

Report from the SMHI monitoring cruise with R/V Aranda



Survey period: 2016-04-18 - 2016-04-25

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 and the Baltic Proper. Data presented in this report has been subject to preliminary quality control procedures only.

The water temperature was slightly above normal in the whole Baltic Proper. The spring bloom was ongoing in the investigated area. Phosphate showed levels above normal in the southwestern part of the Baltic Proper in the surface water. The concentrations of silicate were still above normal in the whole Baltic Proper.

Acute hypoxia (<2ml/l) was measured from 80 meters depth in the eastern and western Gotland Basins and also near bottom at the Hanö Bight and BY4 Christiansö.

Hydrogen sulphide was only present near bottom in the northern part of Baltic Proper and intermediate at BY20 and also from 90 meters depth in the western Gotland basin.

The next regular cruise is scheduled to start 16 May, 2016.

PRELIMINARY RESULTS

The expedition was conducted aboard the Finnish research vessel Aranda. It commenced in Helsinki on April 18th and ended in the same port on April 25th. The winds during the expedition were predominantly western to northern, and varied in strength from brisk to gale. Air temperatures ranged between +1 and +9 ° C.

The Swedish Defence Research Agency (FOI) joined the cruise to do service on their acoustic measurement equipment in the Baltic Proper (<https://biasproject.wordpress.com/>). One safety engineer from Swedish University of Agricultural Sciences (SLU) was studying our working environment on board.

The Skagerrak

The temperature of the surface water varied between 7.3 and 7.7°C, which are normal for the season. The salinity in the surface layer in the western part of the investigated area was lower than normal and in the southern part it was higher than normal and varied between 21.2 and 32.2 psu. The stratification in both temperature and salinity was found at depth between 5 and 15 meters. Nutrient levels were lower than normal in the whole area except for the nitrogen concentrations in the southern part which was much higher than normal. In the surface water, levels of phosphate ranged from 0.06 to 0.11 µmol/l, inorganic nitrogen (nitrite + nitrate) varied from the detection limit (0.1µmol/l) to 10.0 µmol/l, while silicate varied from 0.5 in the outer part to 6.1 µmol/l near the coast. The bottom water was well oxygenated also at Släggö, in the mouth of Gullmarsfjorden. Fluorescence measurements showed high biological activity in the surface layer 0-10 m. For more details on species composition see the separate algal report.

The Kattegat and the Sound

The temperature of the surface water was normal for the season and varied between 7.0 and 8.5°C. The salinity of the surface layer was slightly lower than normal and varied between 18.3 and 19.6 psu. The stratification in Kattegat was developed between 10 and 15 meters. In the Sound, the salinity was 19 psu which is higher than normal and there was a weak stratification at 15 meters depth.

Nutrient levels in the surface water were normal to below normal for the season. Phosphate concentrations in the surface layer varied between 0.06 and 0.16 µmol/l, the sum of nitrite + nitrate was below detection limit (<0.1 µmol/l) and silicate varied between 0.1 and 1.8 µmol/l. The highest levels of nutrient concentrations were found in the Sound.

The oxygen conditions in the deep water were good, and the lowest concentrations were measured in the Sound, 5.02 ml/l.

Fluorescence measurement showed that there still are high activities in the area.

The Baltic Proper

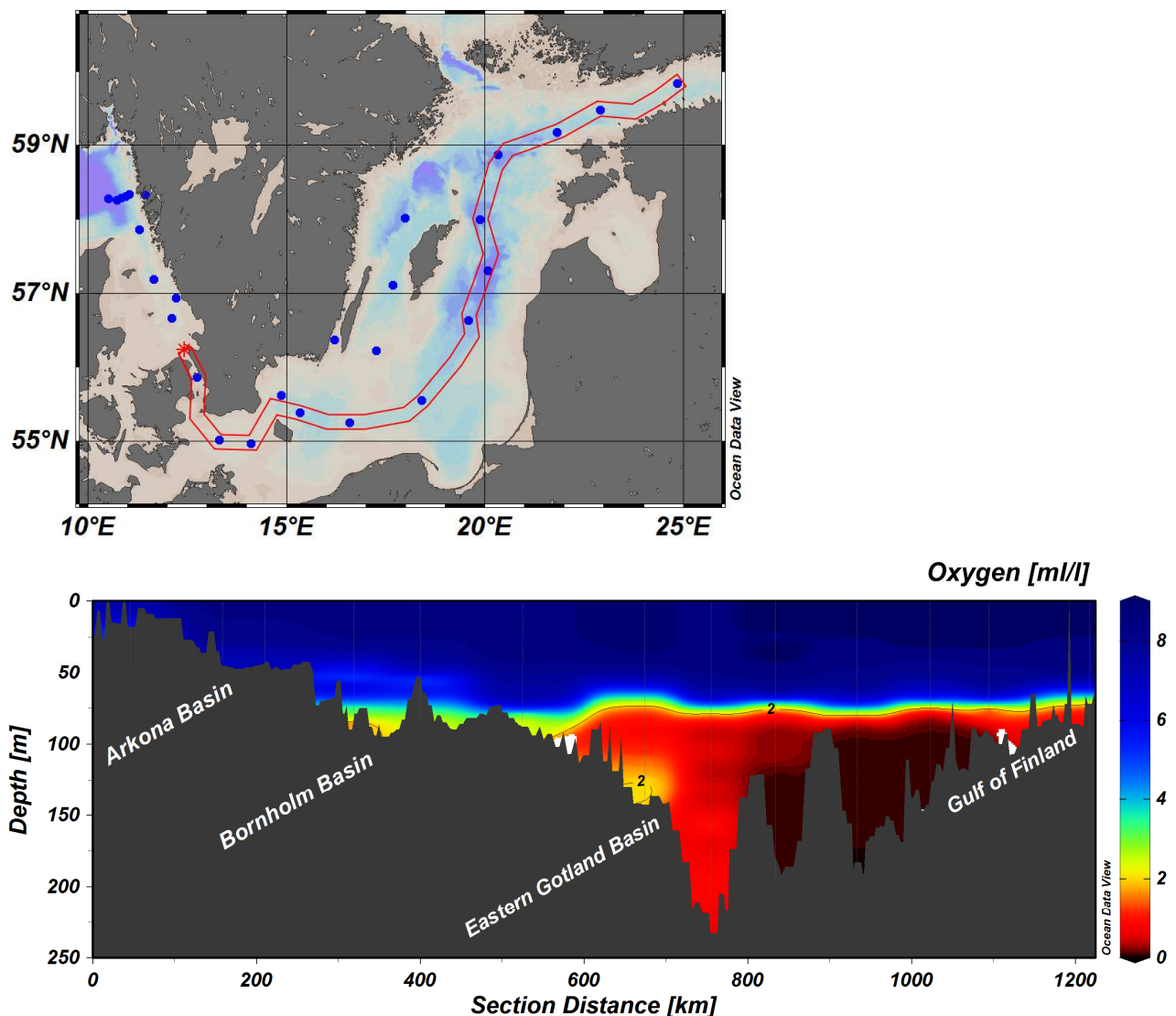
The temperature of the surface layer was slightly above normal for the season and varied from 4.3 to 7.5°C. Surface salinity was also above average in the whole area except in the north east part where it was slightly lower than normal and varied between 6.4 in the north to 7.9 in the south east. The halocline and thermocline coincided and were found at 50-80 metres in the area. In the north and the south west a weak stratification was found about 10-15 meters. In the eastern Gotland Basin a weak thermocline was found at 40 meters.

The phosphate concentration in the surface water was normal for the season except in the south west where it was above normal and varied between 0.36 and 0.51 µmol/l. The concentrations of nitrite +

nitrate were normal throughout the investigated area and were below detection limit ($<0.1 \mu\text{mol/l}$). The concentrations of silicate were above to high above normal in the whole area. The concentrations ranged between 11.3 and $16.6 \mu\text{mol/l}$.

In the Hanö Bight and BY4 Christiansö acute hypoxia ($<2 \text{ ml/l}$) occurred only near bottom. Acute hypoxia was measured at depths exceeding $70\text{--}80$ metres in the eastern and western Gotland Basins. Hydrogen sulphide was present only near bottom in the northern part of the investigated area and intermediate at BY20 and also from 90 meters in the western Gotland Basin.

Fluorescence measurements showed quite high activity in the surface layer in the whole Baltic Proper, lowest in the Arkona Basin.



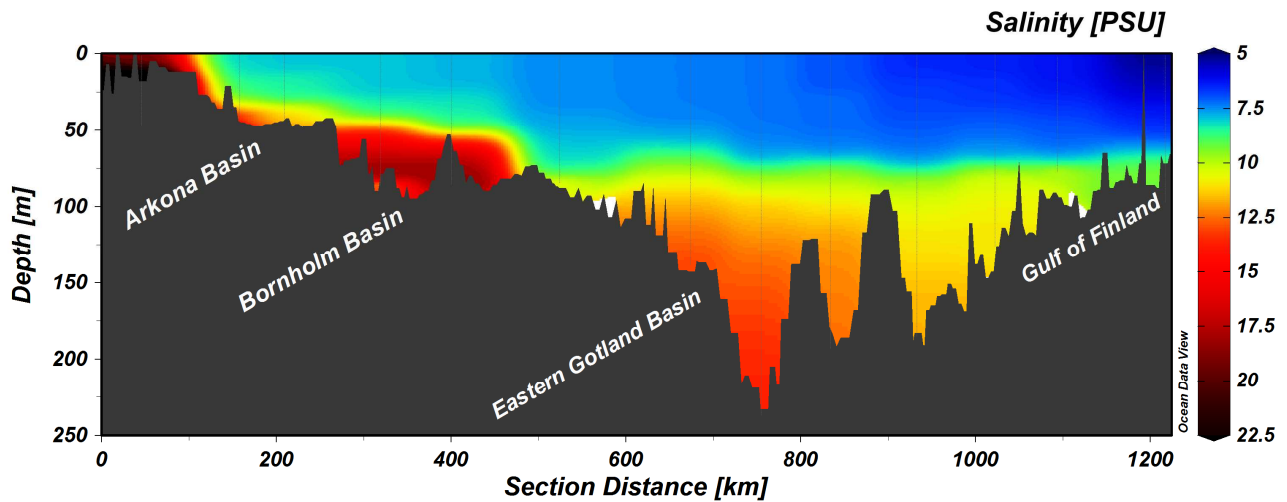


Figure 1. Transect showing the oxygen and salinity from the Sound to the Gulf of Finland.

PARTICIPANTS

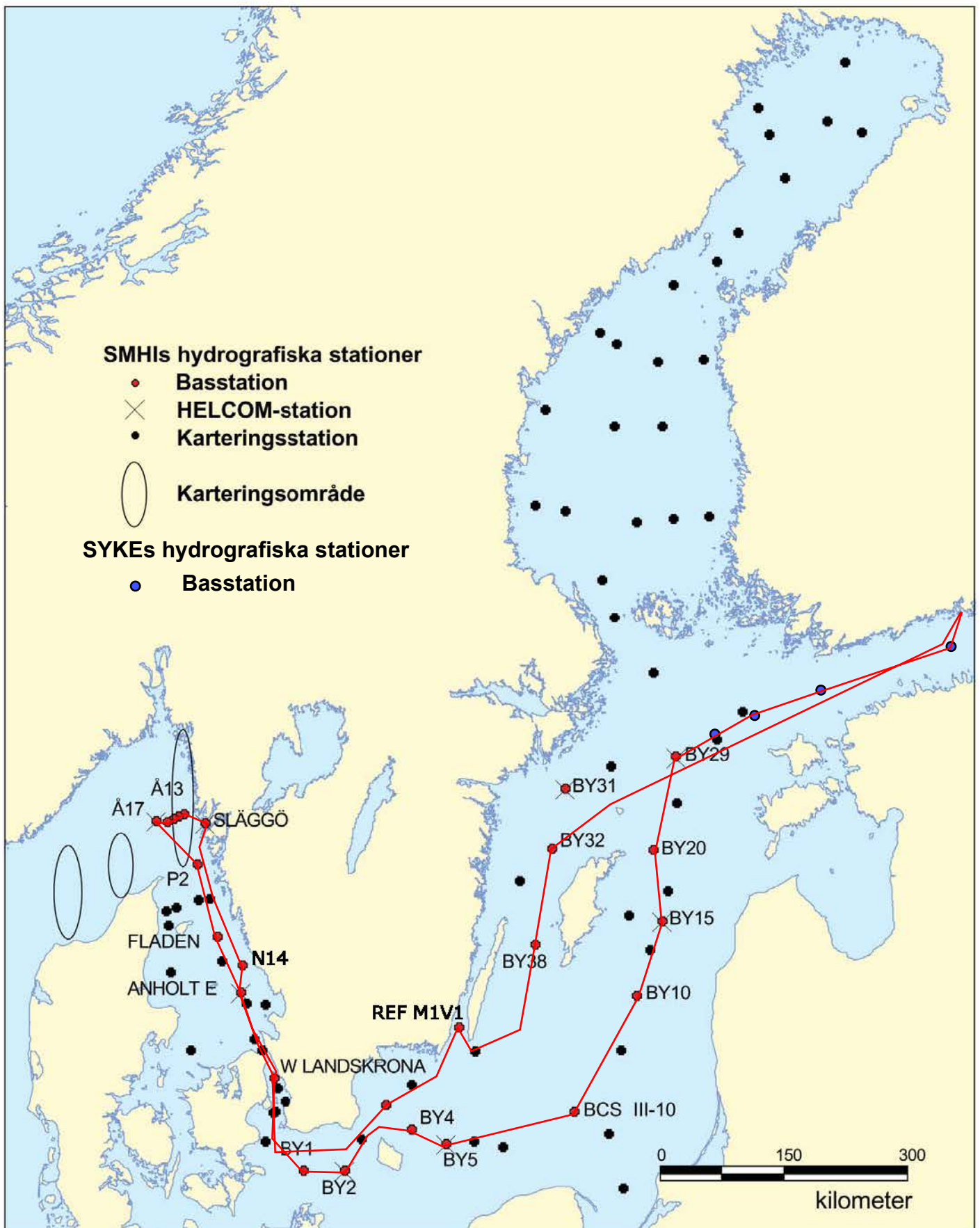
Name		Institute
Anna-Kerstin Thell	Chief scientist	SMHI
Johan Håkansson		SMHI
Sara Johansson		SMHI
Johan Kronsell		SMHI
Johanna Linders		SMHI
Daniel Simonsson		SMHI
Ann-Turi Skjevik		SMHI
Stefan Andersson		SLU
Mathias Andersson		FOI

