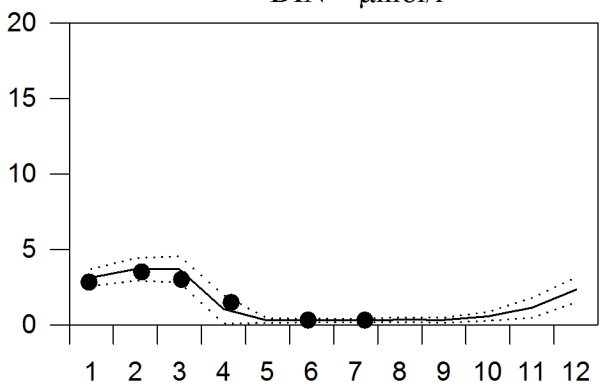
Salinity psu



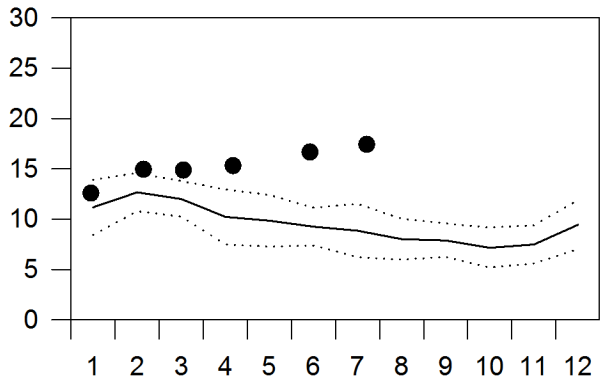
PO_4 µmol/l



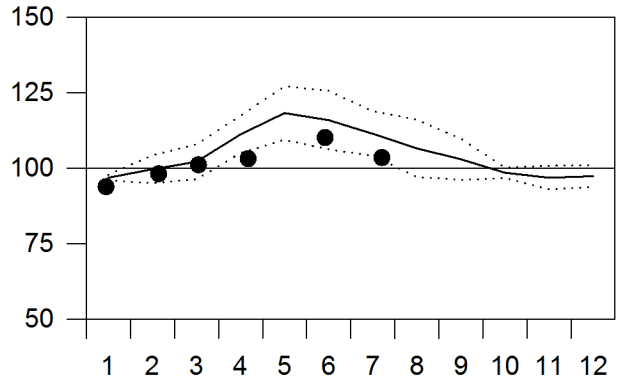
DIN µmol/l



SiO_3 µmol/l

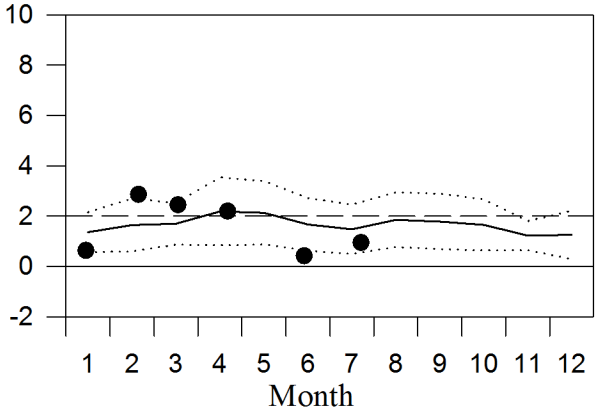


O_2 saturation %

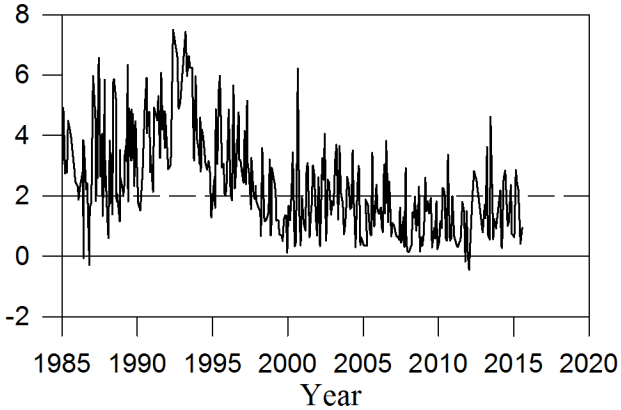


OXYGEN IN BOTTOM WATER (depth > 80m)

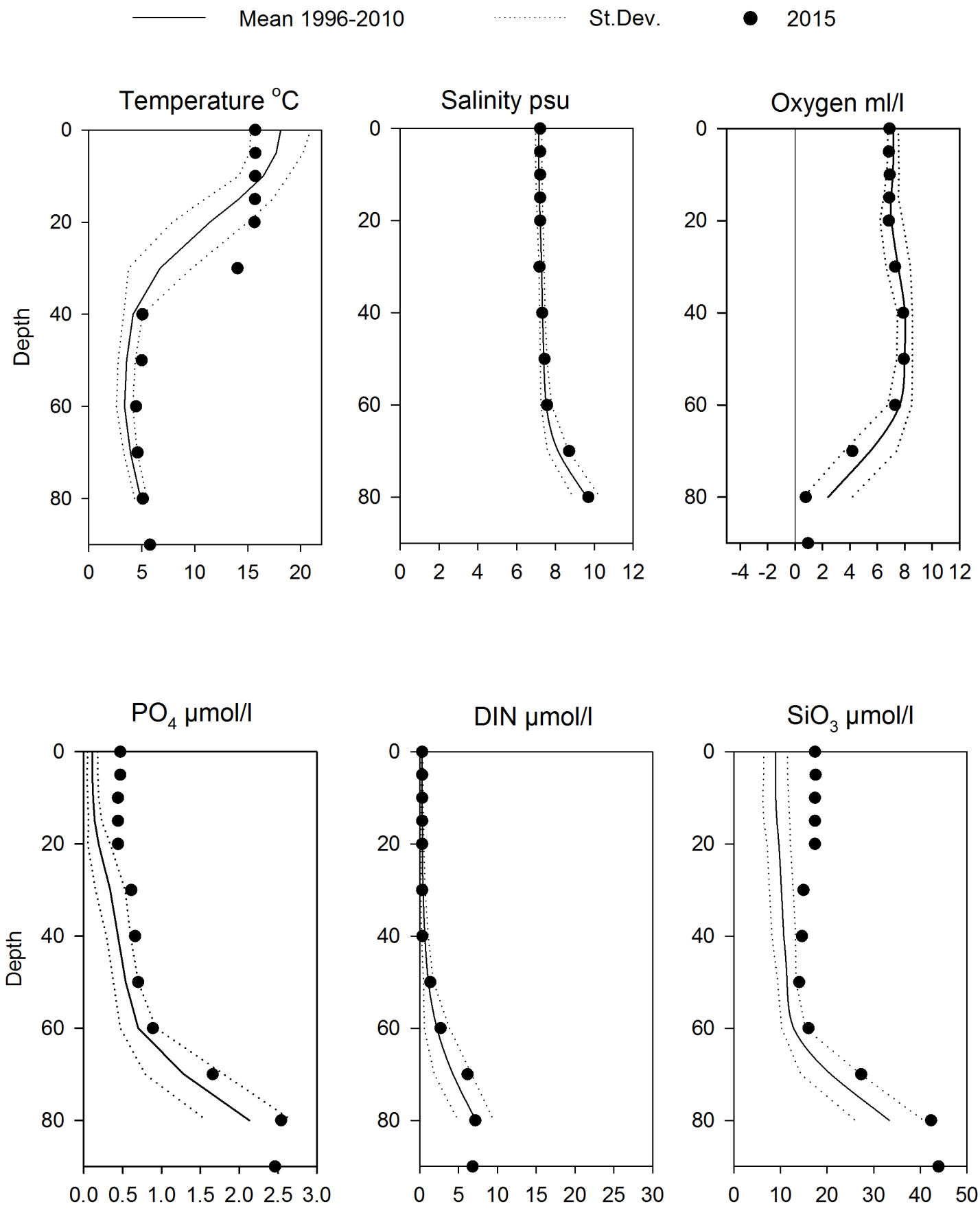
O_2 ml/l



O_2 ml/l

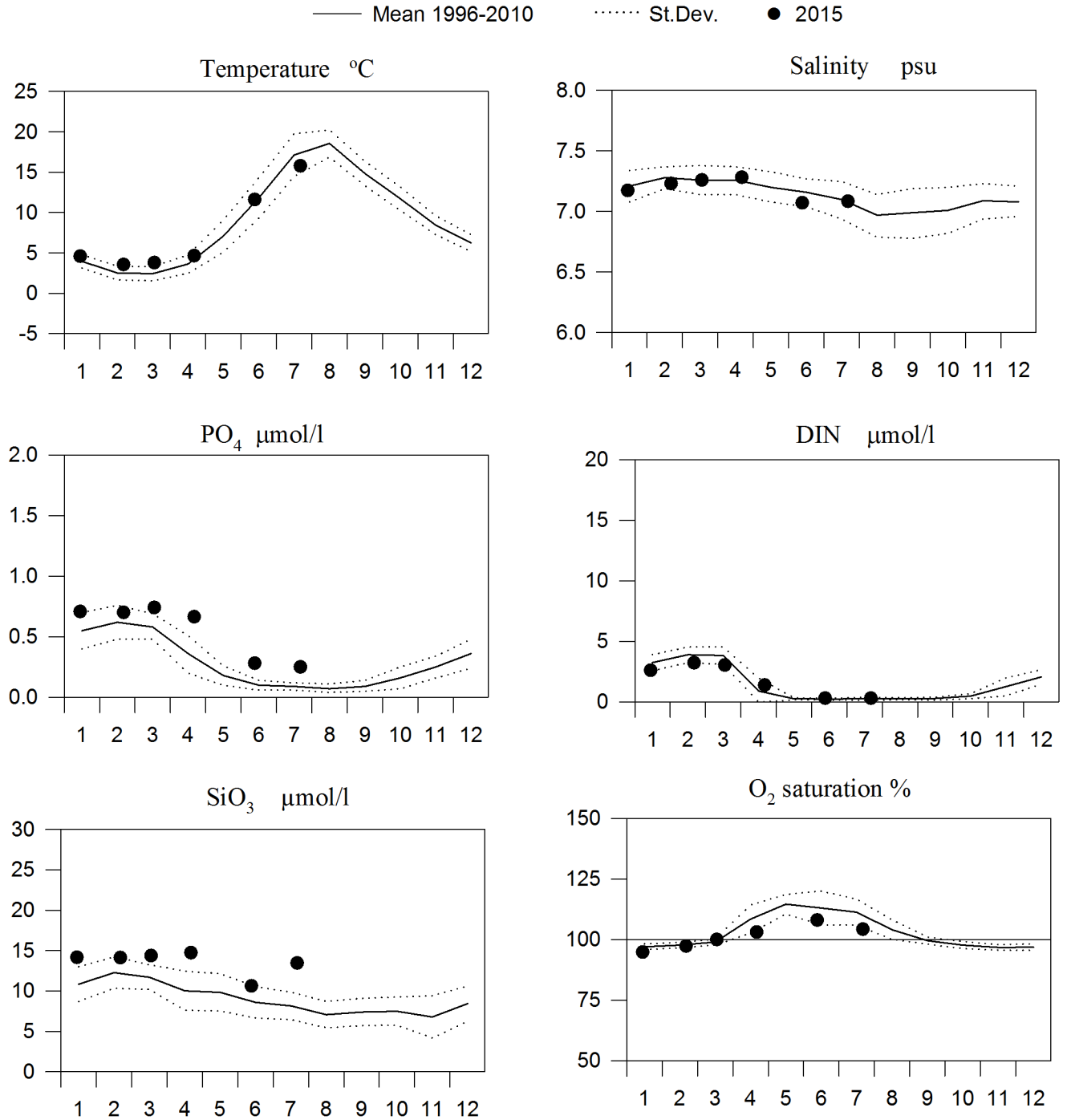


Vertical profiles BCS III-10 July

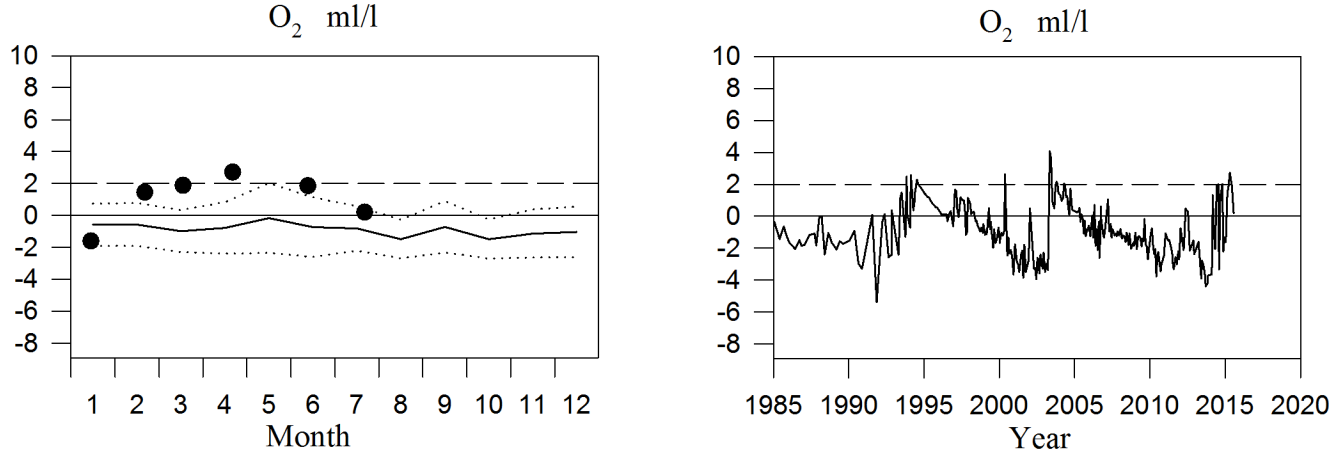


STATION BY10 SURFACE WATER

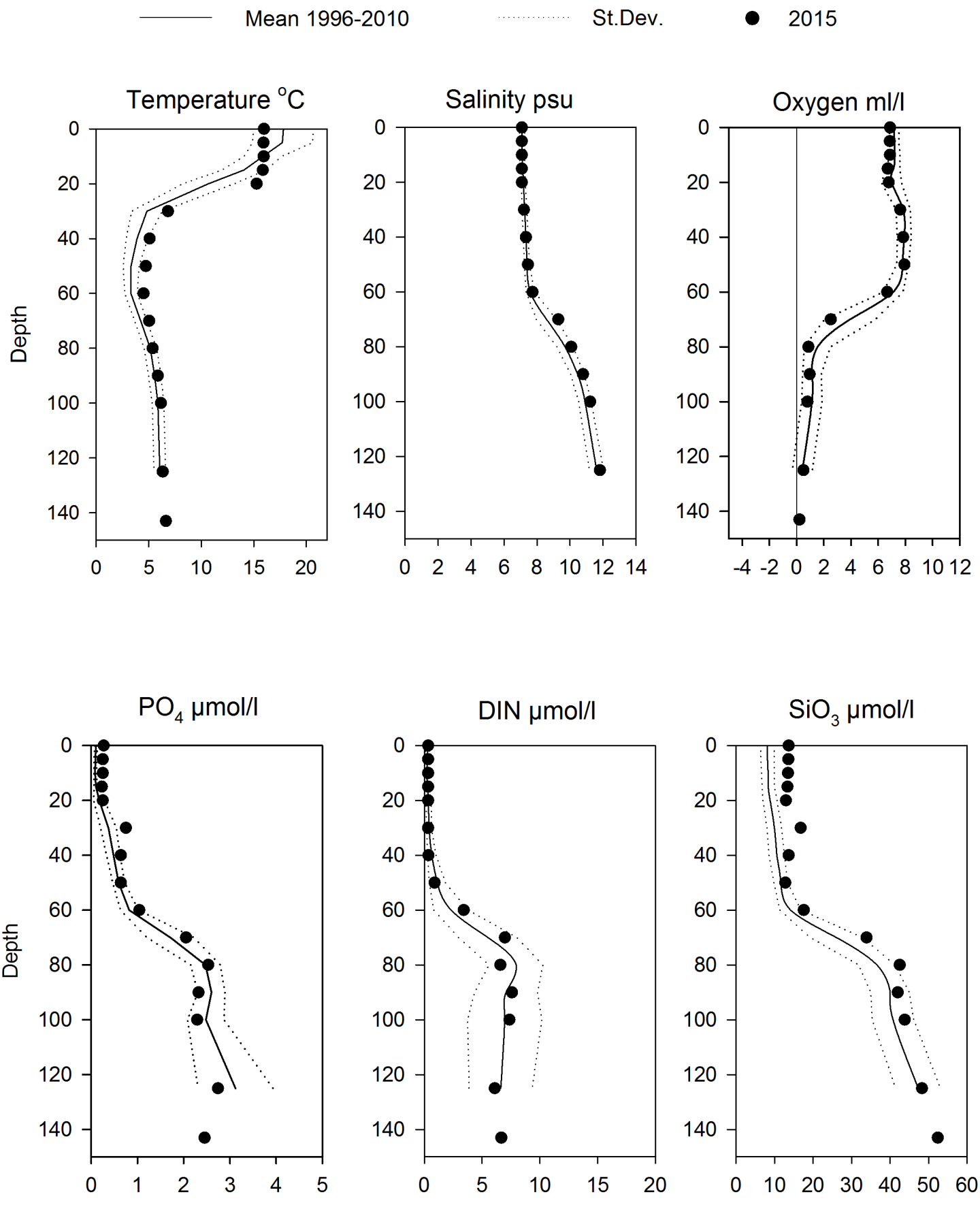
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >125m)



Vertical profiles BY10 July

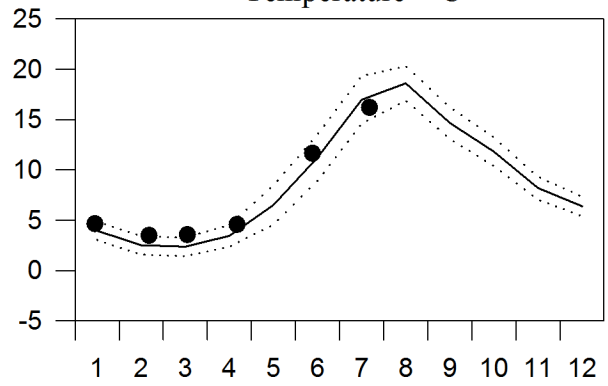


STATION BY15 SURFACE WATER

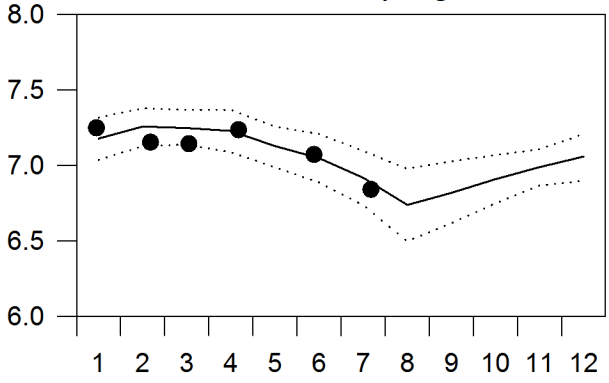
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