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

Country: Sweden
 Ship: R/V ARANDA
 Date: 20160418-20160425
 Series: 0212-0240



Date: 2016-04-25
Time: 11:41

Ser no	Stat code	P r o j	Station-----	Lat-----	Lon-----	Date yyyymmdd	Time hhmm utc	Bottom depth m	Secchi depth m	Wind di ve	Air temp C	Air pres hPa	WCSI elec t aoae d	C PPCPZT Hrhhoo P l	No de	T e a ml p n	S h x pi g	O x 2 y S	H P T N N N T A S H L P T C	P o o o o h o l i u i O O O	N t k o m g n c c m
0212	GFXX29EXT	BY23/LL7		N5950.5	E2450.3	20160418	1125	102		25 13	3.5	1001	1640	x --x----	13	x	x	- x - x x x x x x - x - - - - x			
0213	BPNX60EXT	LL12		N5929.0	E2254.0	20160418	1730	83		23 12	4.8	1003	1340	x --x----	11	x	x	- x x x x x x x - x - - - - x			
0214	BPNX00BAS	LL15		N5911	E2144.81	20160418	2145	132		23 11	5.2	1001	9990	x -----	15	x	x	- x - - - - - - - - - - x			
0215	BPNX35EXT	BY29		N5853	E2019	20160419	0240	187		24 12	5.1	1000	2740	x -----	16	-	x	x x - - - - - - - - - - x			
0216	BPEX26BAS	BY20	FÄRÖDJ	N5800	E1953	20160419	0810	192		22 10	5.6	1001	2740	x --x----	17	x	x	- x x x x x x x - x - - - - x			
0217	BPEX21BAS	BY15	GOTLANDSDJ	N5720	E2003	20160419	1240	240	9	24 11	5.4	1003	2840	x -xxxx--	19	x	x	x x - x x x x x x x x x - - - - x			
0218	BPEX13BAS	BY10		N5638	E1935	20160419	1900	145		32 10	5.6	1008	9990	x --x----	15	x	x	- x - x x x x x x - x - - - - x			
0219	BPSE11BAS	BCS IIII-10		N5533.3	E1824	20160420	0230	90		27 10	5.7	1015	1630	x --x----	12	x	x	- x - x x x x x x - x - - - - x			
0220	BPSB07BAS	BY5	BORNHOLMSDJ	N5515	E1559	20160420	1015	91	8	27 9	6.2	1022	1130	x -xxxx--	12	x	x	x x - x x x x x x x x x - - - - x			
0221	BPSB06BAS	BY4	CHRISTIANSSÖ	N5523	E1520	20160420	1335	92	7	26 11	7.3	1022	1130	x --x----	12	x	x	- x - x x x x x x - x - - - - x			
0222	BPSA03BAS	BY2	ARKONA	N5500	E1405	20160420	1930	47		27 6	7.7	1025	9930	x -xxxx--	8	x	x	- x - x x x x x x - x x - - - - x			
0223	BPSA02BAS	BY1		N5500	E1318	20160420	2300	46		29 8	7.0	1025	9990	x --x----	8	x	x	- x - x x x x x x - x - - - - x			
0224	SOCX39BAS	W LANDSKRONA		N5552.0	E1245.0	20160421	0535	52	7	29 9	6.0	1022	1120	x --x----	9	x	x	- x - x x x x x x - x - - - - x			
0225	KAXE29BAS	ANHOLT E		N5640.0	E1207.0	20160421	1050	63	8	26 9	7.1	1020	2740	x -xxxx--	10	x	x	x - x x x x x x x x x - - - - x			
0226	KANX25BAS	FLADEN		N5711.5	E1140	20160421	1430	84		28 15	8.6	1015	1450	x --x----	12	x	x	- x - x x x x x x - x - - - - x			
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0228	SKEX18BAS	Å17		N5816.5	E1030.8	20160421	2320	352	33	13	7.8	1013	9990	x -xx---	15	x	x	x - x x x x x x x x x - - - - x			
0229	SKEX17BAS	Å16		N5816	E1043.5	20160422	0115	203		32 12	7.3	1013	9990	x -----	13	-	-	- - - - - - - - - - - - - - x			
0230	SKEX16BAS	Å15		N5817.7	E1051	20160422	0245	136		34 12	7.1	1014	1150	x --x----	12	x	x	- x - x x x x x x - x - - - - x			
0231	SKEX15BAS	Å14		N5819	E1056.5	20160422	0415	112		35 10	7.0	1014	1150	x -----	11	-	-	- - - - - - - - - - - - - - x			
0232	SKEX14BAS	Å13		N5820.2	E1102	20160422	0523	98		35 9	6.9	1015	0040	x --x----	10	x	x	- x - x x x x x x - x - - - - x			
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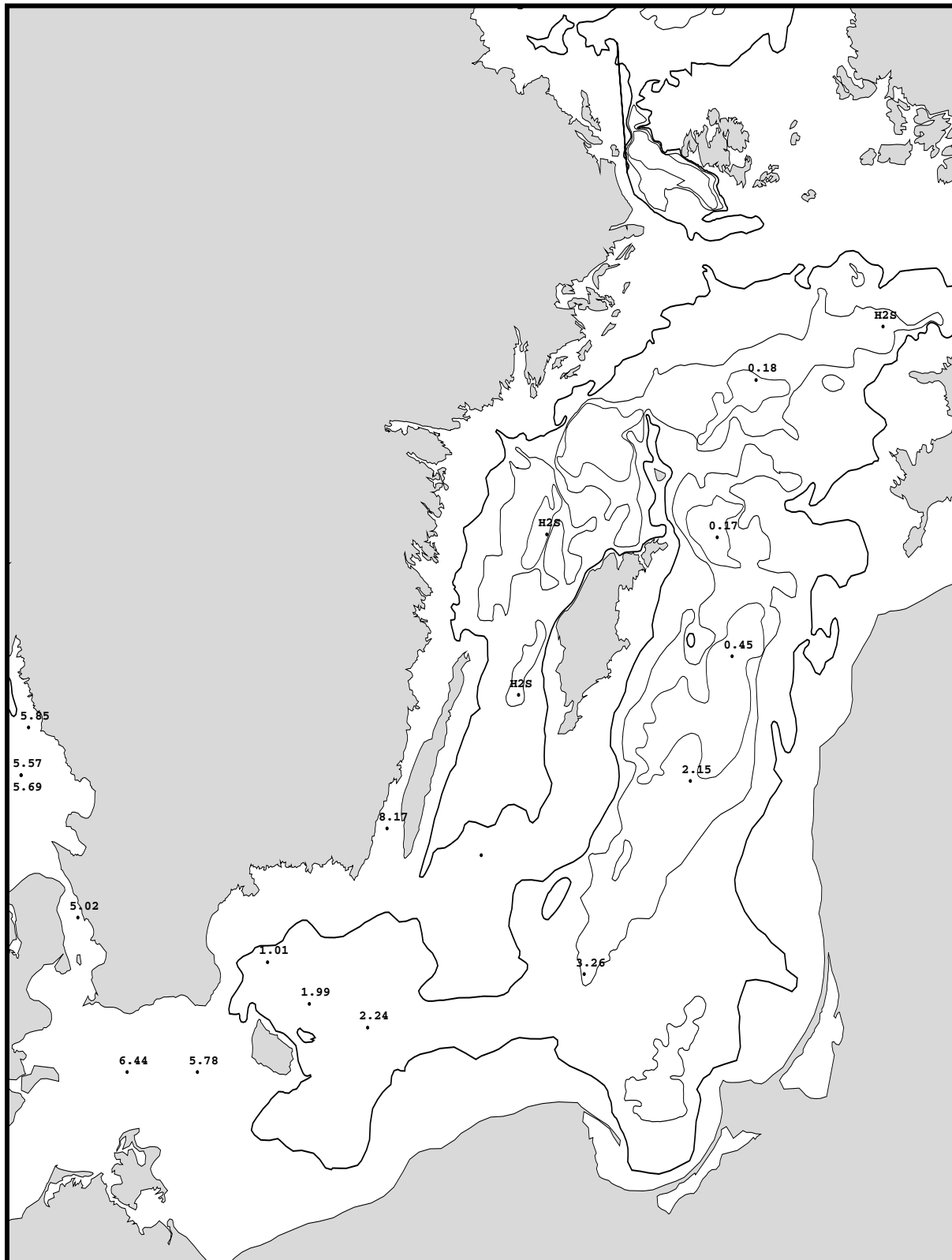
Bottom water oxygen concentration (ml/l)

Country: Finland

Ship : Aranda

Date : 20160418-20160424

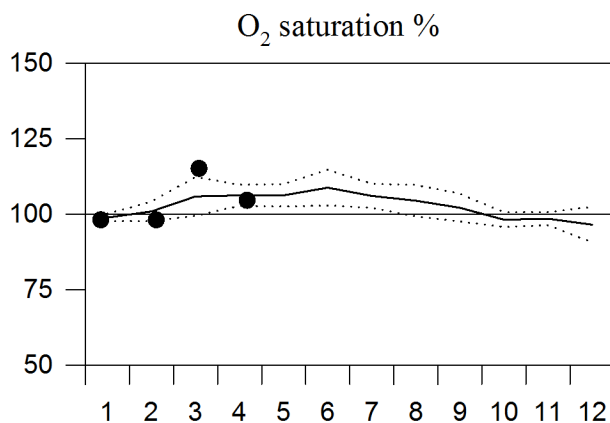
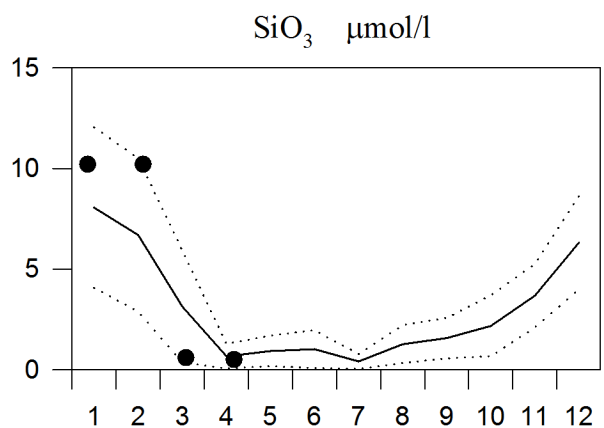
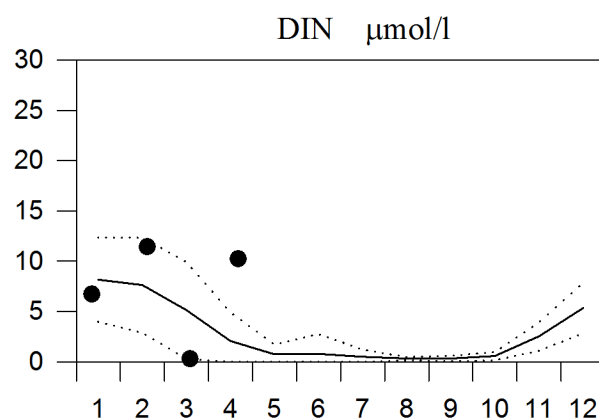
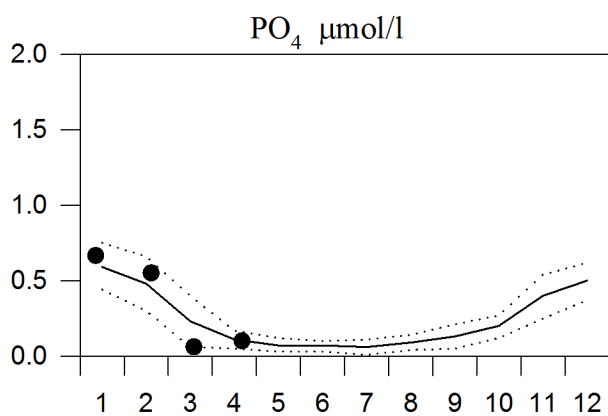
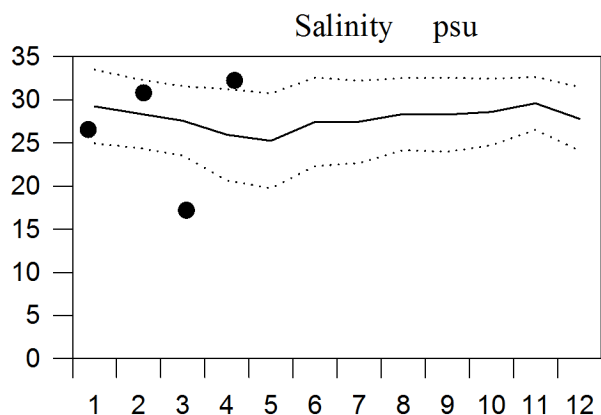
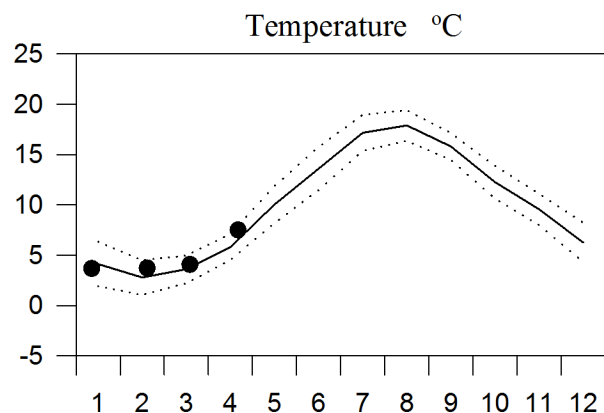
Series : 0212-0240



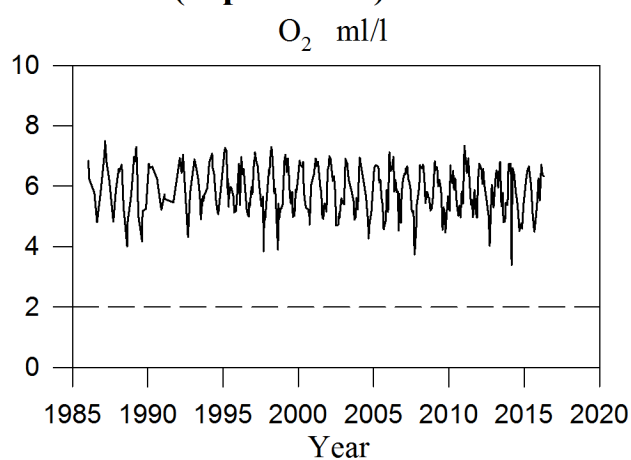
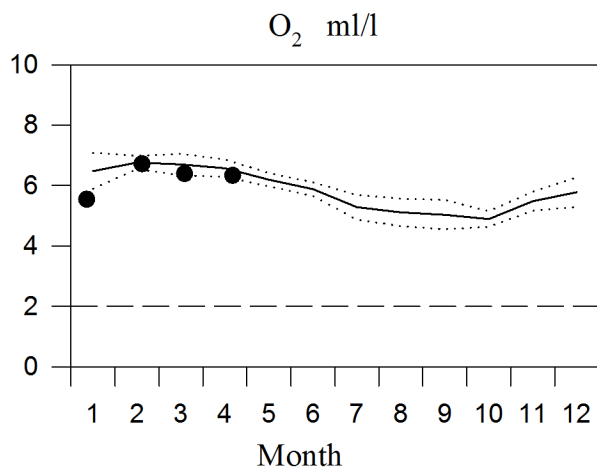
STATION P2 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2016

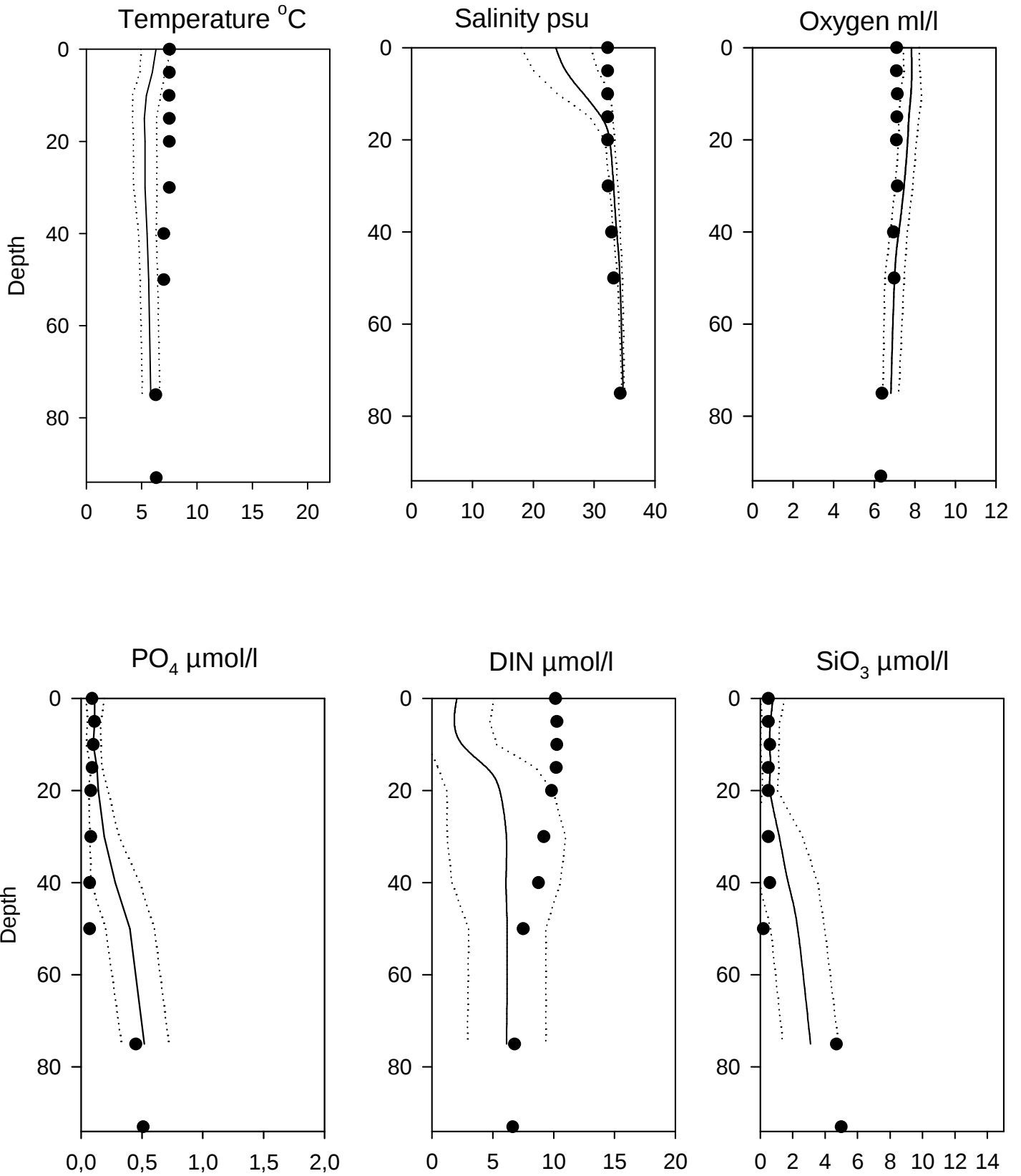


OXYGEN IN BOTTOM WATER (depth >75m)