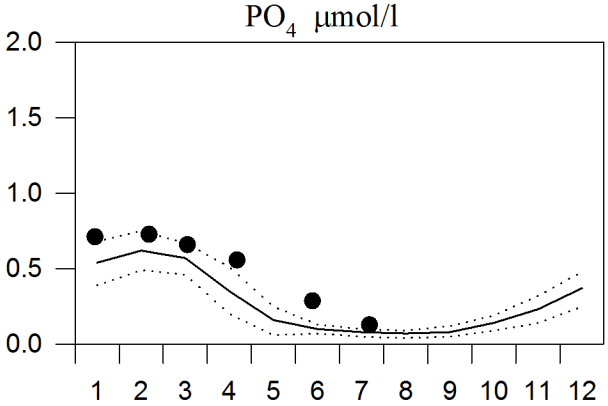
Temperature °C



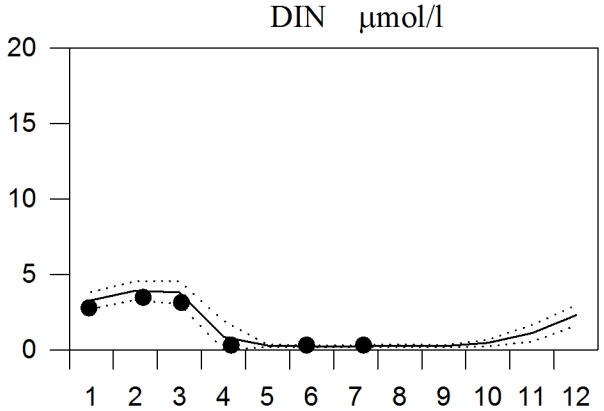
Salinity psu



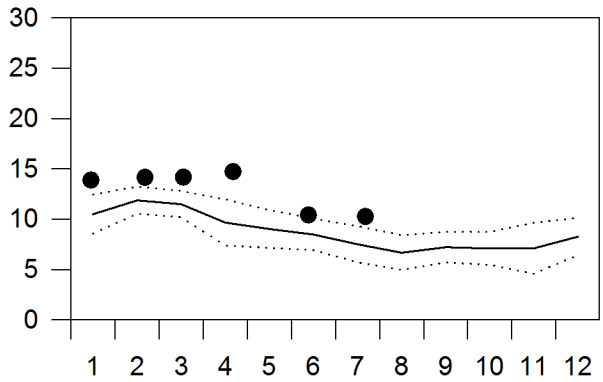
PO_4 µmol/l



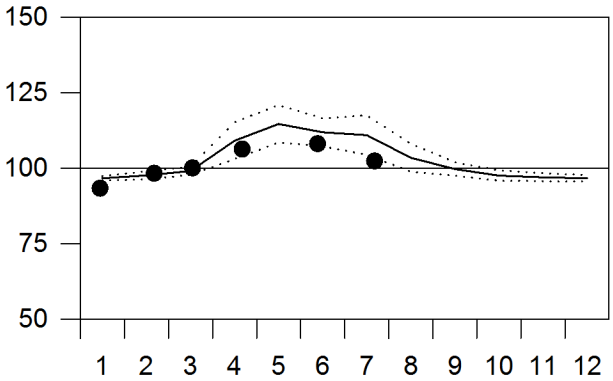
DIN µmol/l



SiO_3 µmol/l

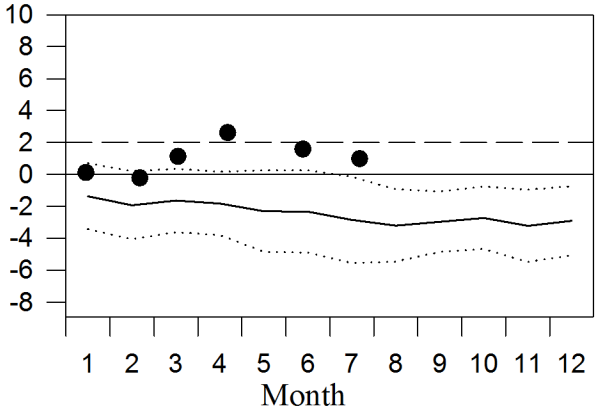


O_2 saturation %

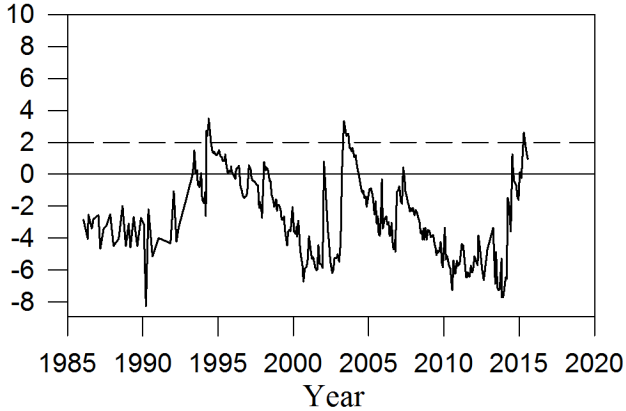


OXYGEN IN BOTTOM WATER (depth >225m)

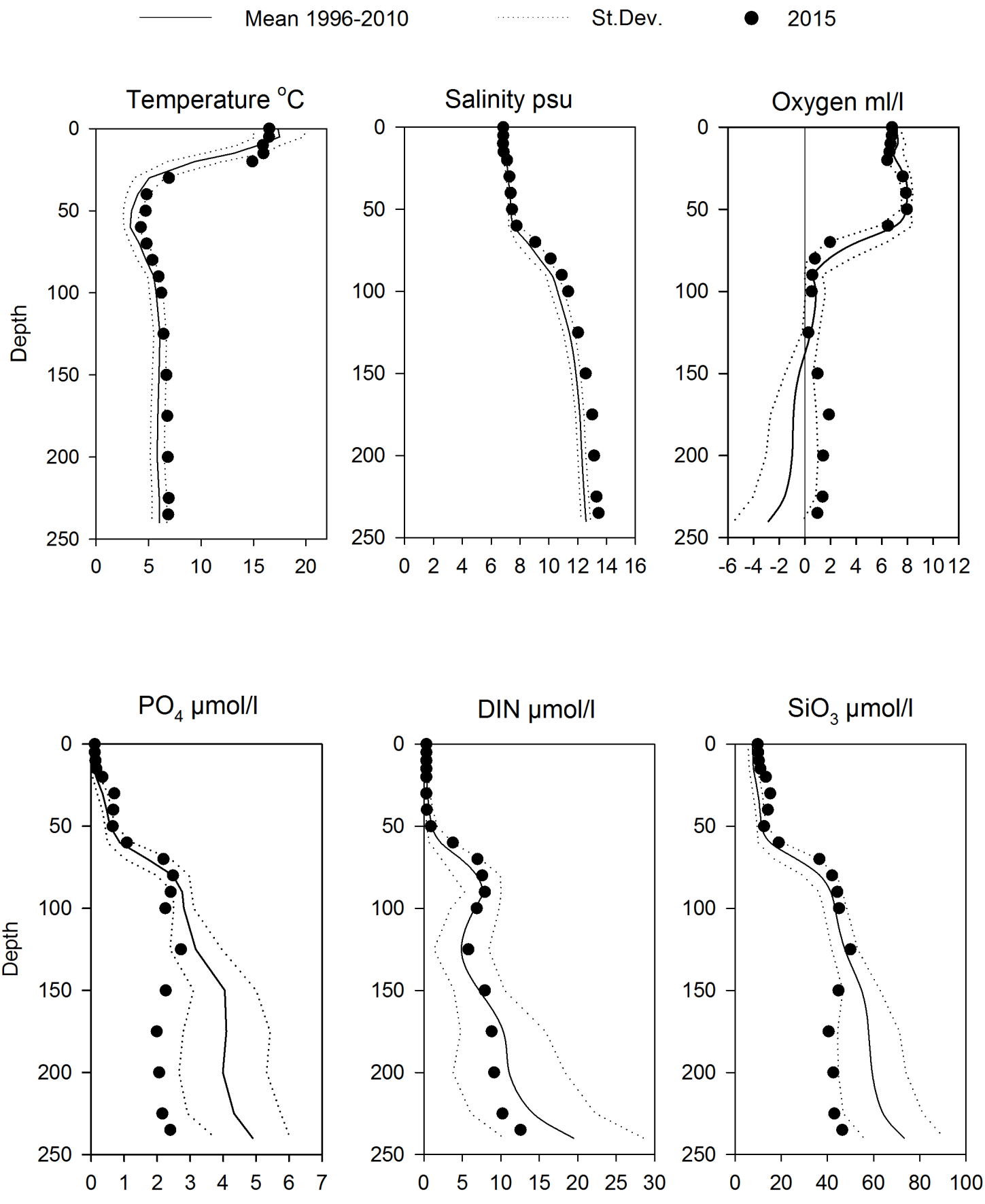
O_2 ml/l



O_2 ml/l



Vertical profiles BY15 July

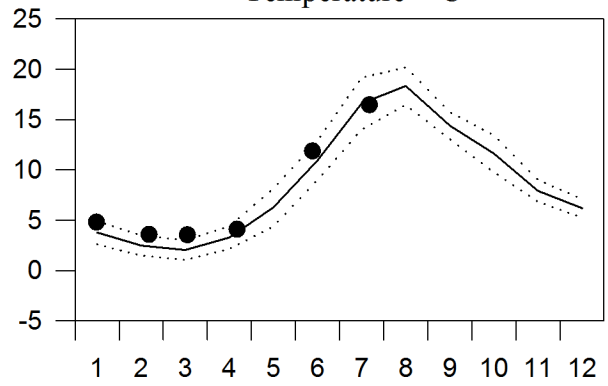


STATION BY20 SURFACE WATER

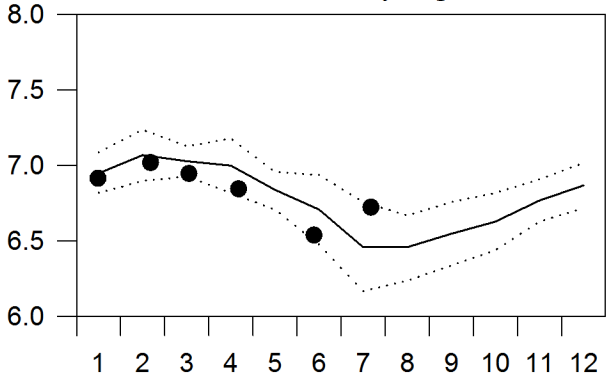
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