Vertical profiles P2 April

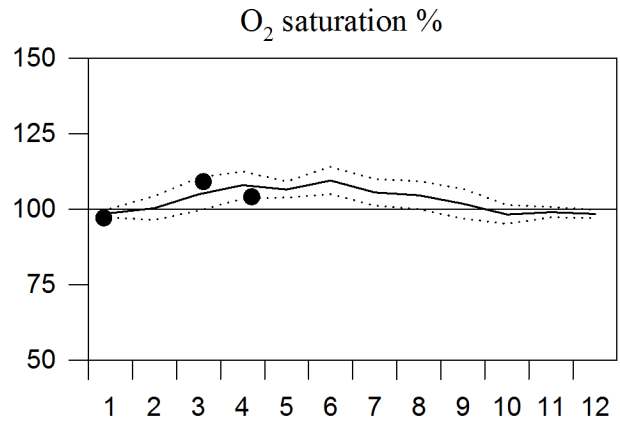
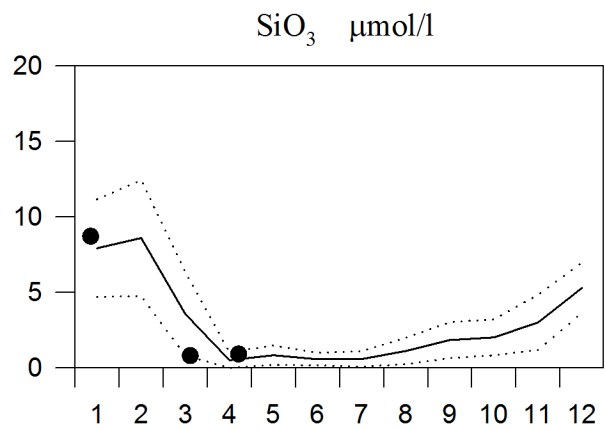
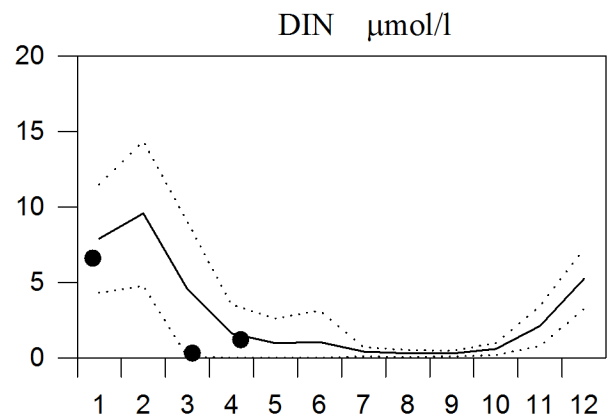
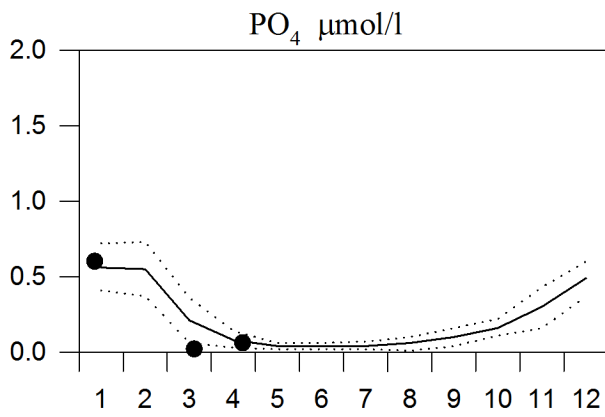
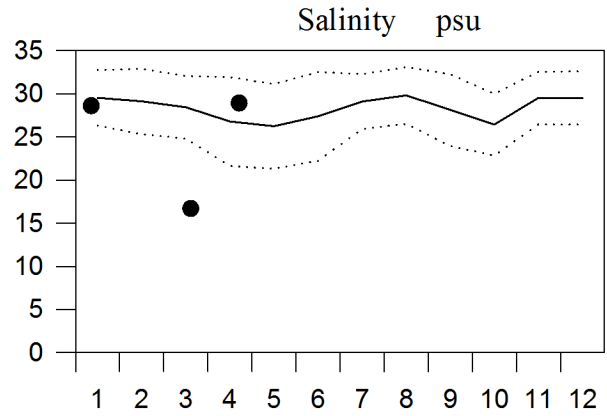
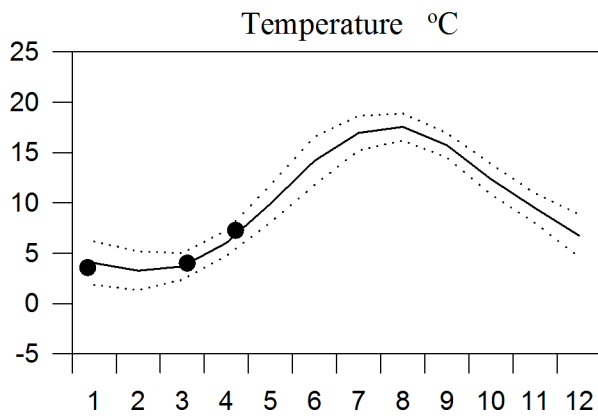
— Mean 1996-2010 St.Dev. ● 2016



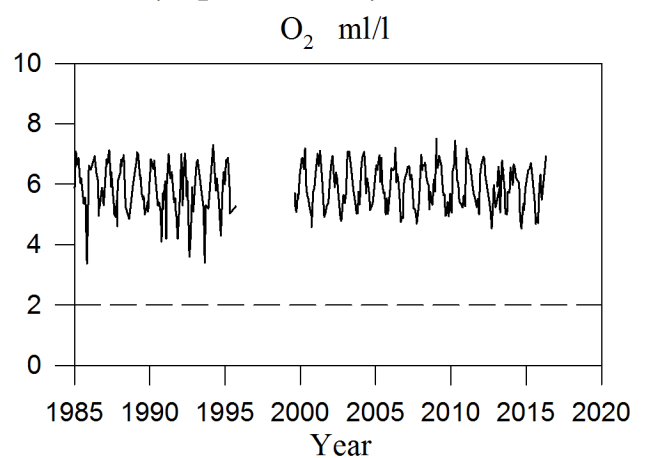
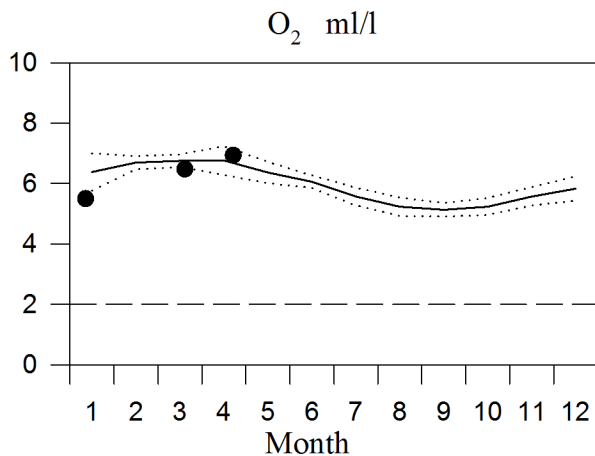
STATION Å13 SURFACE WATER

Annual Cycles

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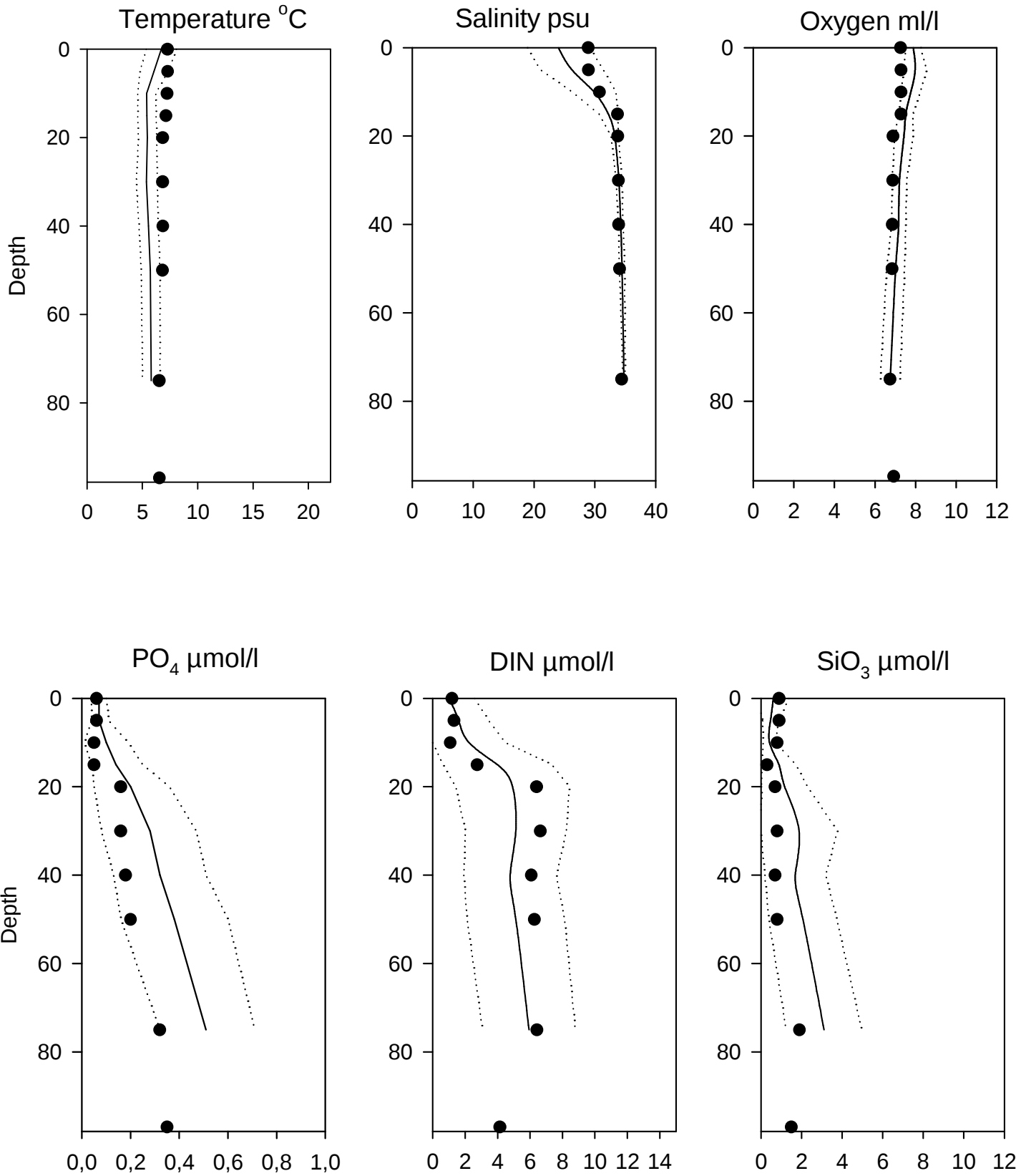


OXYGEN IN BOTTOM WATER (depth >=75m)



Vertical profiles Å13 April

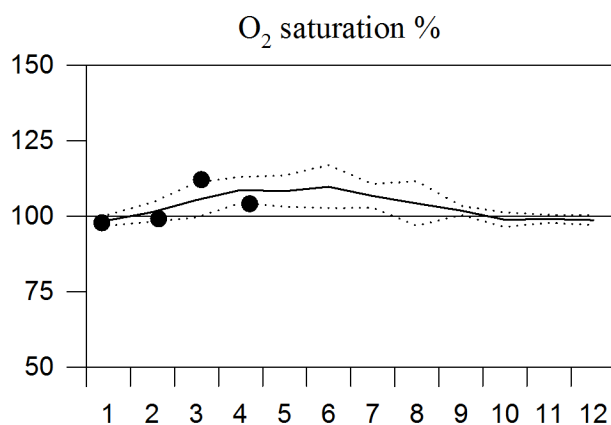
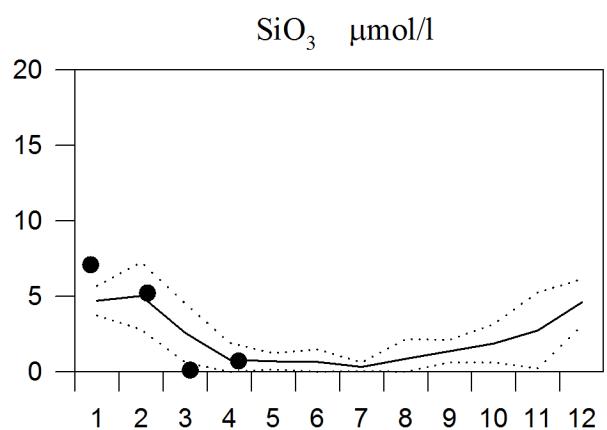
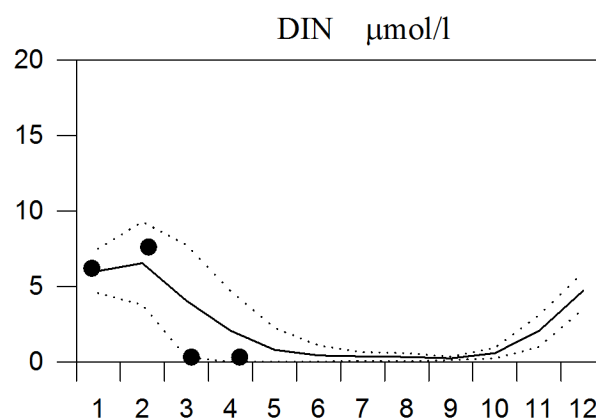
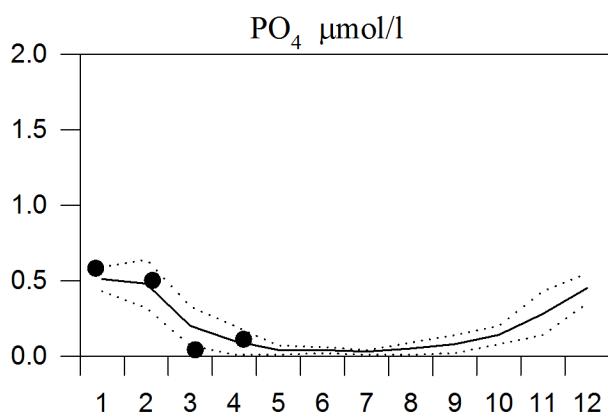
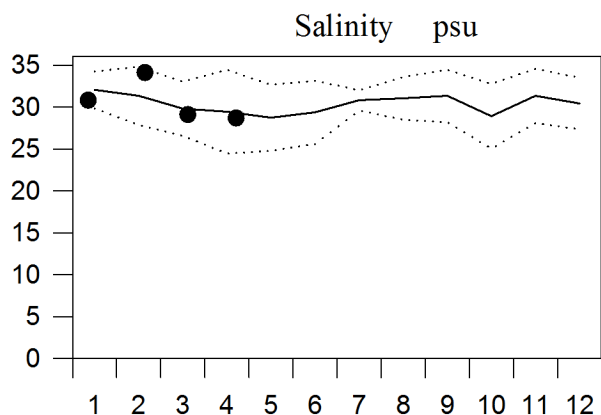
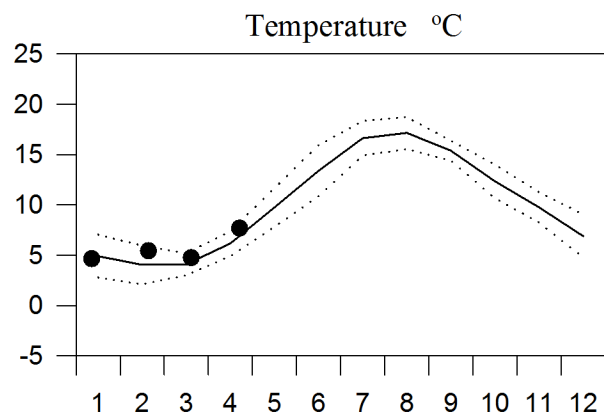
— Mean 1996-2010 St.Dev. ● 2016



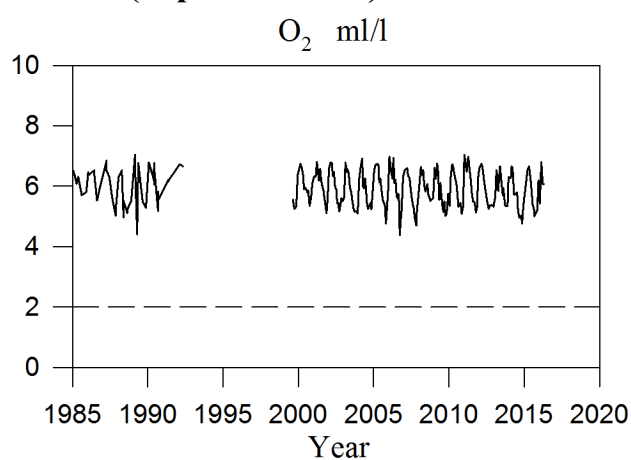
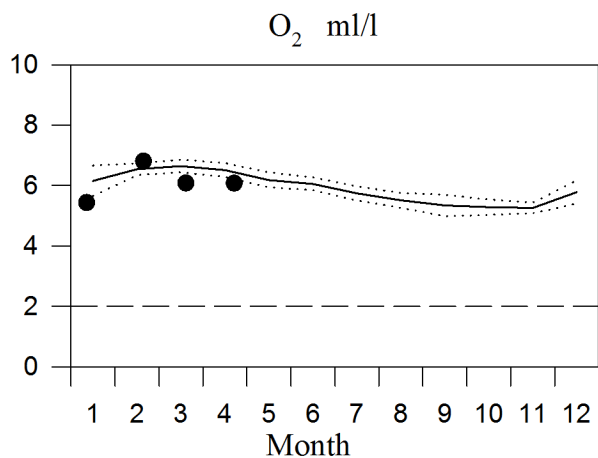
STATION Å15 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2016



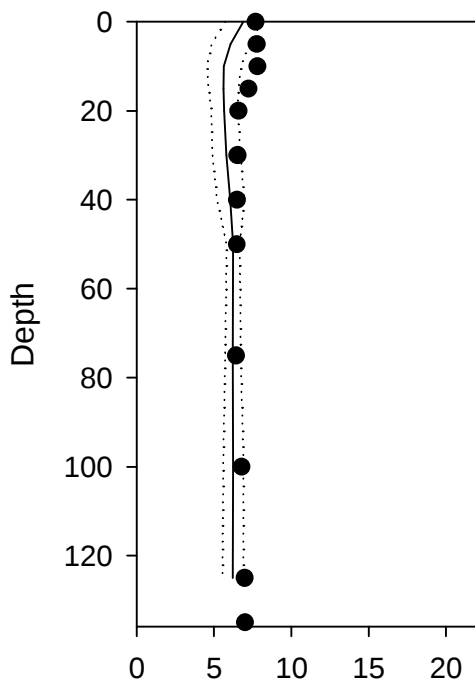
OXYGEN IN BOTTOM WATER (depth >=125m)



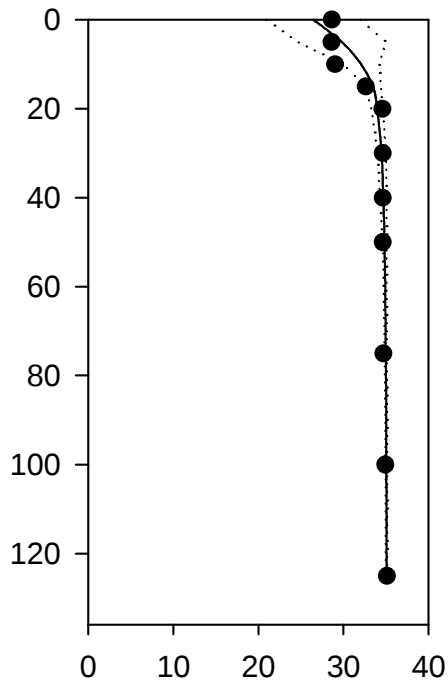
Vertical profiles Å15 April

— Mean 1996-2010 St.Dev. ● 2016

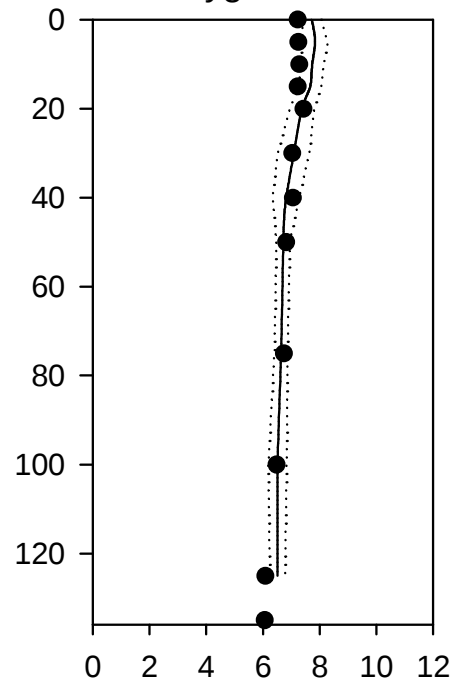
Temperature °C



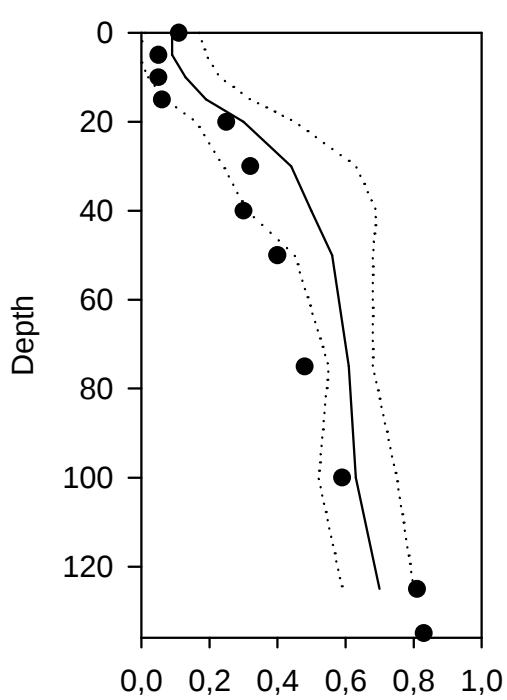
Salinity psu



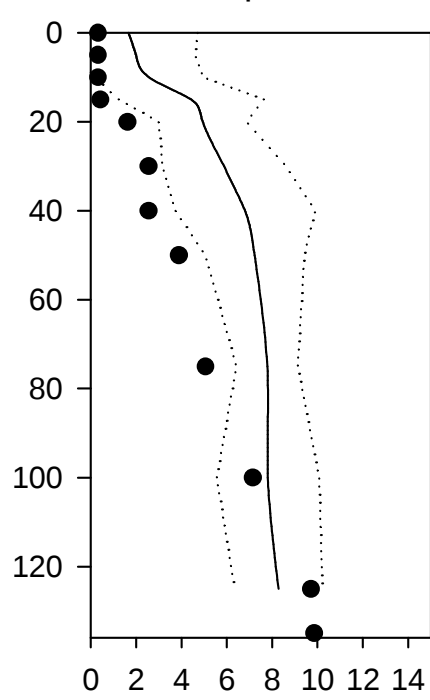
Oxygen ml/l



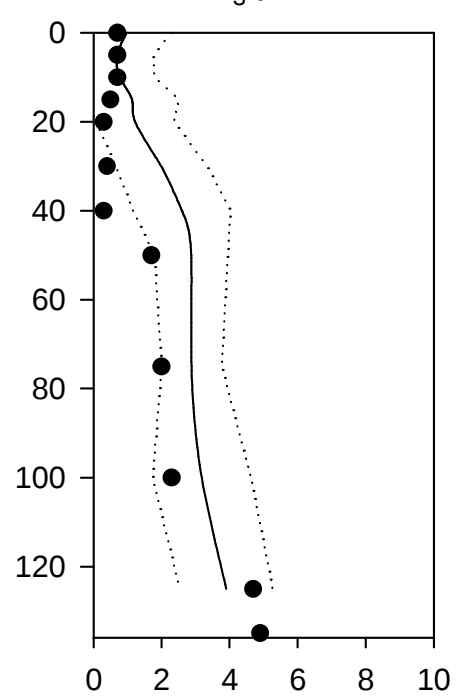
PO₄ µmol/l



DIN µmol/l



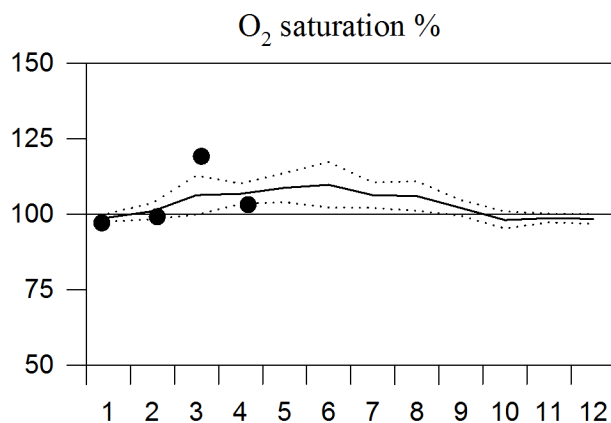
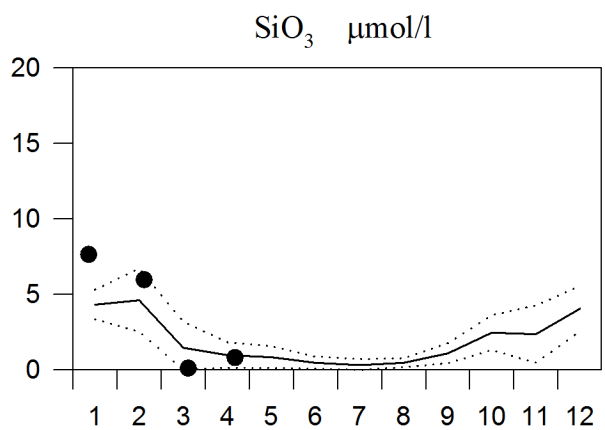
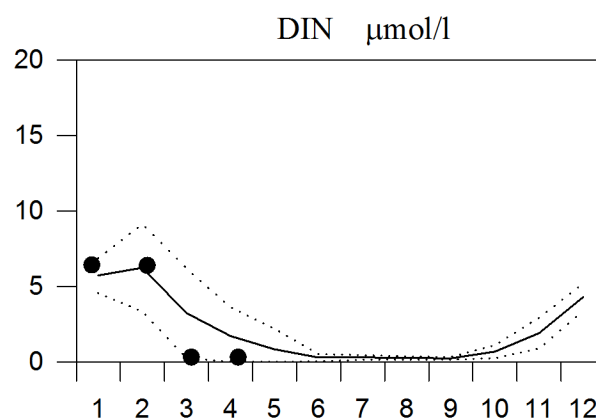
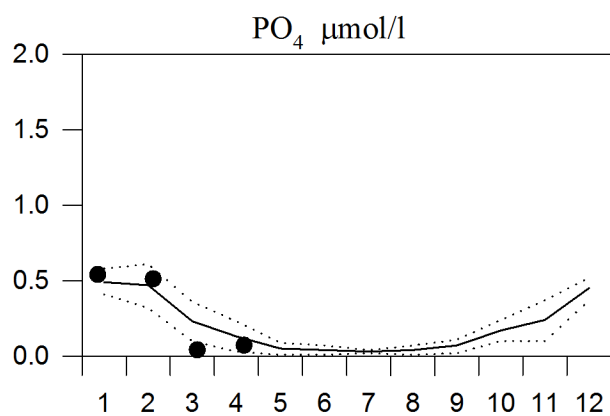
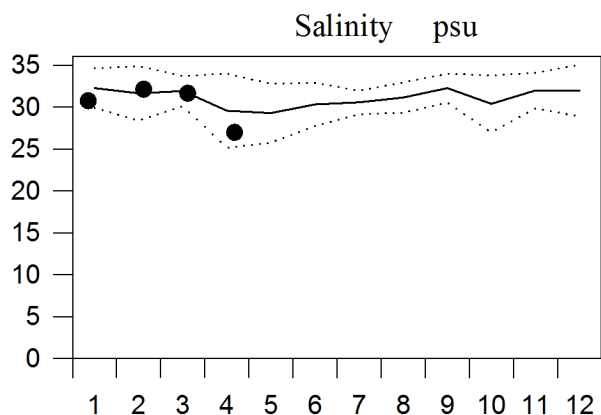
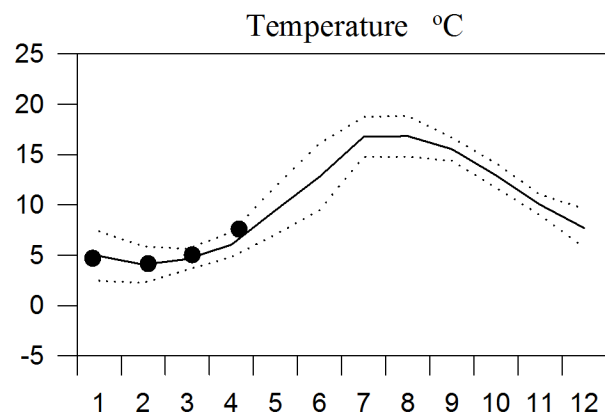
SiO₃ µmol/l



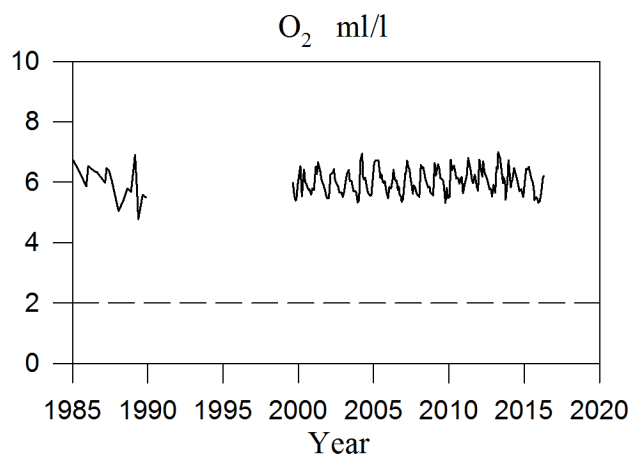
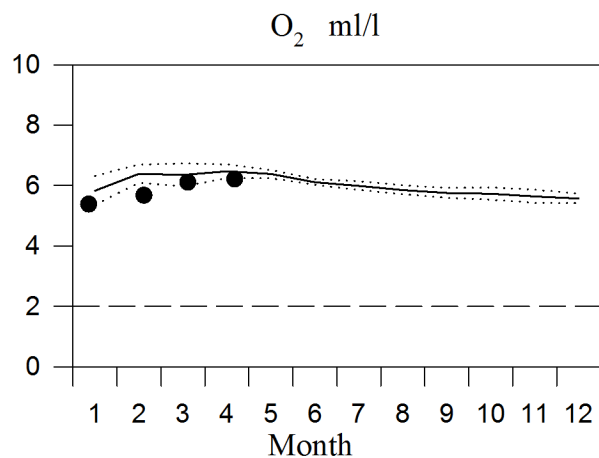
STATION Å17 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2016