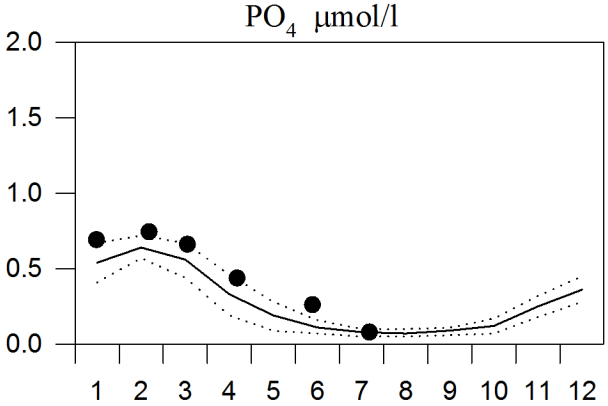
Temperature °C



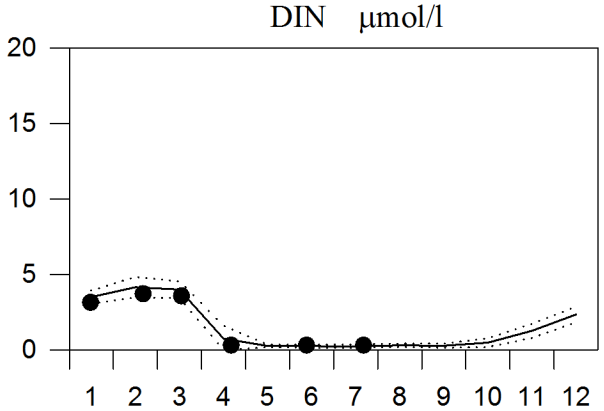
Salinity psu



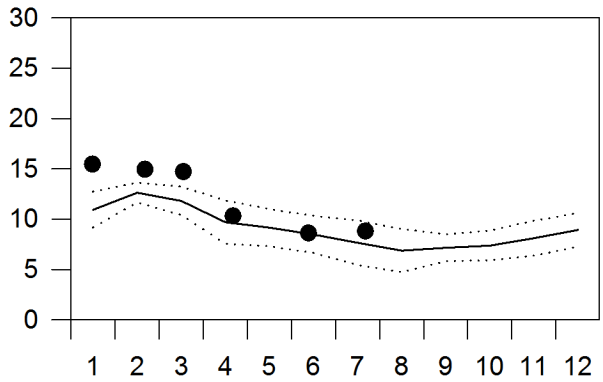
PO_4 µmol/l



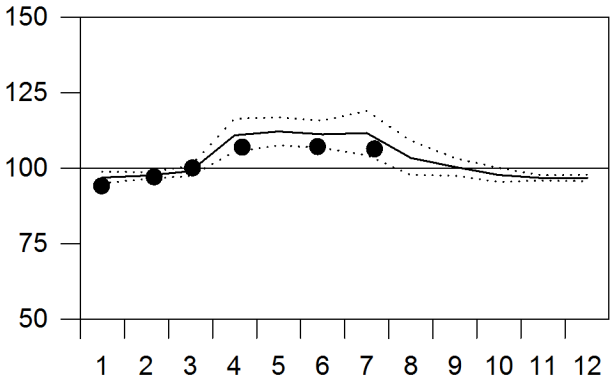
DIN µmol/l



SiO_3 µmol/l

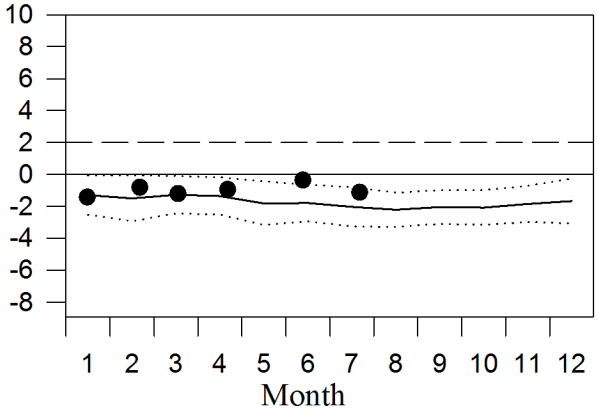


O_2 saturation %

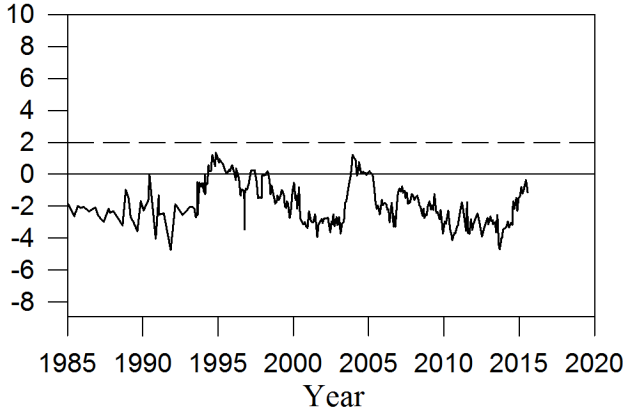


OXYGEN IN BOTTOM WATER (depth >175m)

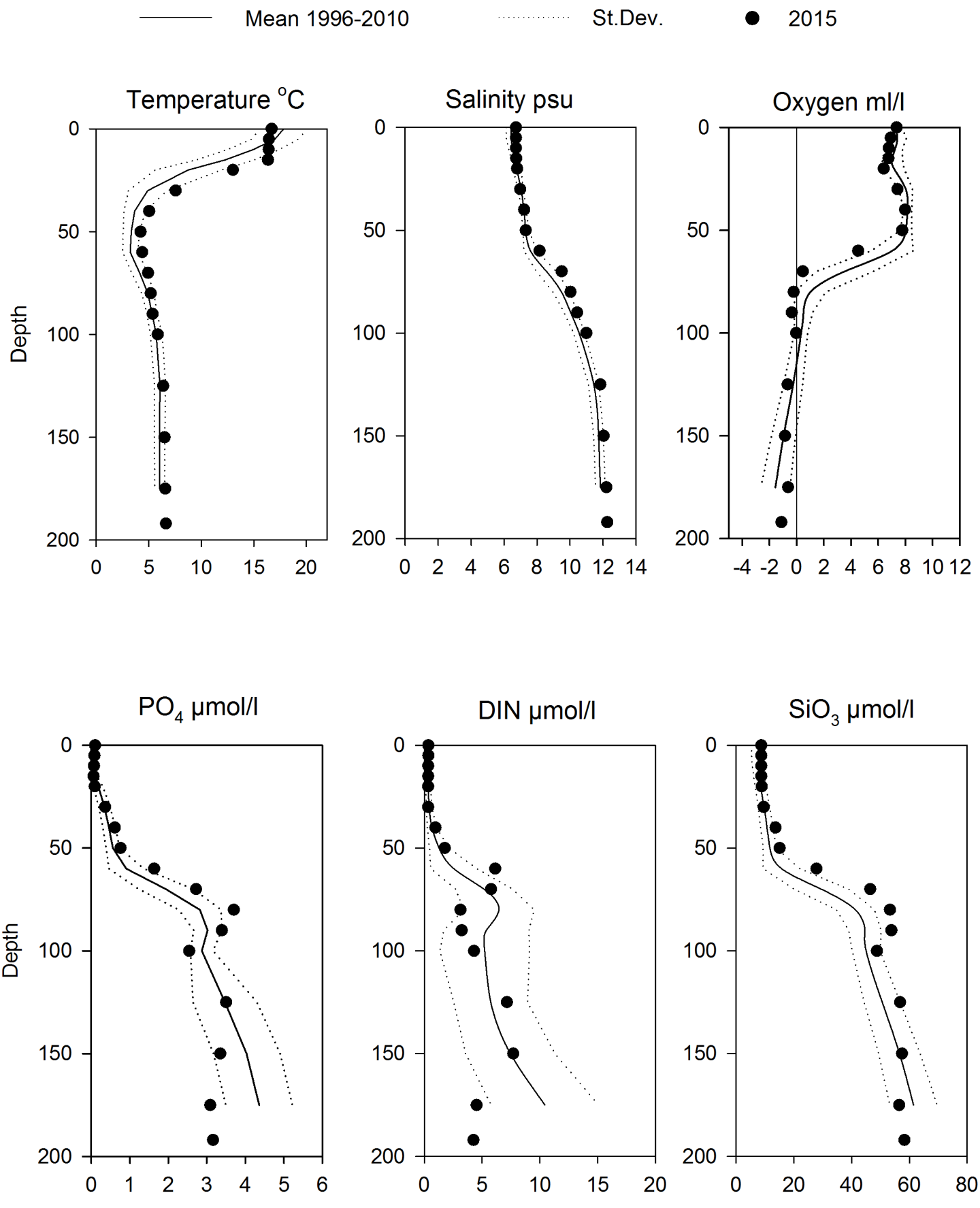
O_2 ml/l



O_2 ml/l



Vertical profiles BY20 July

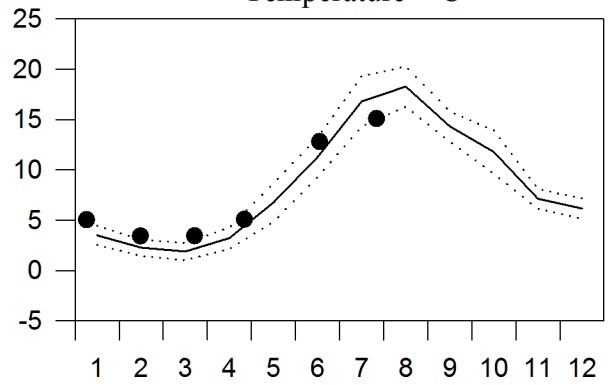


STATION BY32 SURFACE WATER

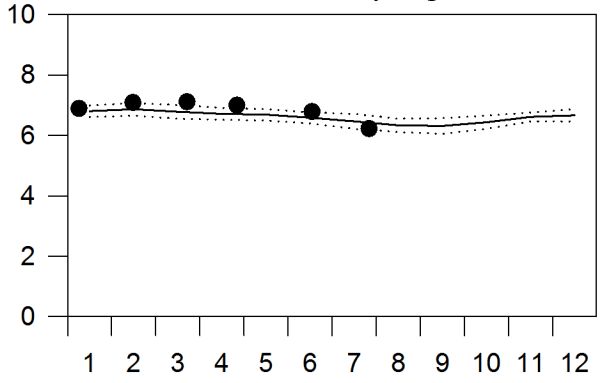
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