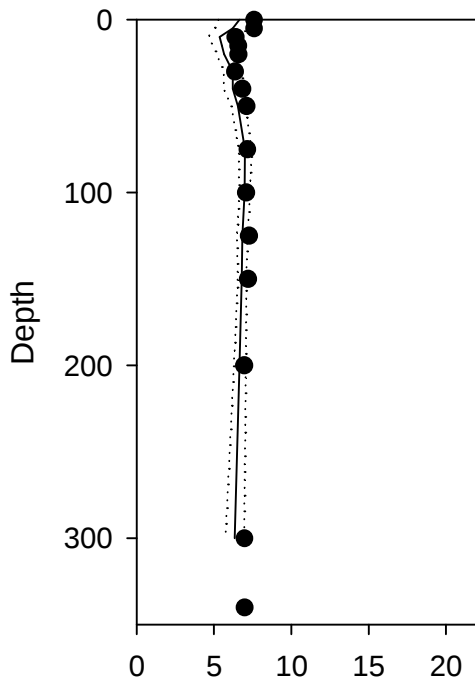
OXYGEN IN BOTTOM WATER (depth = 300m)



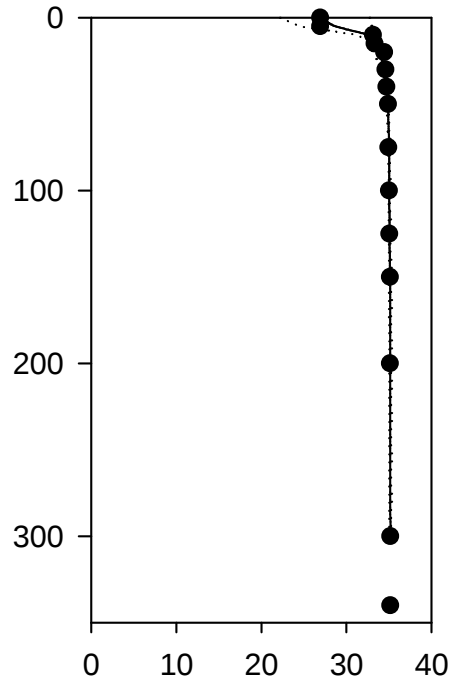
Vertical profiles Å17 April

— Mean 1996-2010 St.Dev. ● 2016

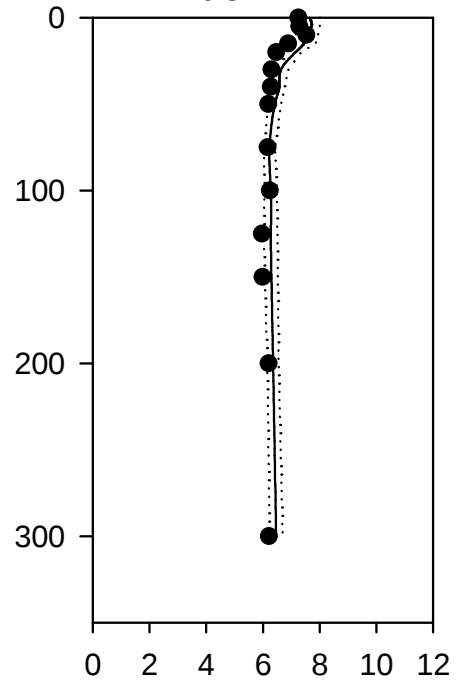
Temperature °C



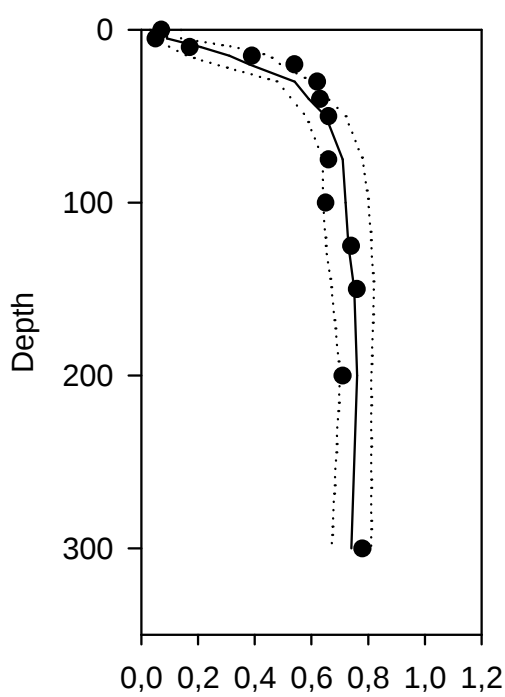
Salinity psu



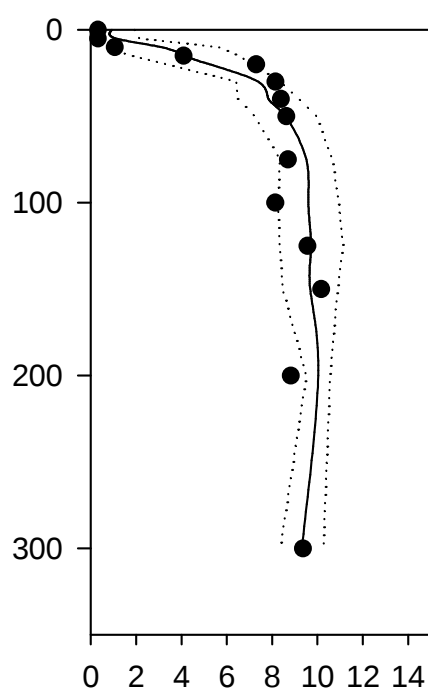
Oxygen ml/l



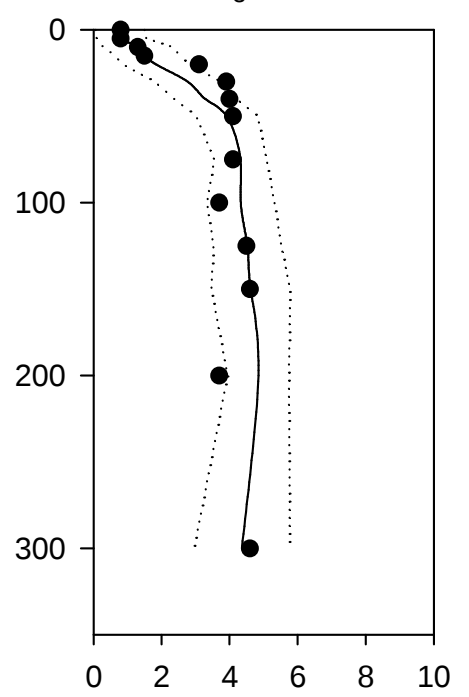
PO₄ µmol/l



DIN µmol/l



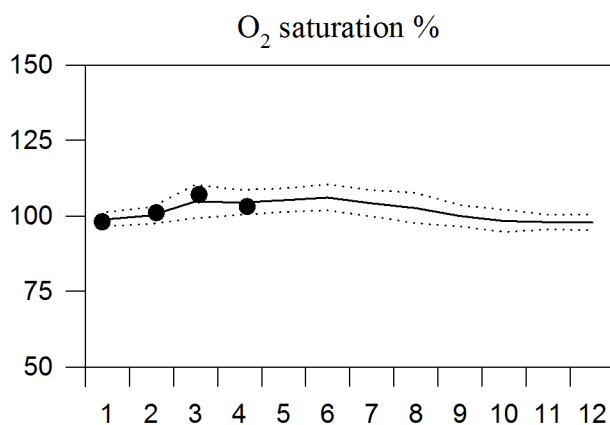
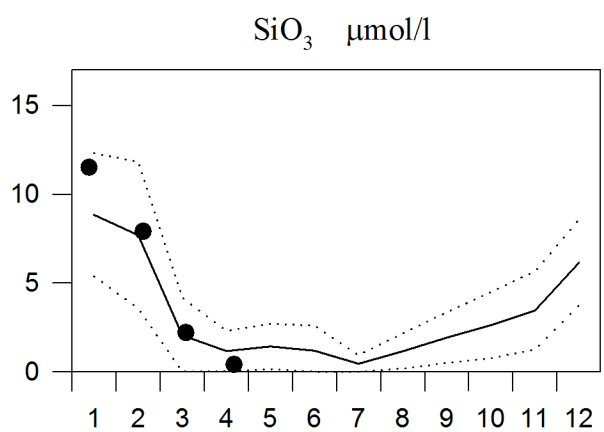
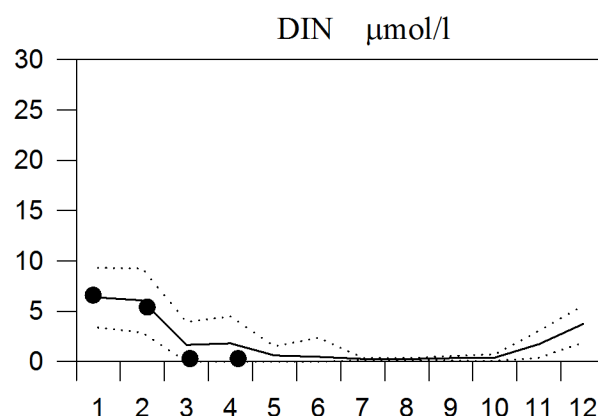
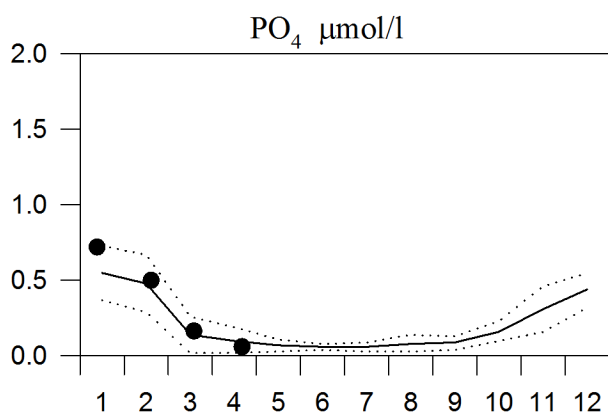
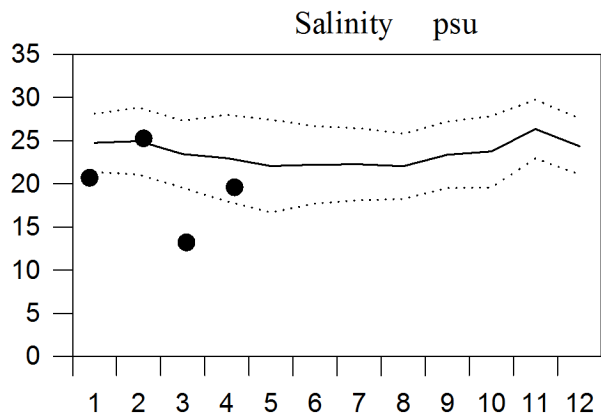
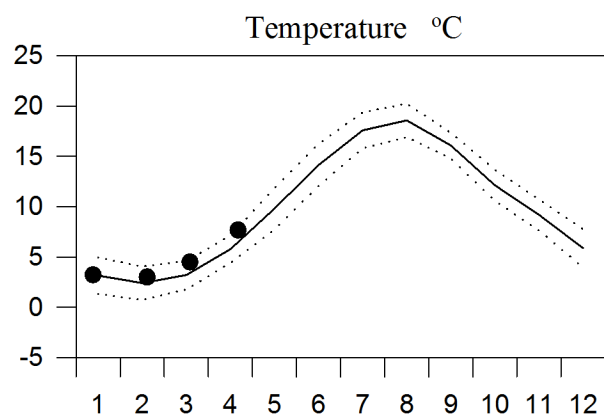
SiO₃ µmol/l



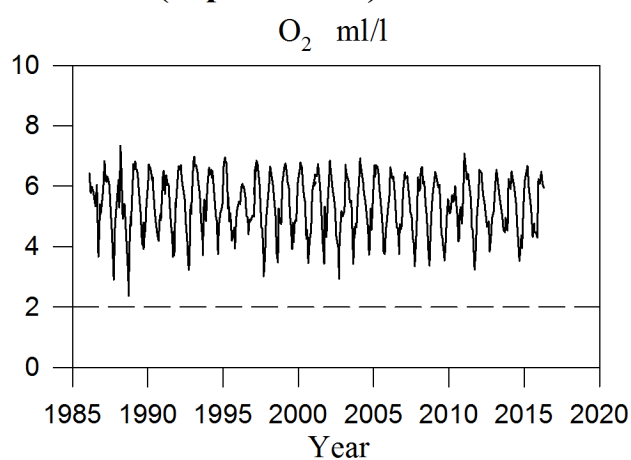
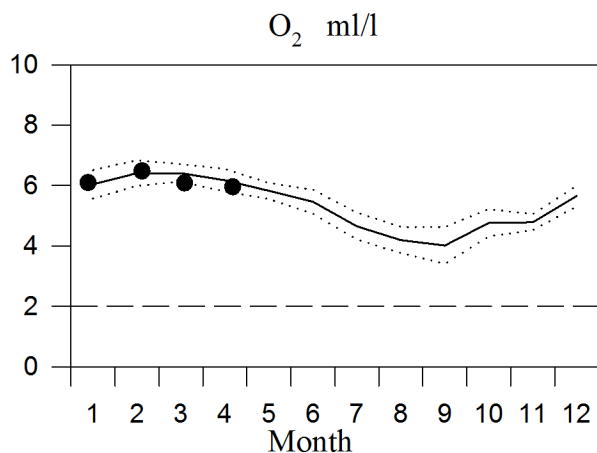
STATION FLADEN SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2016

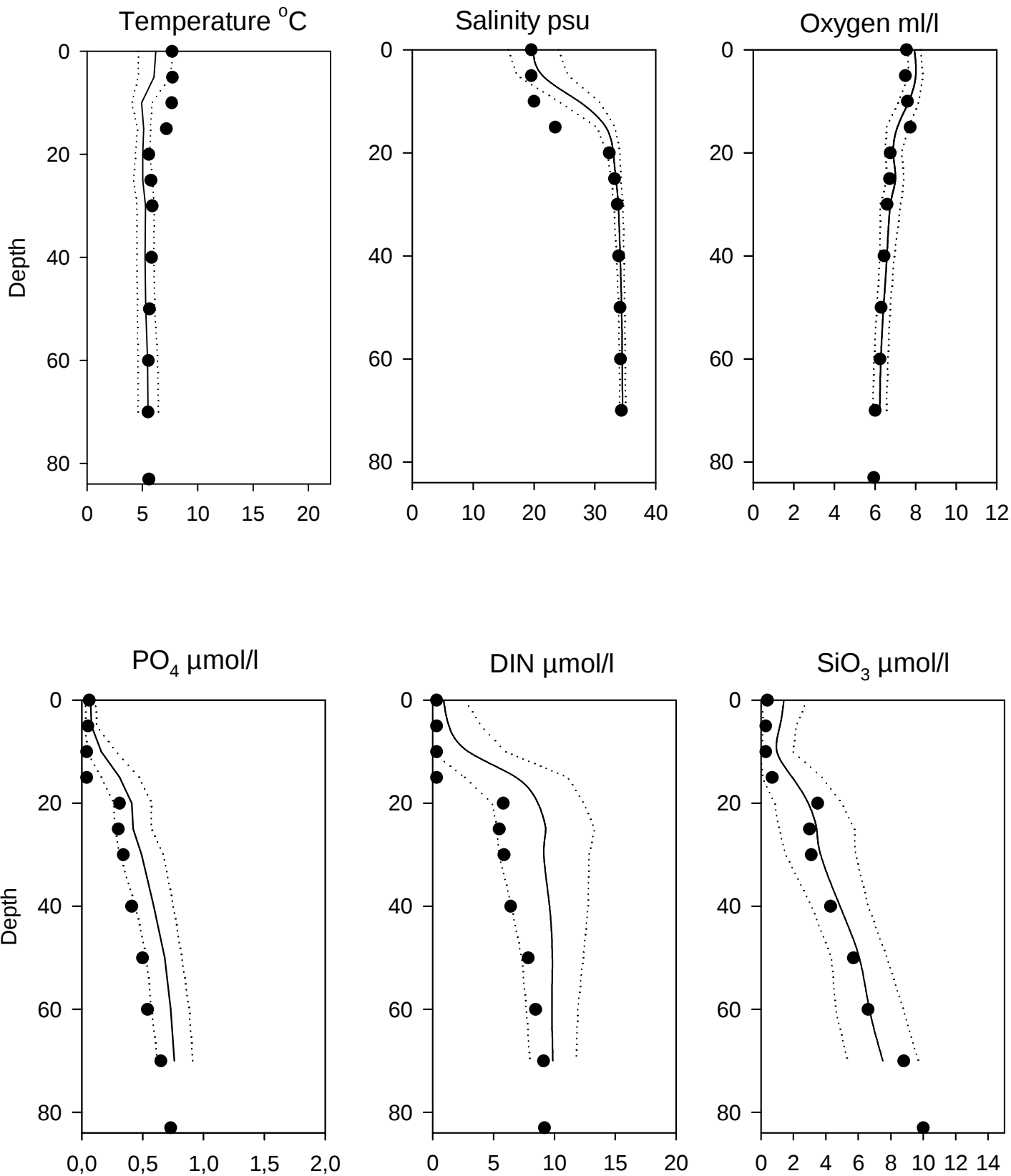


OXYGEN IN BOTTOM WATER (depth > 70m)



Vertical profiles Fladen April

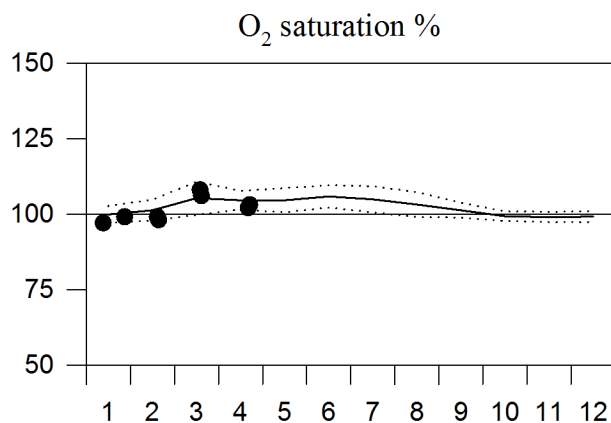
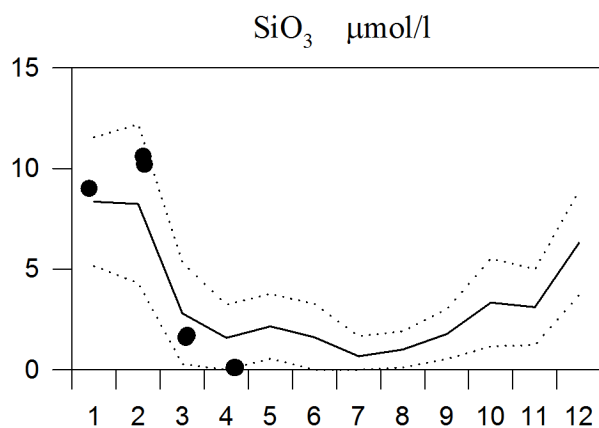
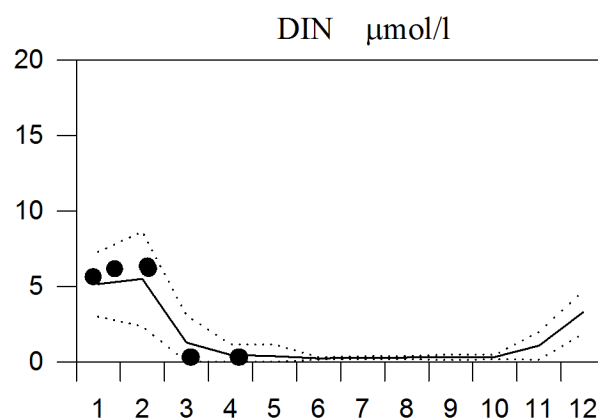
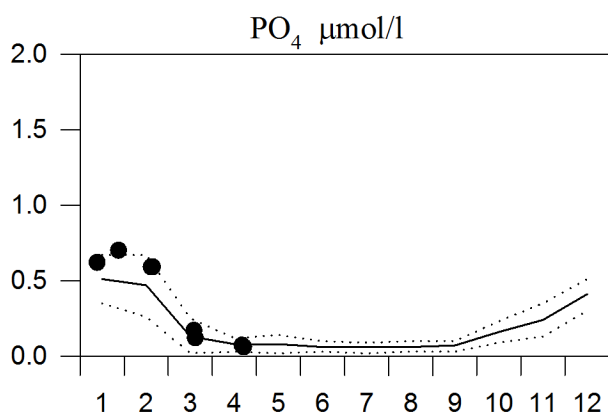
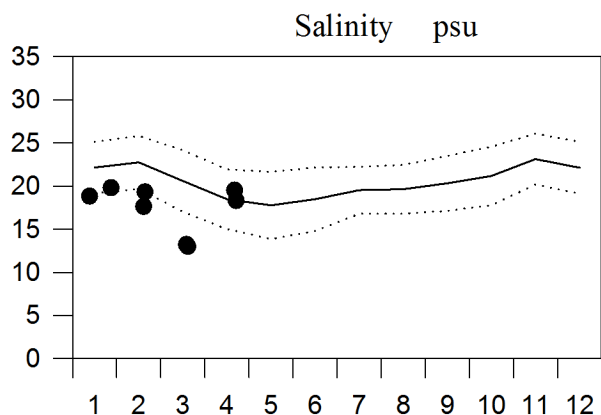
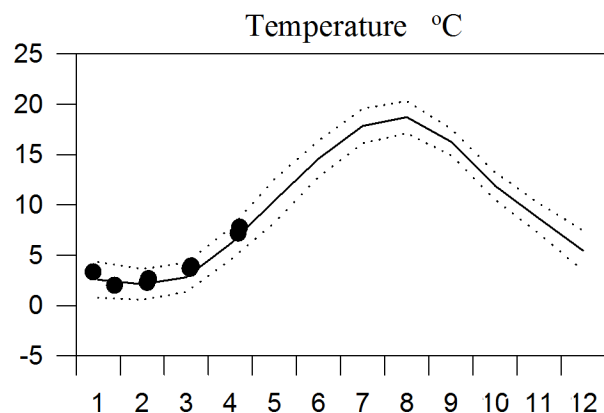
— Mean 1996-2010 St.Dev. ● 2016



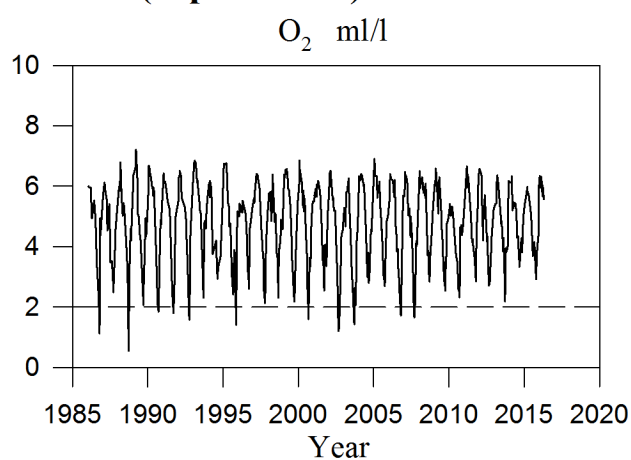
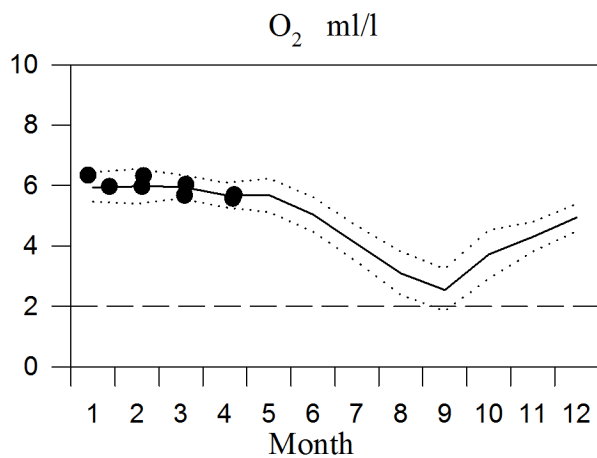
STATION ANHOLT E SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2016

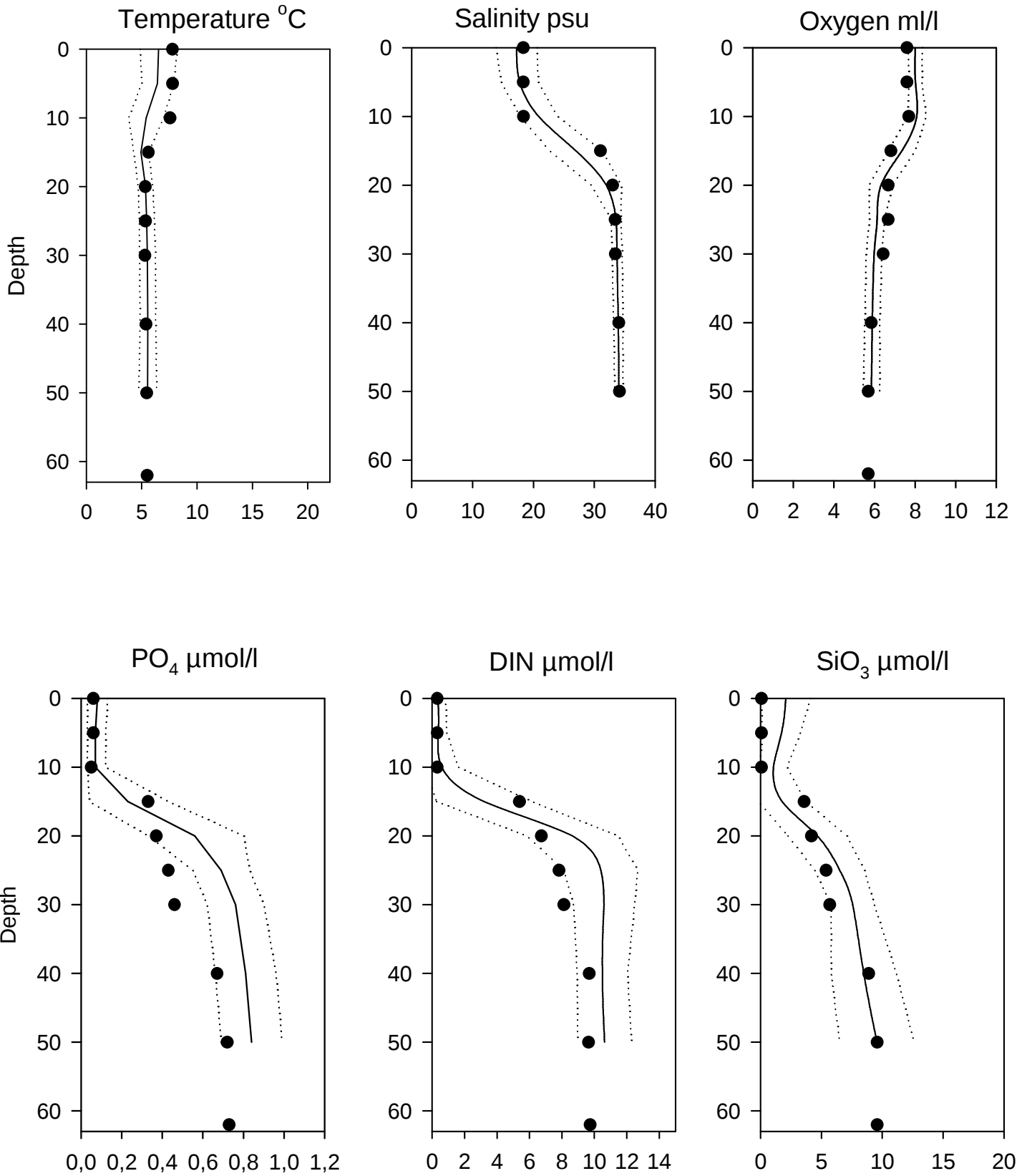


OXYGEN IN BOTTOM WATER (depth > 50m)



Vertical profiles Anholt E April

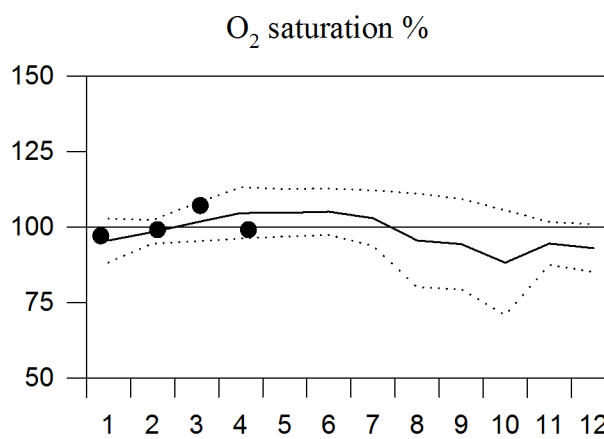
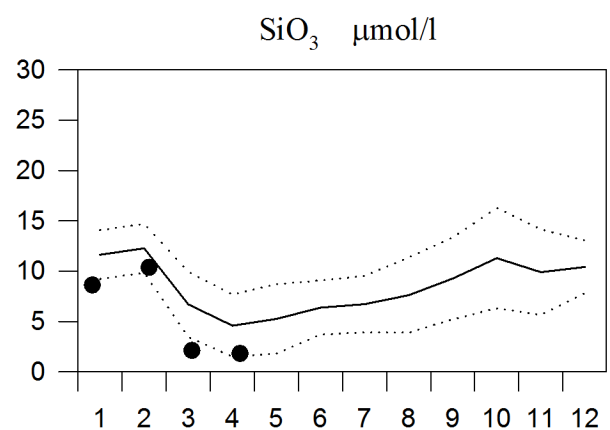
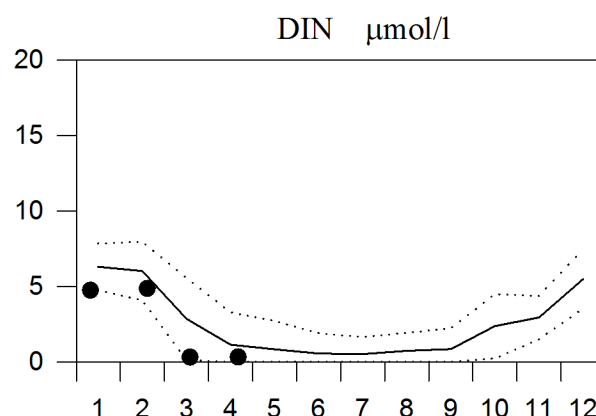
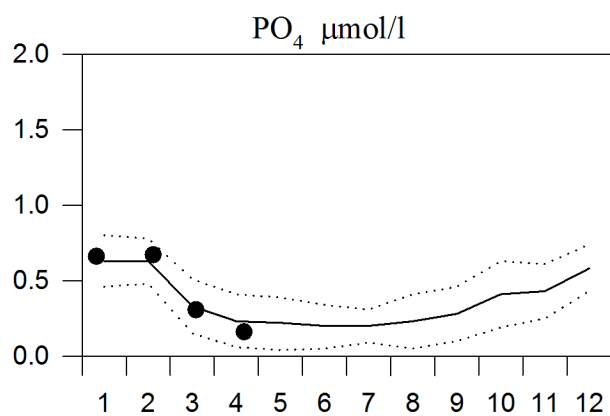
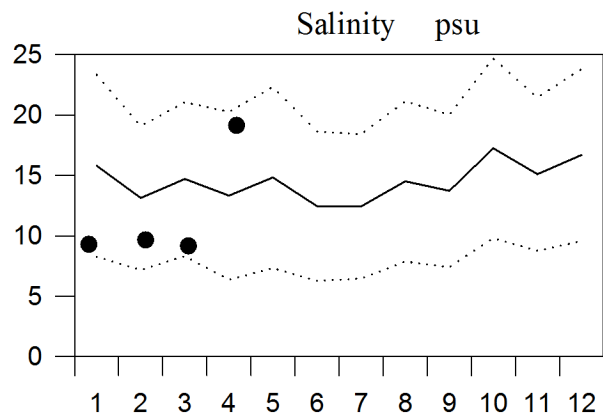
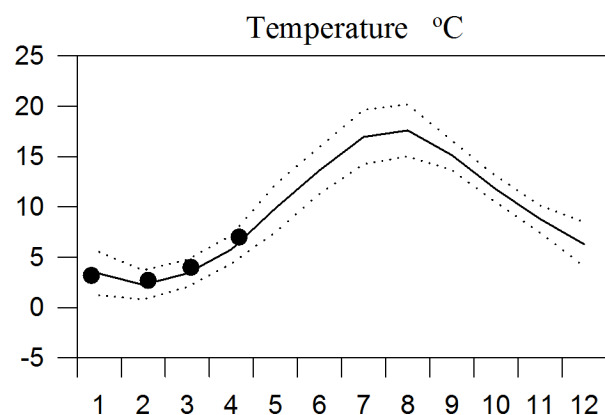
— Mean 1996-2010 St.Dev. ● 2016