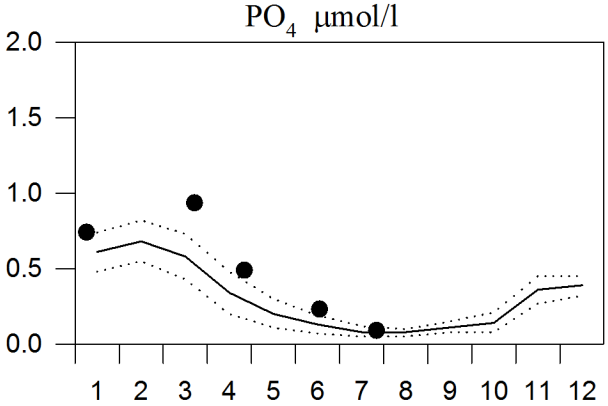
Temperature °C



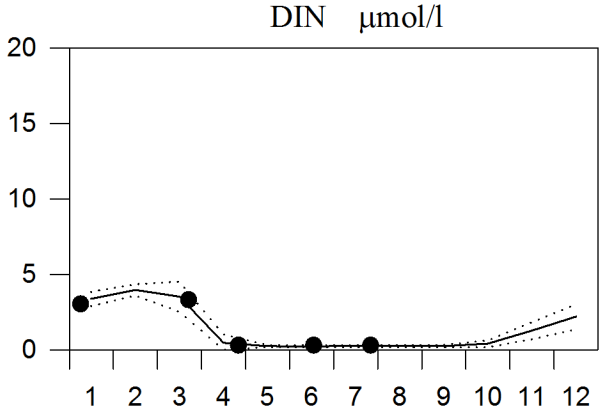
Salinity psu



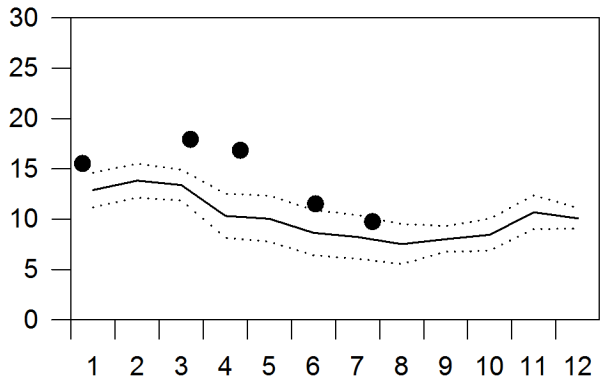
PO_4 µmol/l



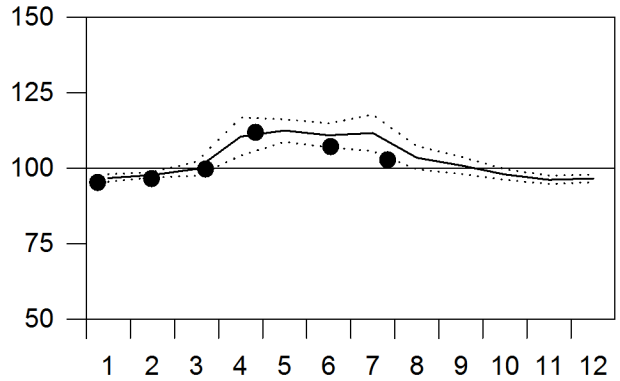
DIN µmol/l



SiO_3 µmol/l

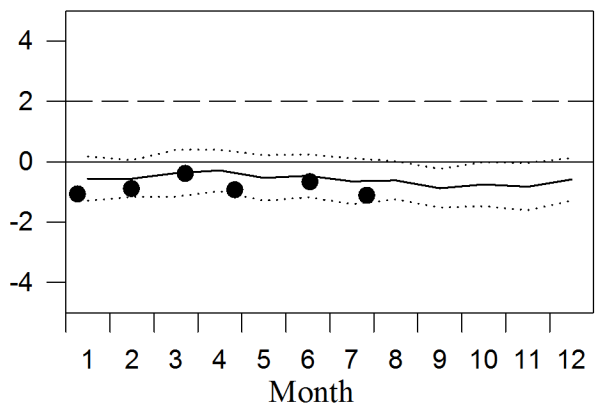


O_2 saturation %

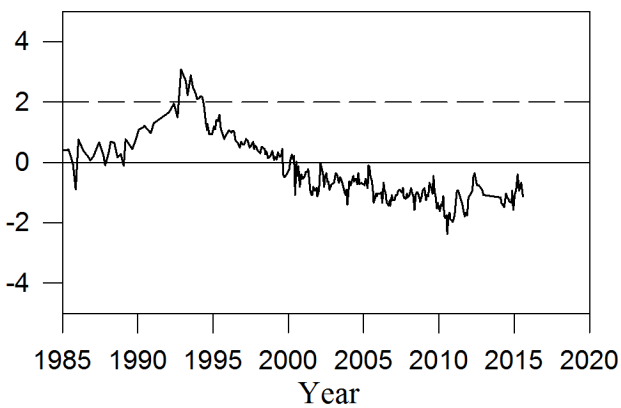


OXYGEN IN BOTTOM WATER (depth > 175m)

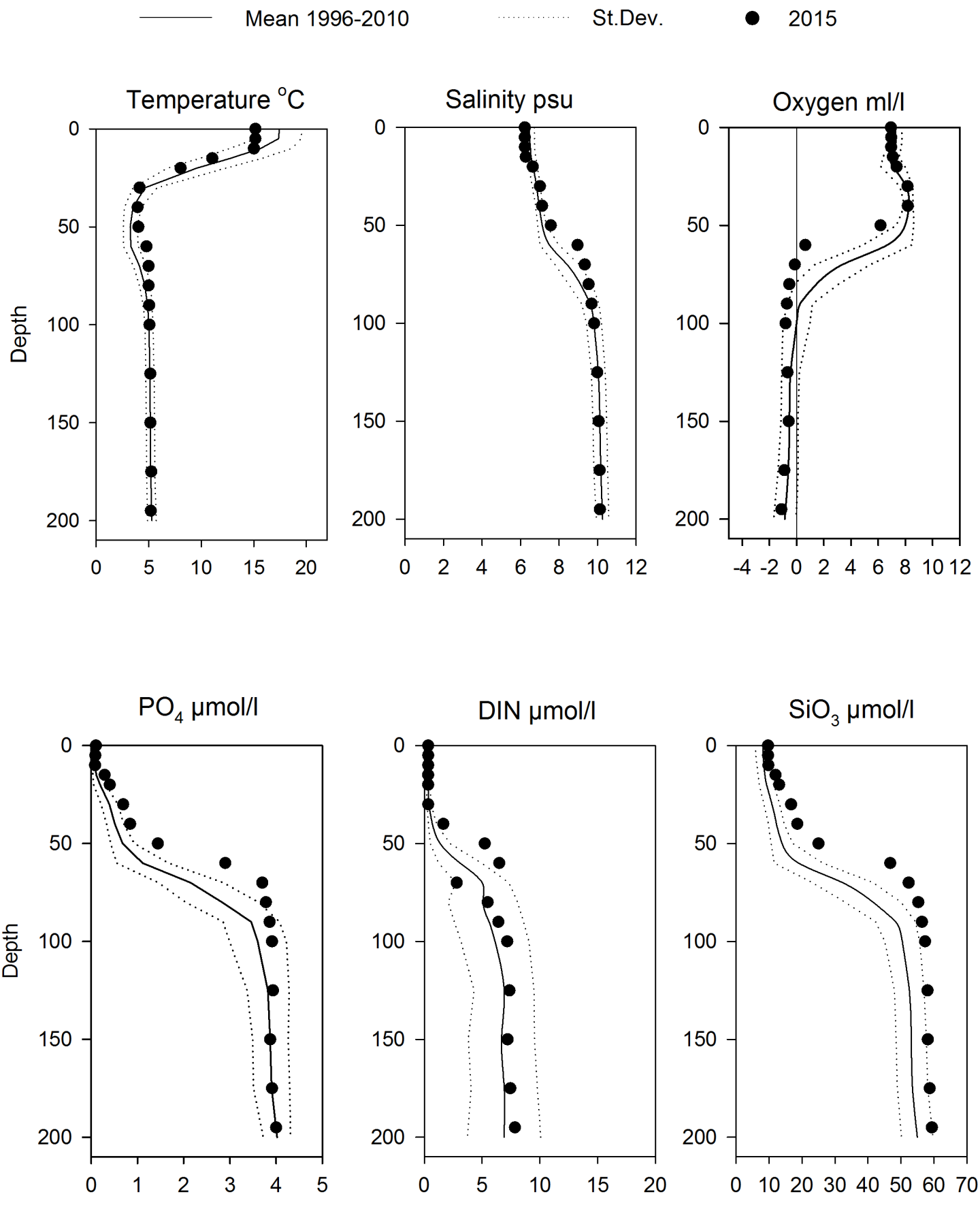
O_2 ml/l



O_2 ml/l



Vertical profiles BY32 July

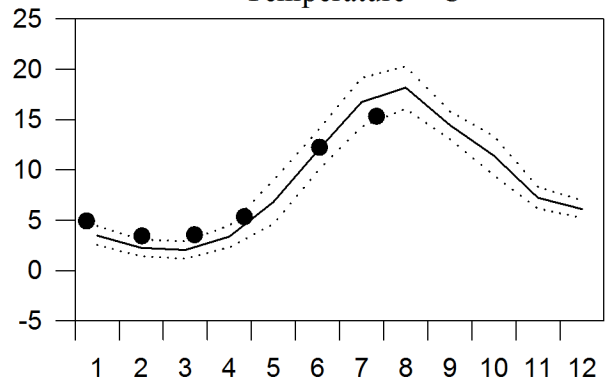


STATION BY38 SURFACE WATER

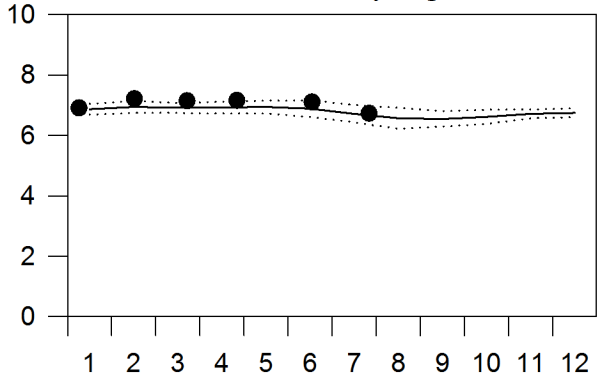
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

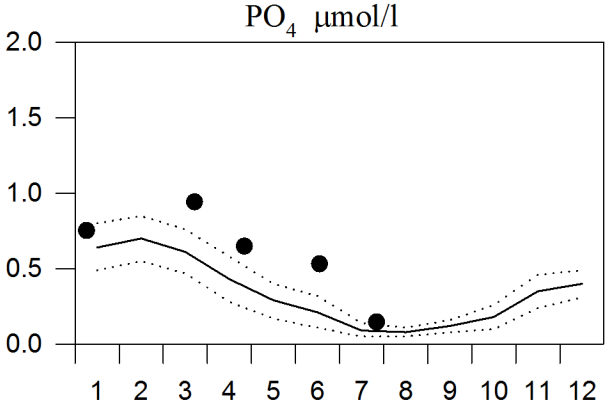
Temperature °C



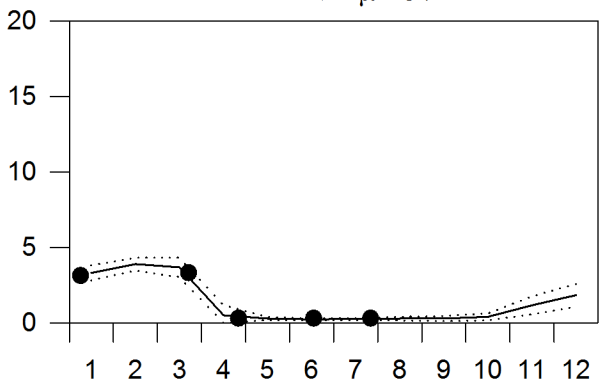
Salinity psu



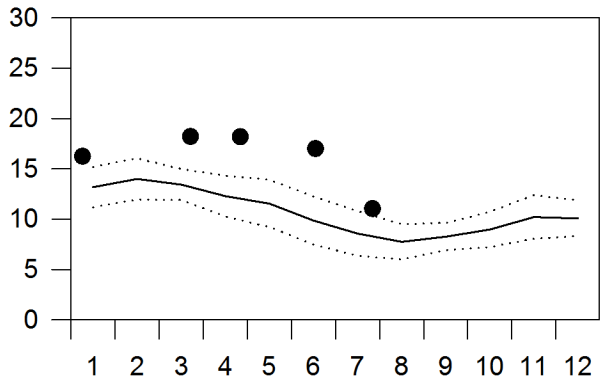
PO_4 µmol/l



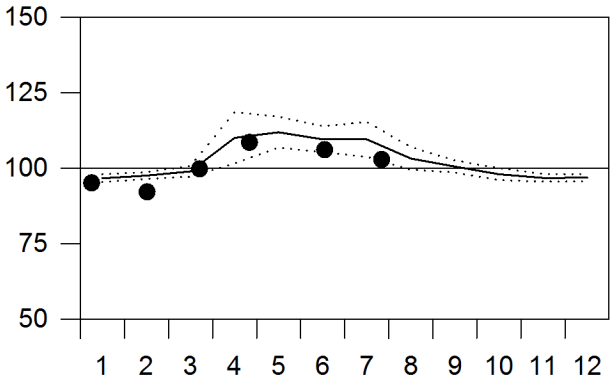
DIN µmol/l



SiO_3 µmol/l

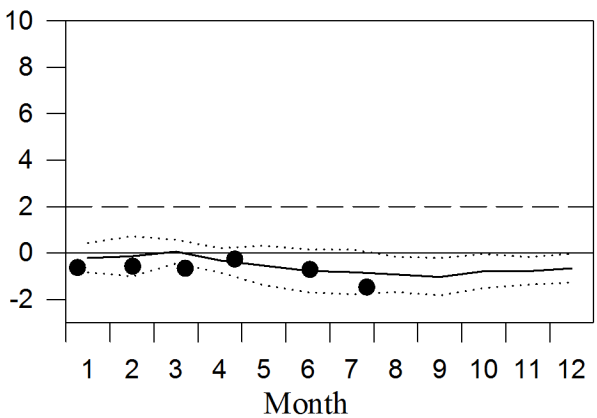


O_2 saturation %

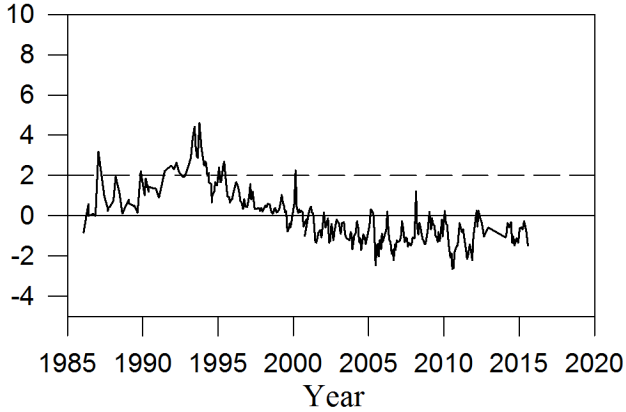


OXYGEN IN BOTTOM WATER (> 100m)