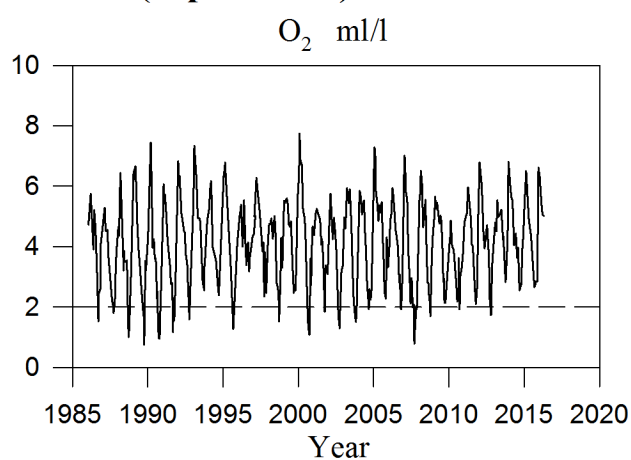
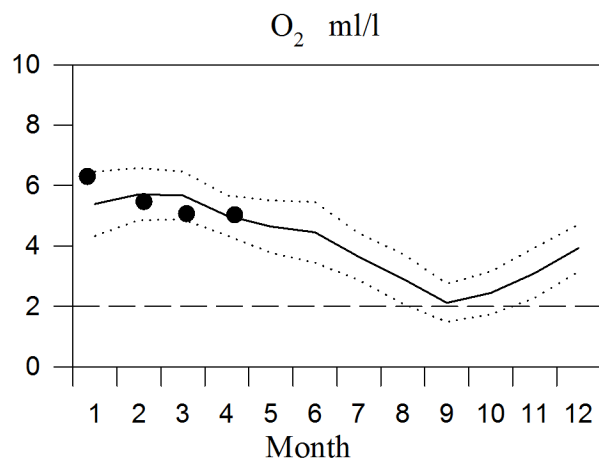
STATION W LANDSKRONA SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2016

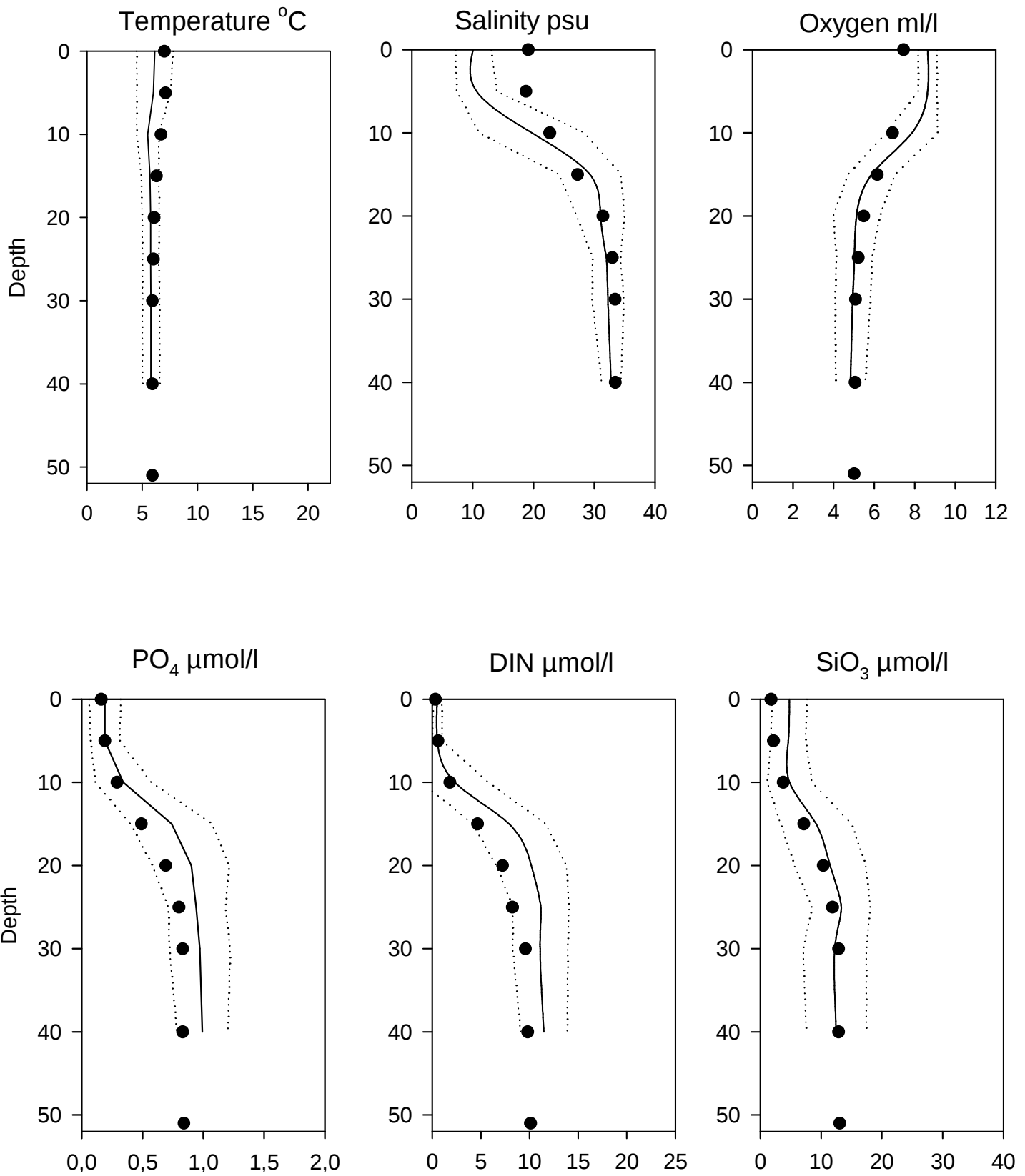


OXYGEN IN BOTTOM WATER (depth >40m)



Vertical profiles W Landskrona April

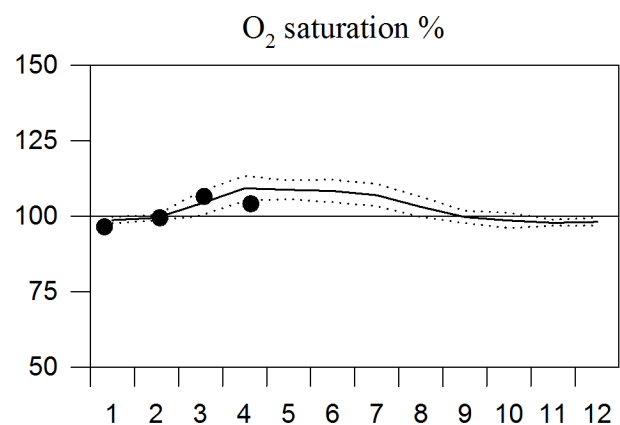
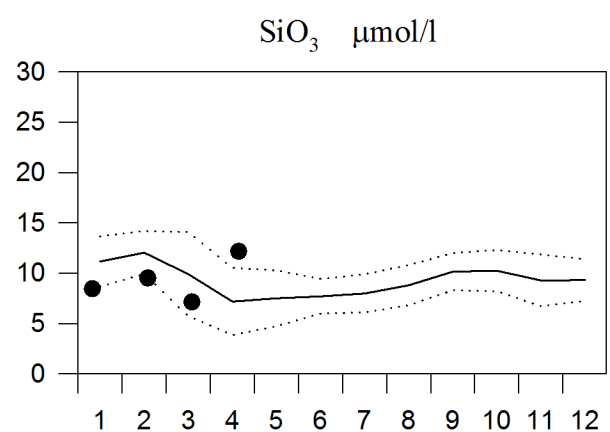
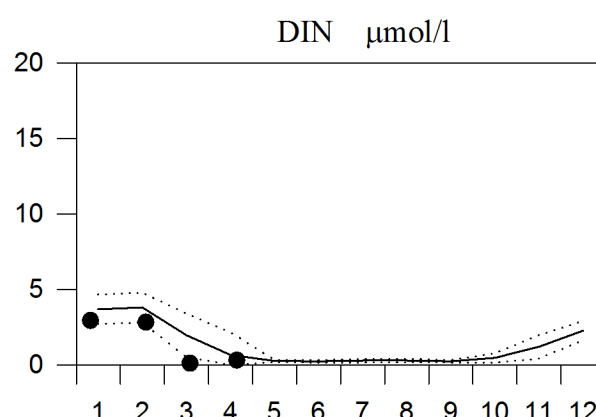
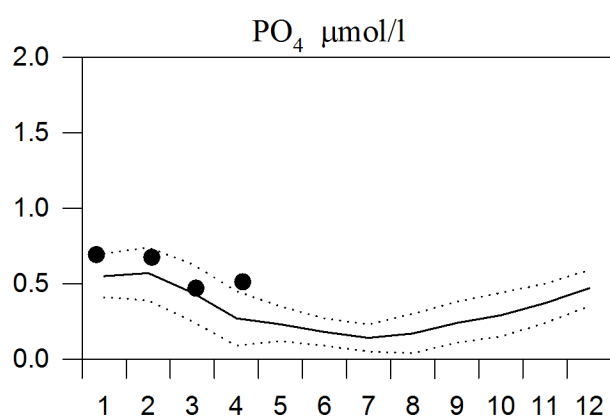
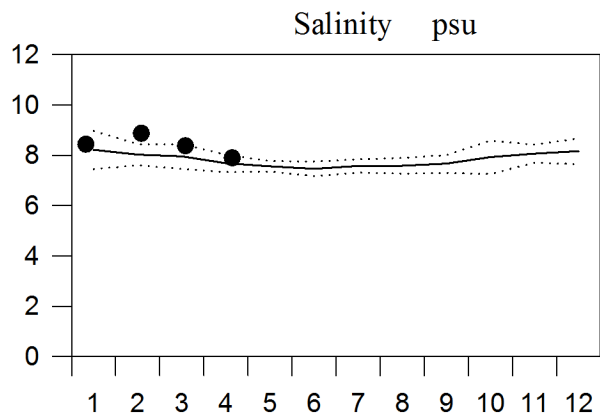
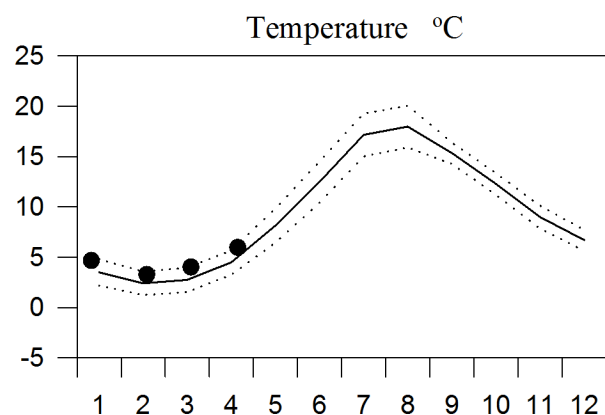
— Mean 1996-2010 St.Dev. ● 2016



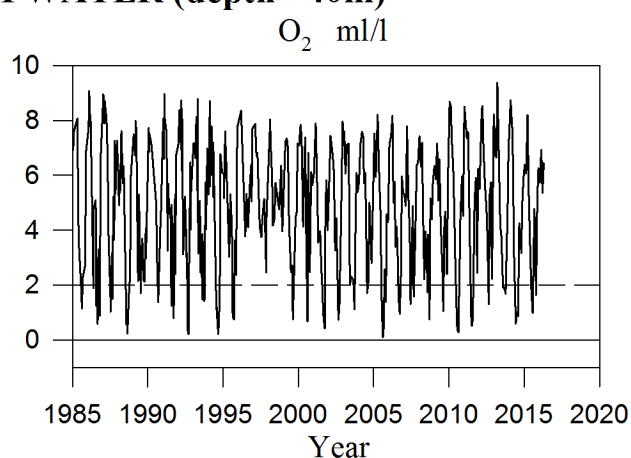
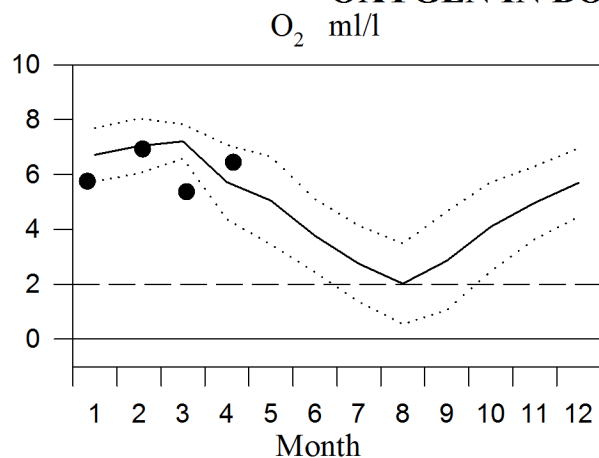
STATION BY1 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2016

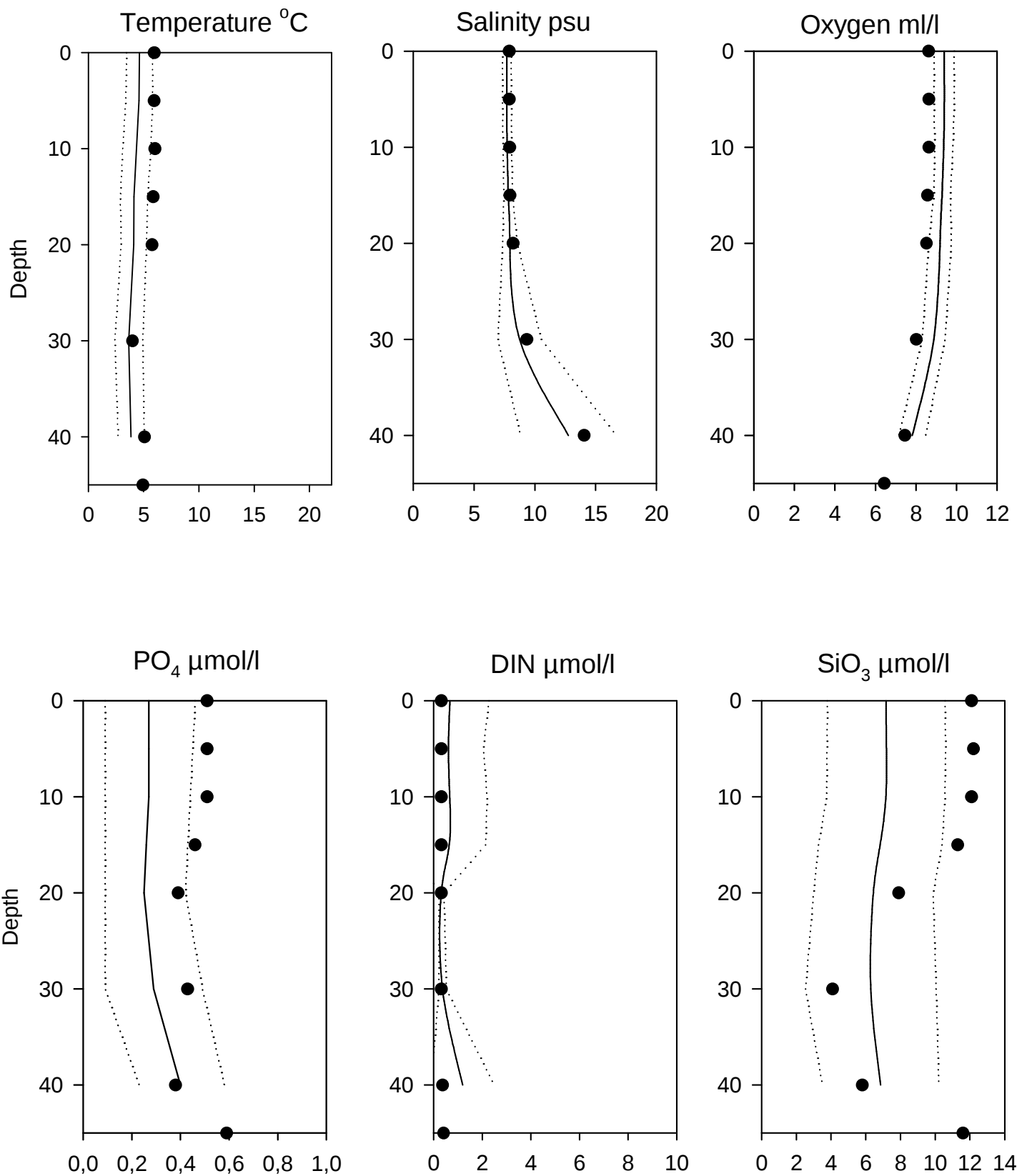


OXYGEN IN BOTTOM WATER (depth >40m)