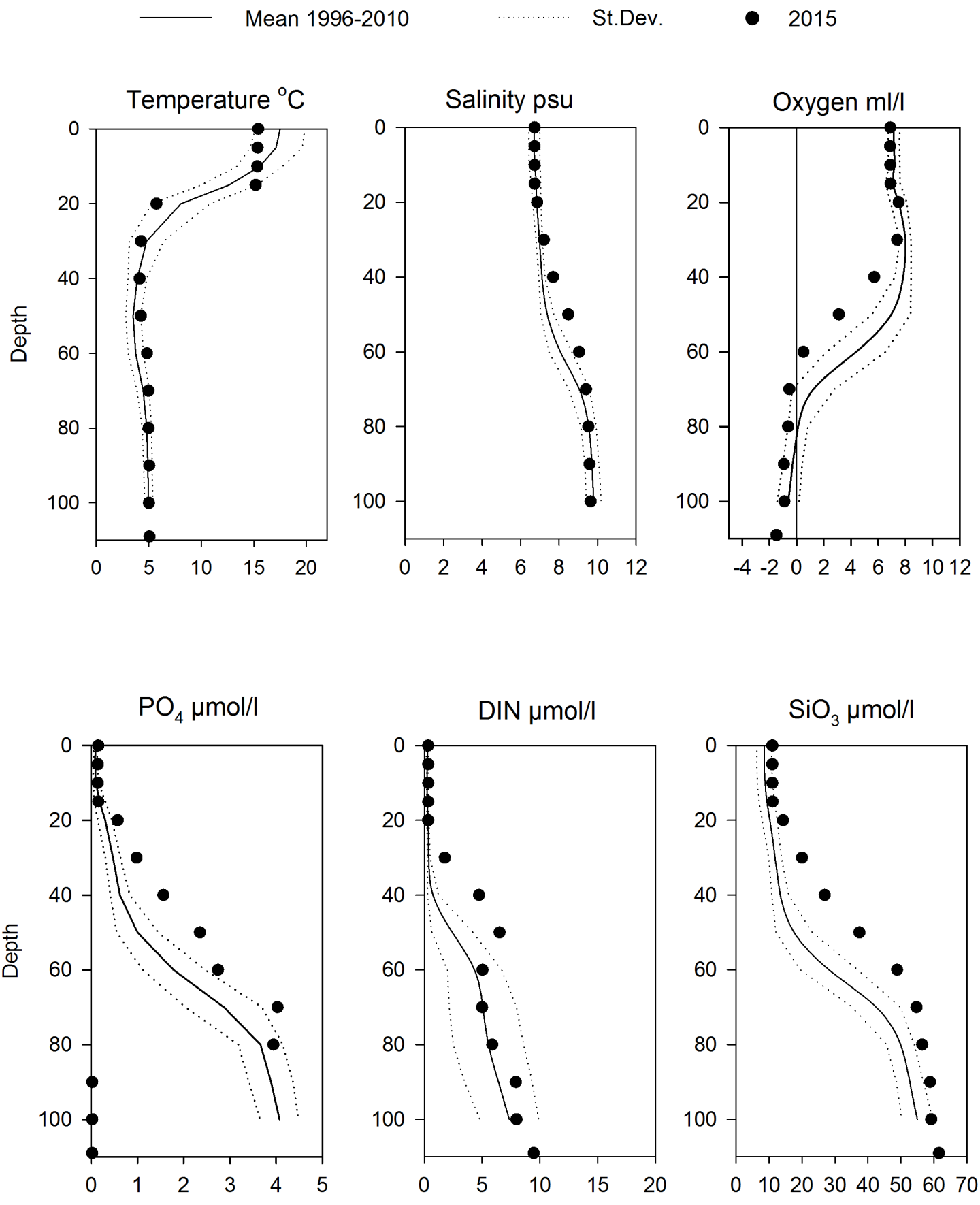
O_2 ml/l



O_2 ml/l



Vertical profiles BY38 July

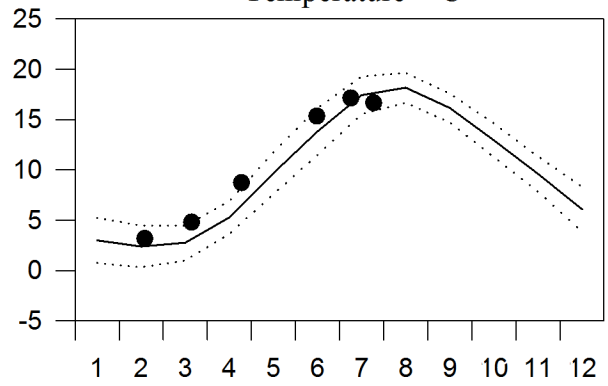


STATION SLÄGGÖ SURFACE WATER

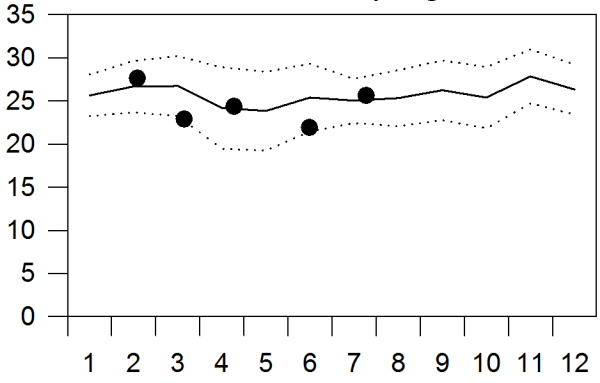
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

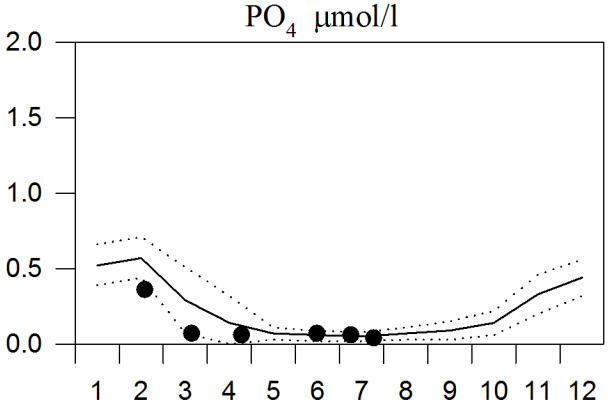
Temperature °C



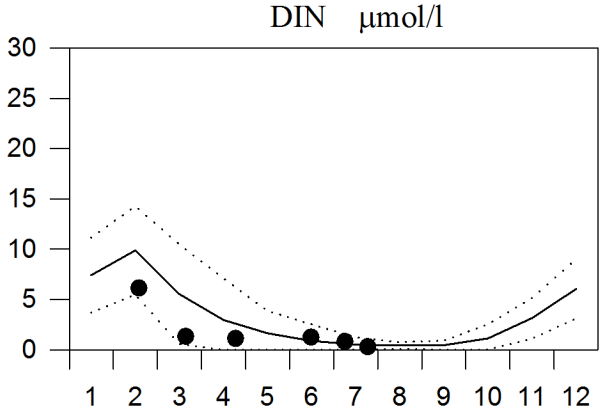
Salinity psu



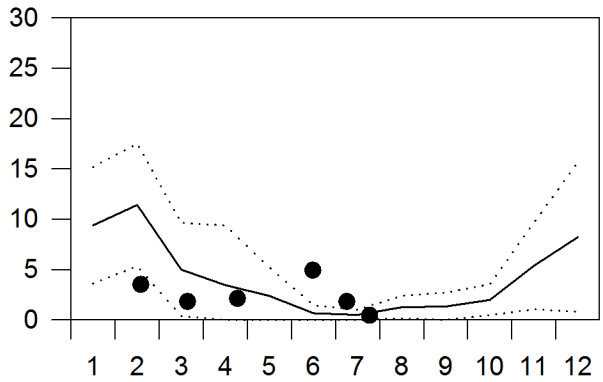
PO_4 µmol/l



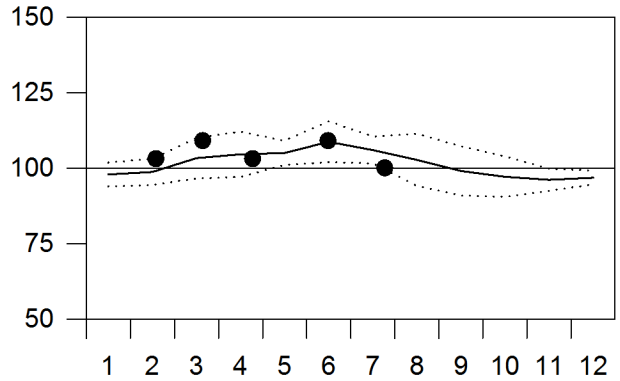
DIN µmol/l



SiO_3 µmol/l

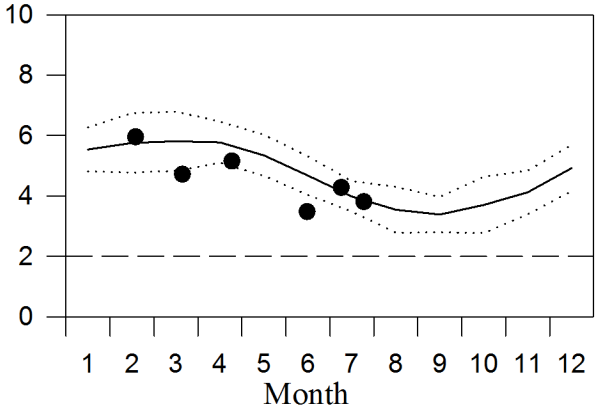


O_2 saturation %

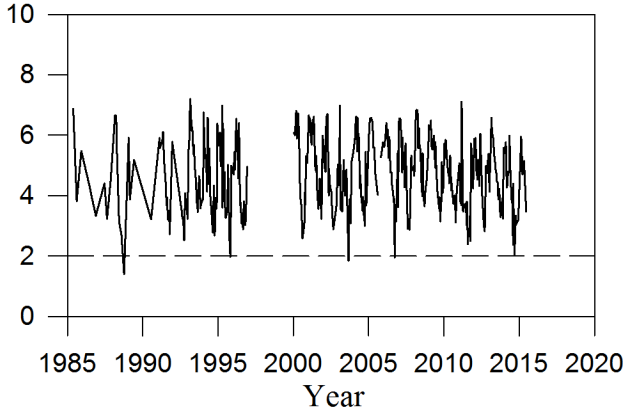


OXYGEN IN BOTTOM WATER (depth >50m)

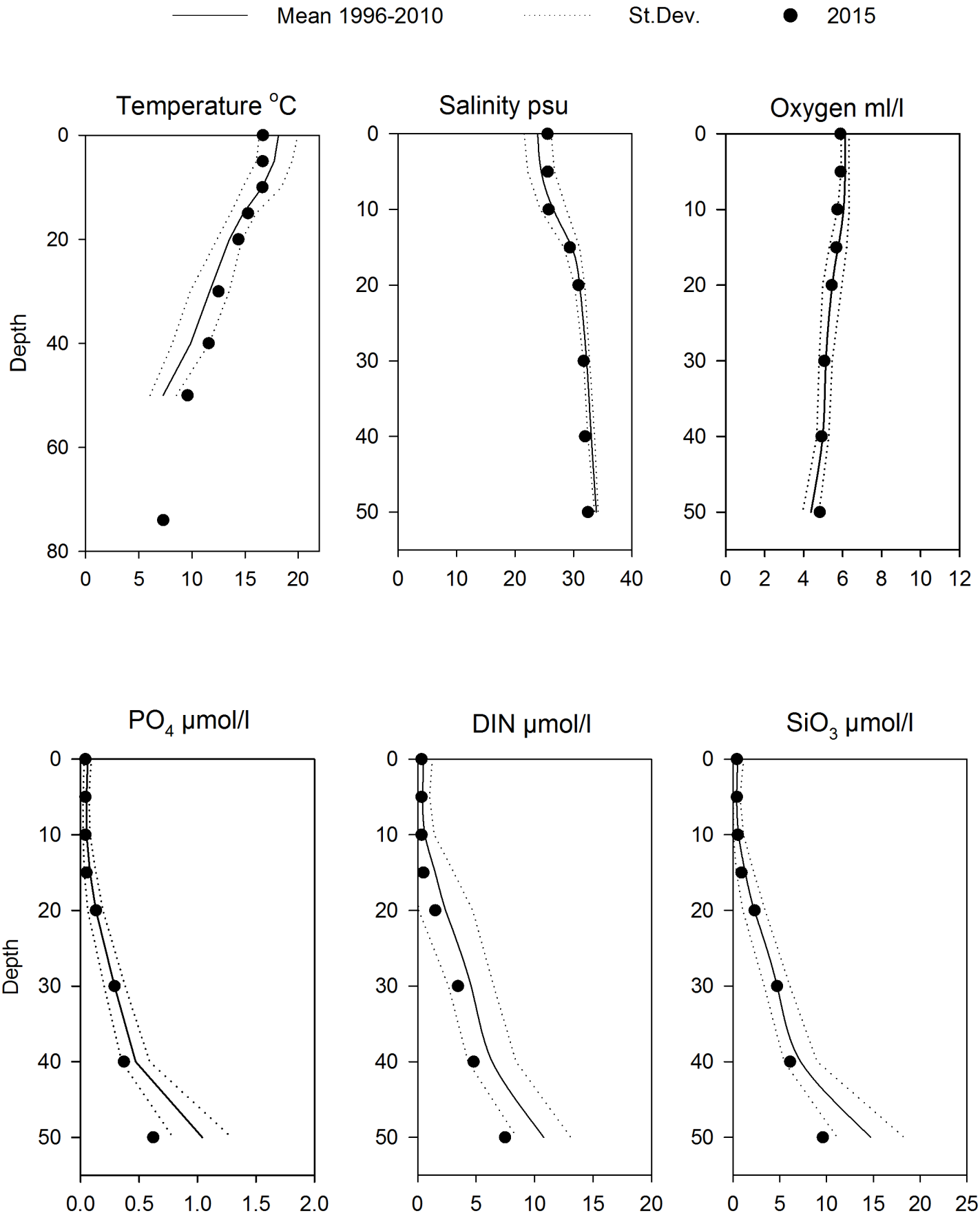
O_2 ml/l



O_2 ml/l

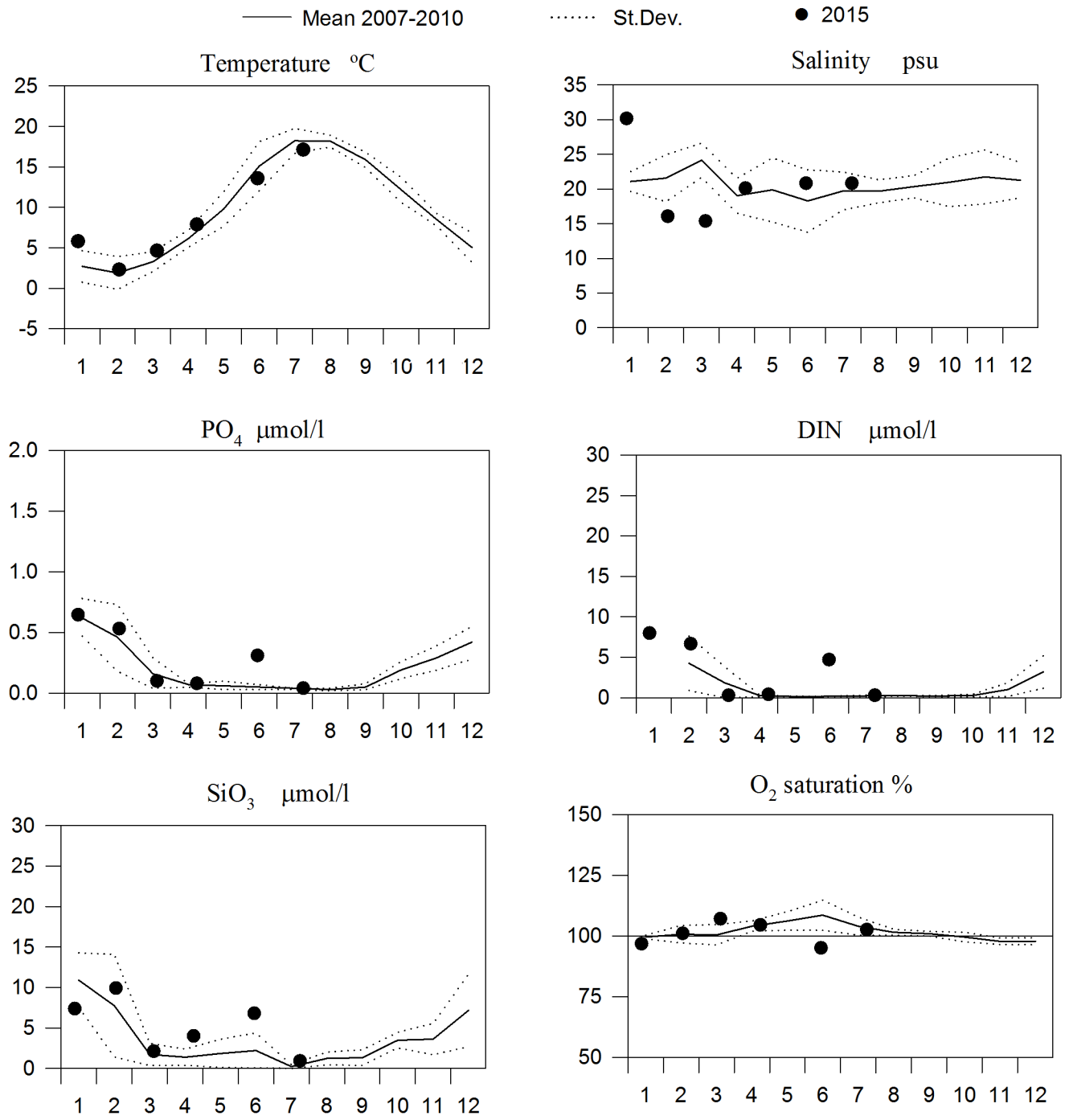


Vertical profiles Släggö July

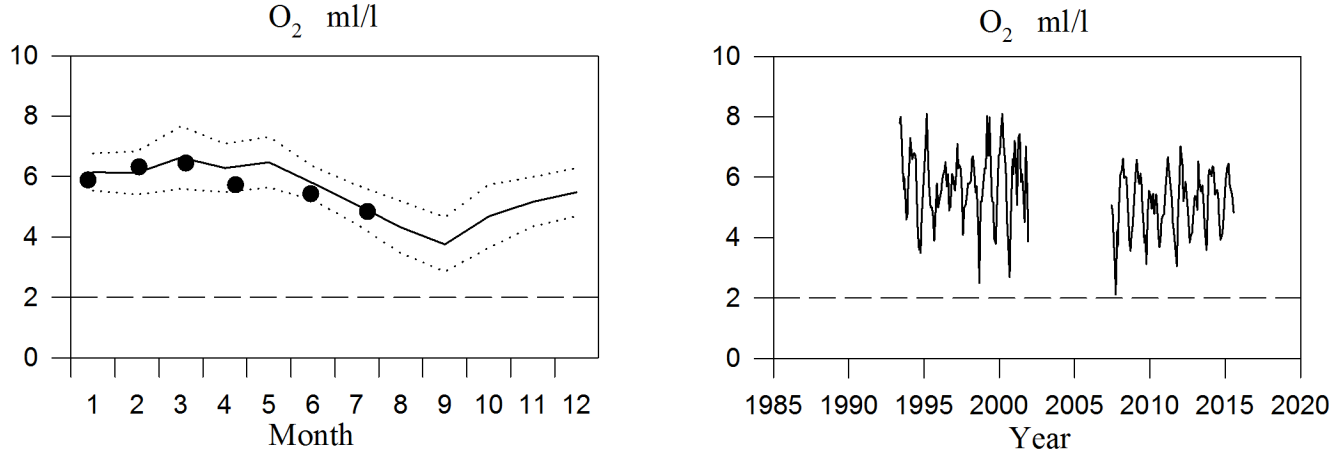


STATION N14 Falkenberg SURFACE WATER

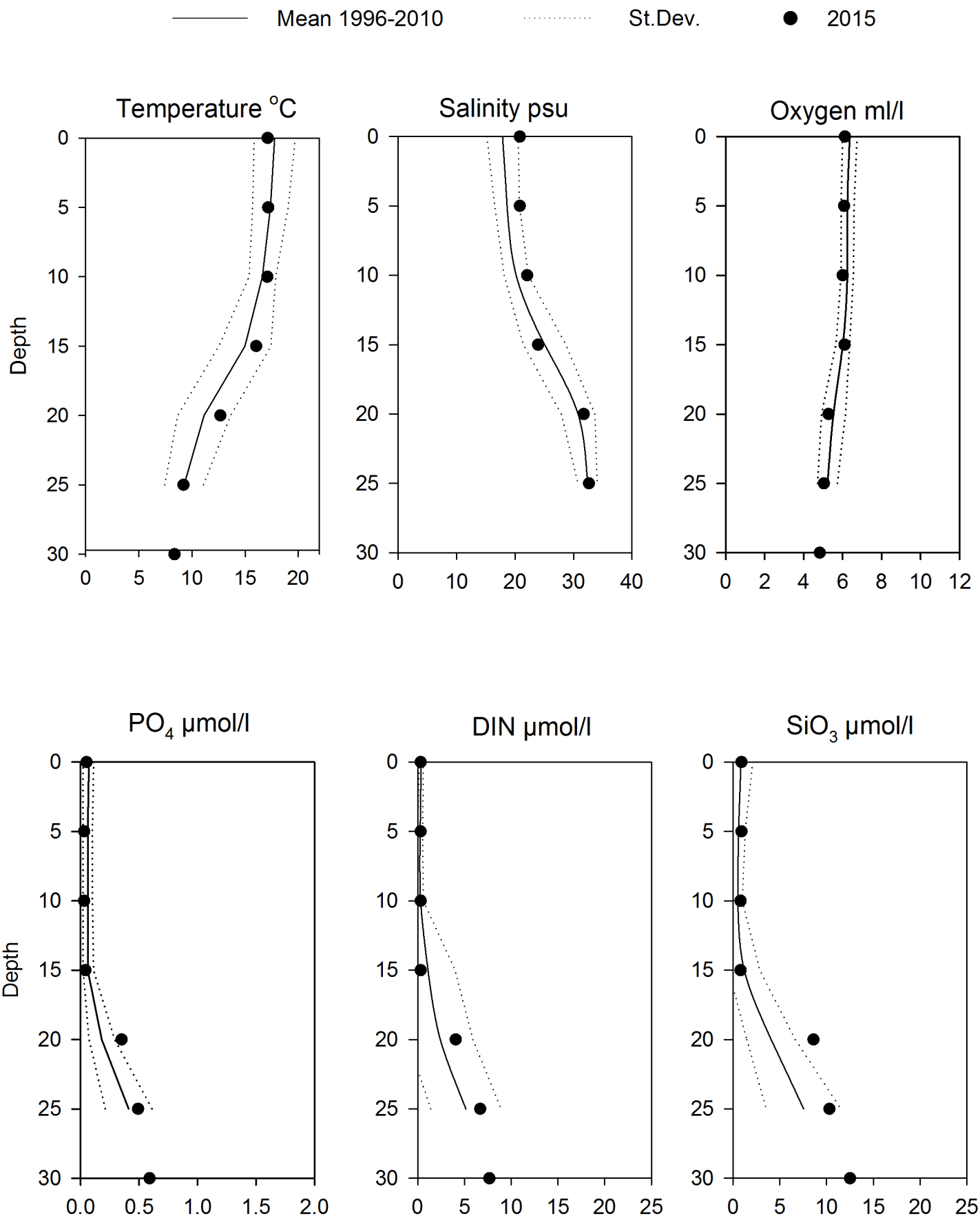
Annual Cycles



OXYGEN IN BOTTOM WATER (depth > 25m)



Vertical profiles N14 Falkenberg July

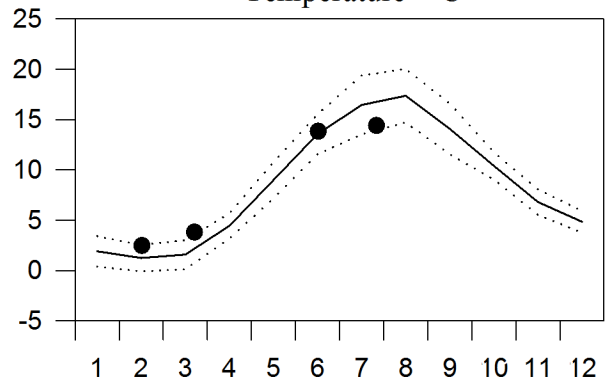


STATION REF M1V1 SURFACE WATER

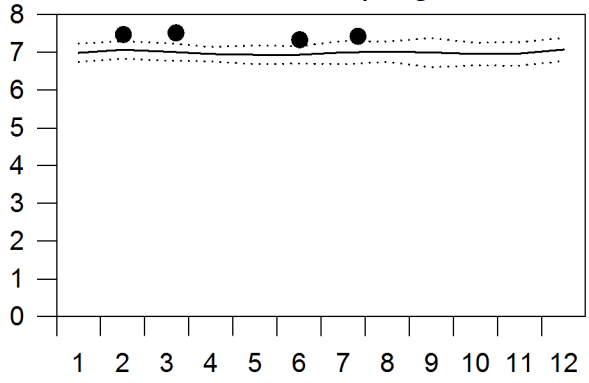
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

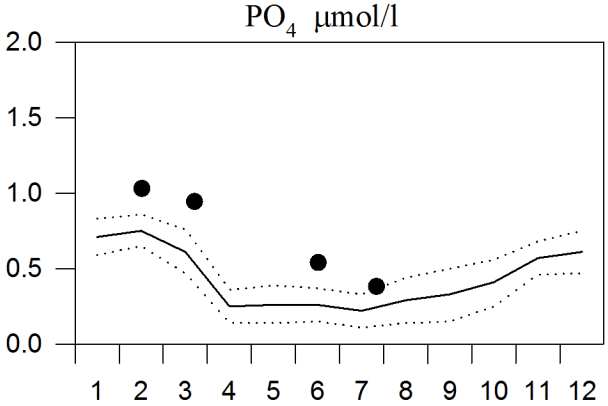
Temperature °C



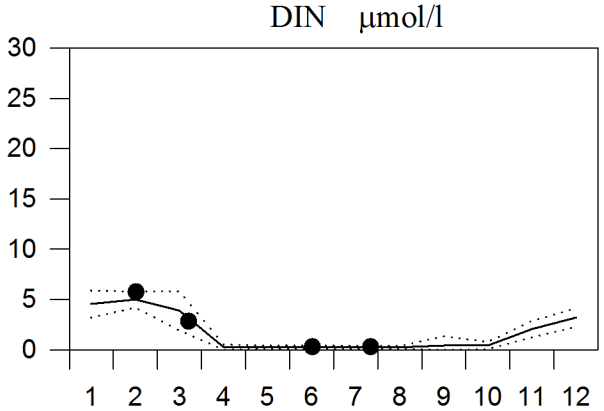
Salinity psu



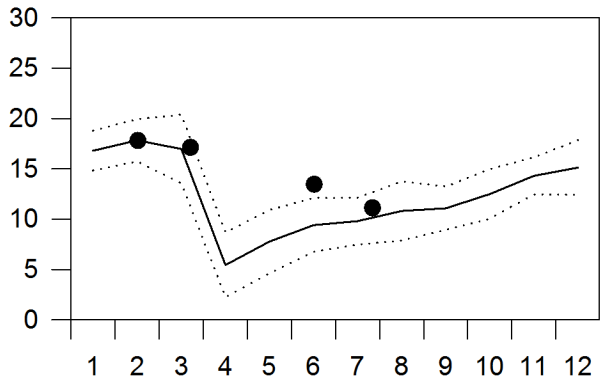
PO_4 µmol/l



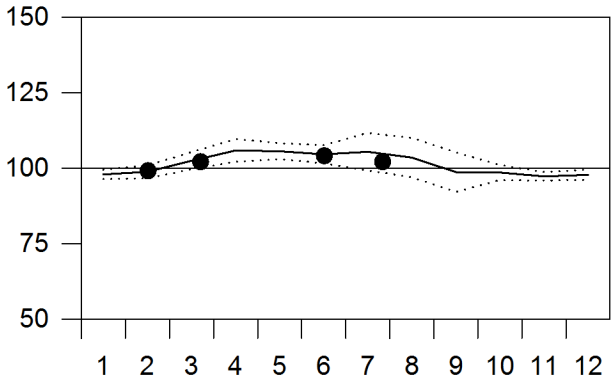
DIN µmol/l



SiO_3 µmol/l

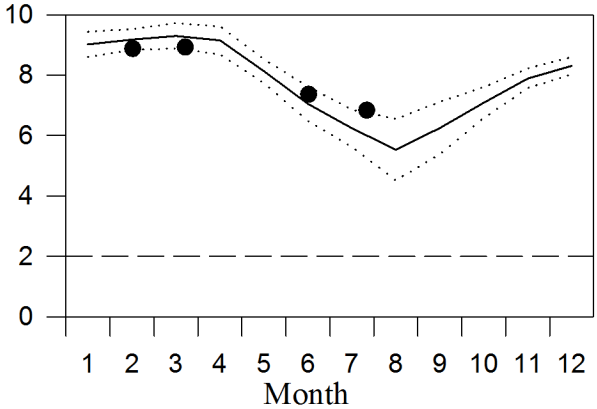


O_2 saturation %

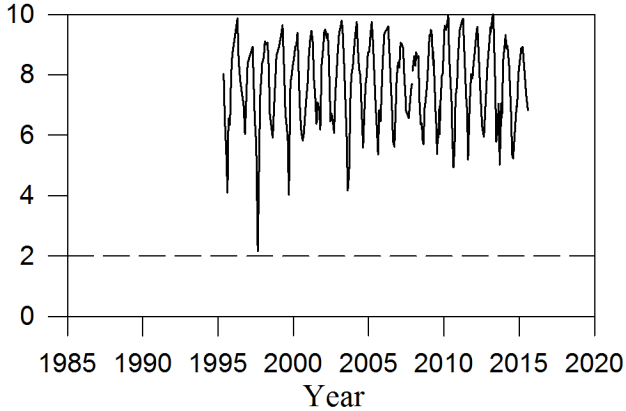


OXYGEN IN BOTTOM WATER (depth >15m)

O_2 ml/l



O_2 ml/l



Vertical profiles Ref M1V1 July