Vertical profiles BY1 April

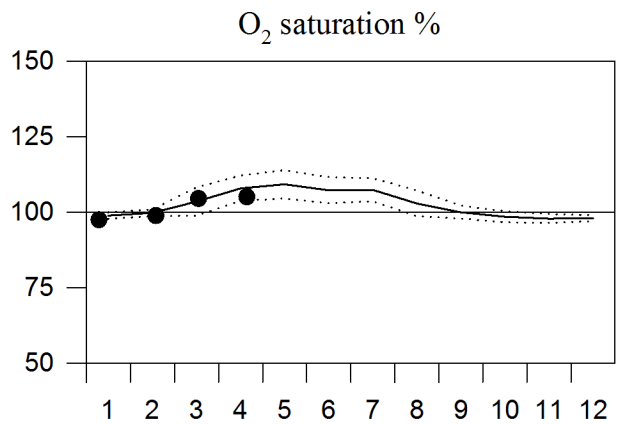
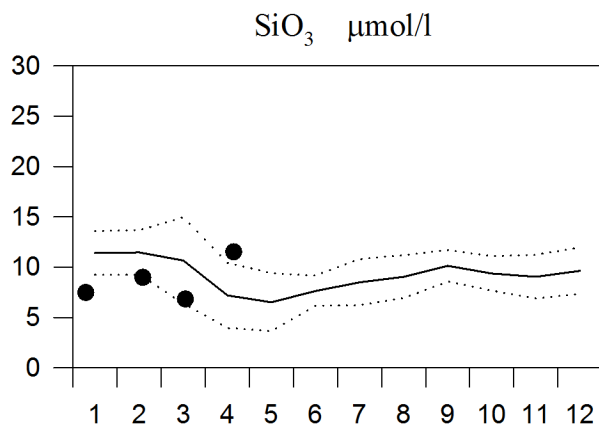
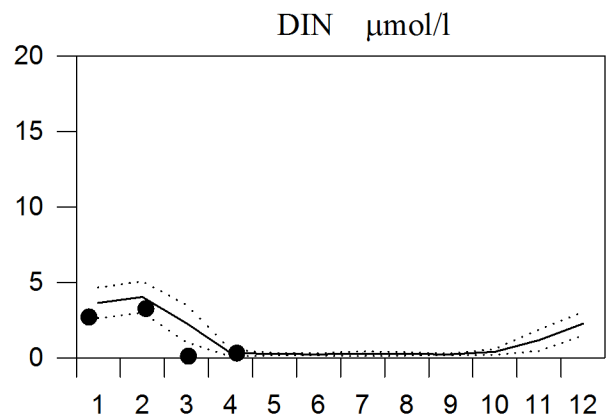
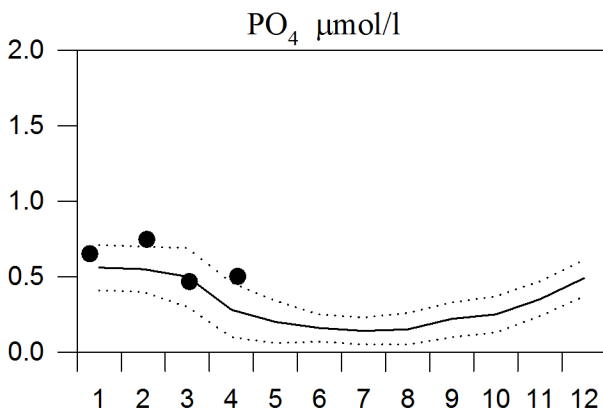
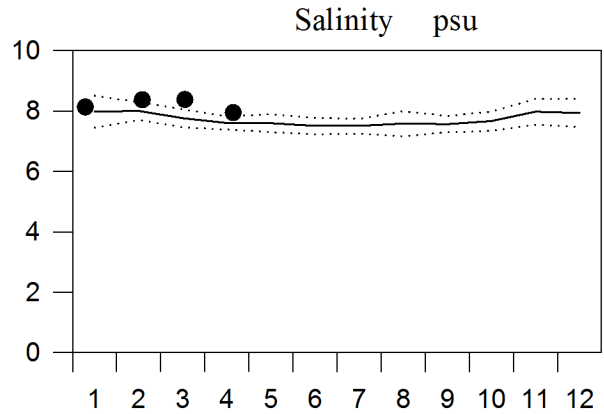
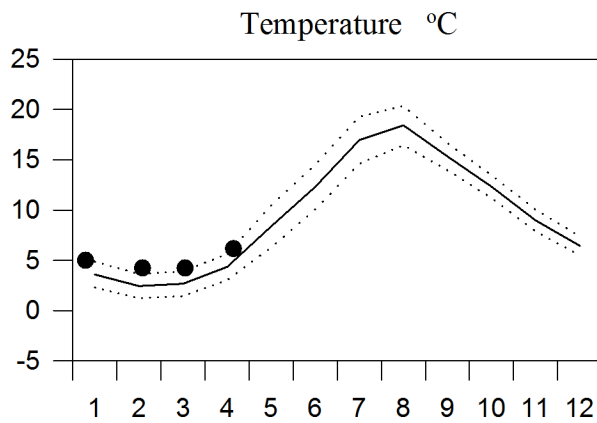
— Mean 1996-2010 St.Dev. ● 2016



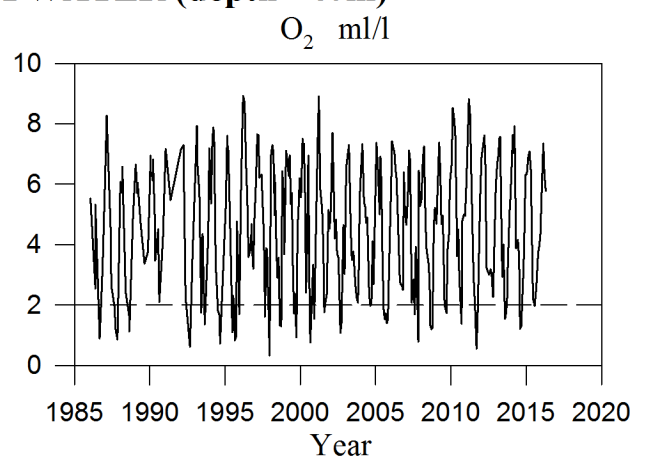
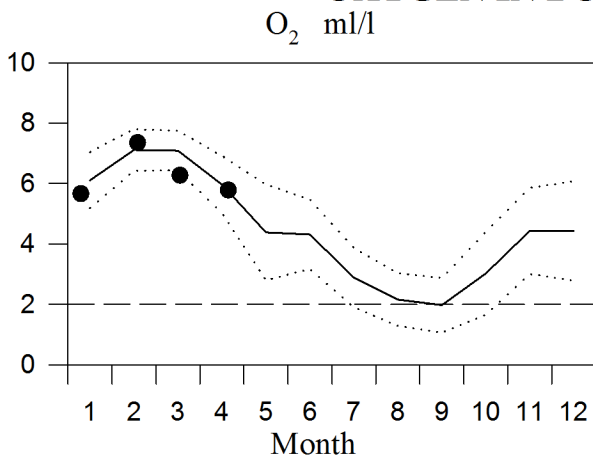
STATION BY2 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2016

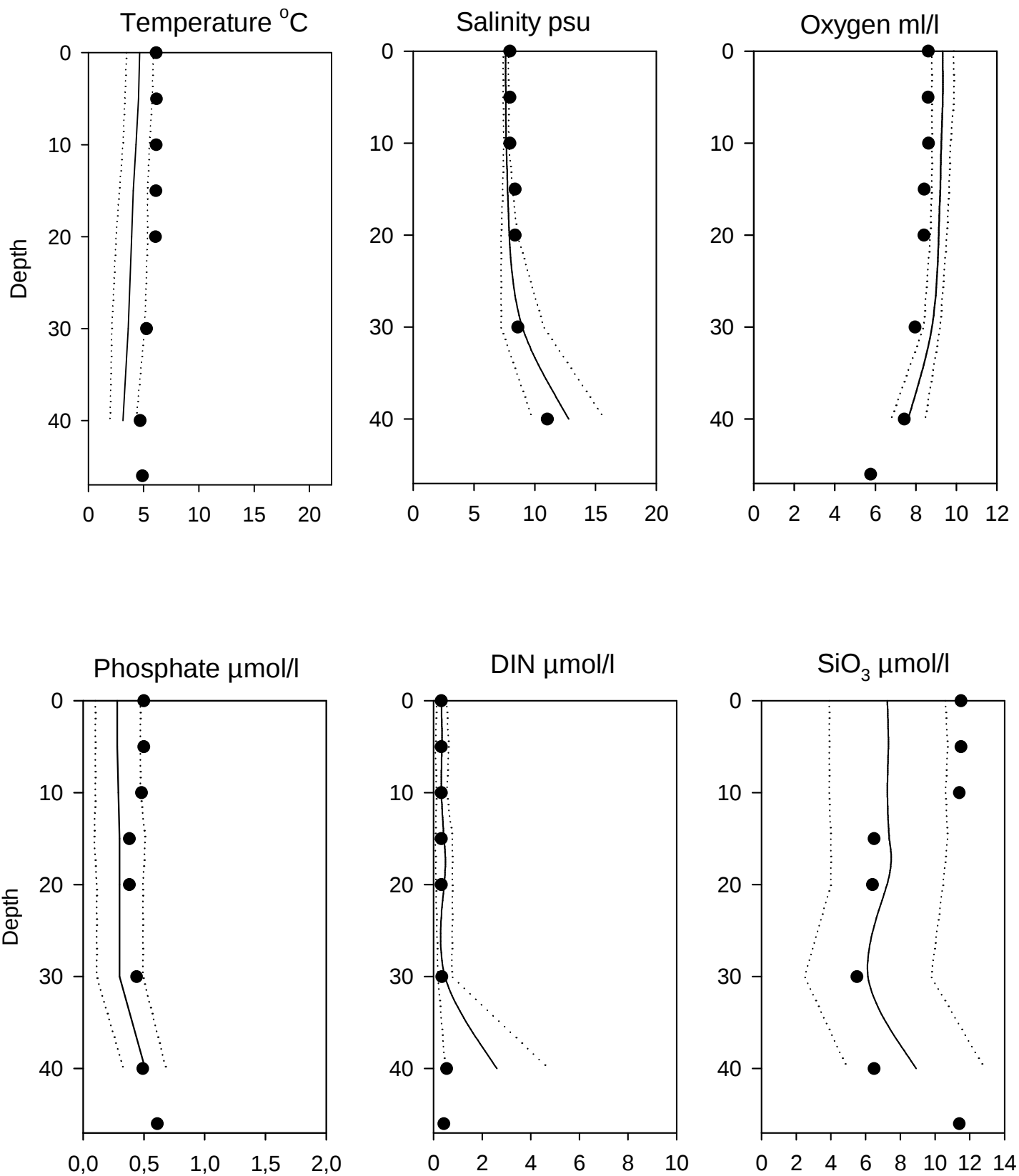


OXYGEN IN BOTTOM WATER (depth >40m)



Vertical profiles BY2 April

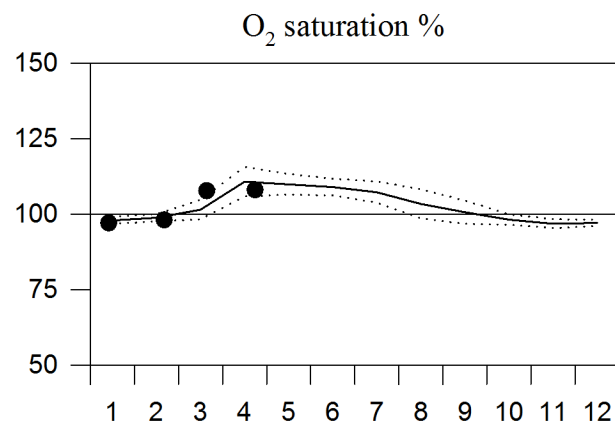
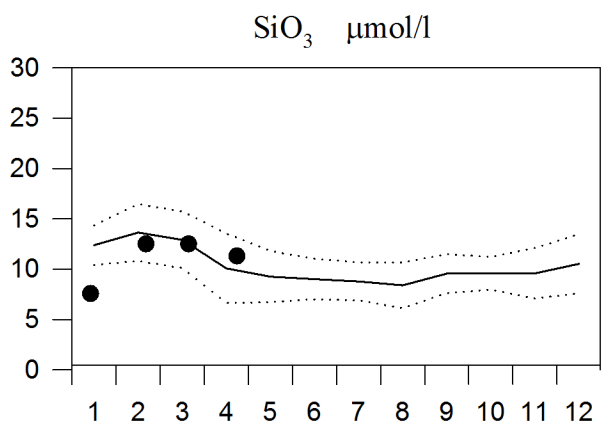
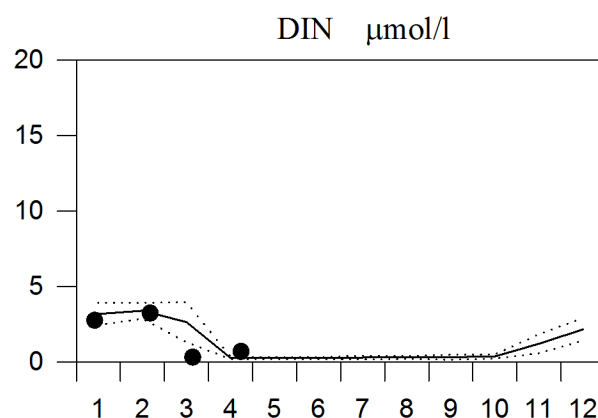
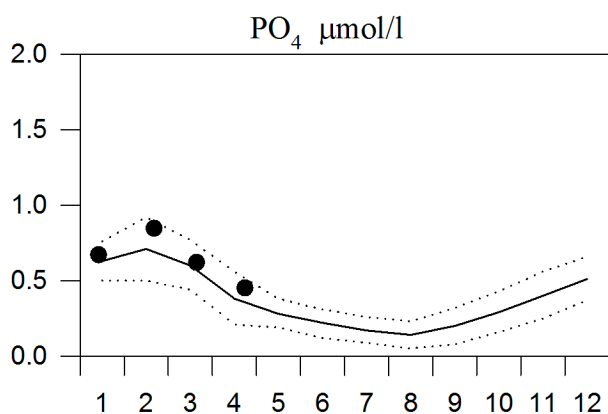
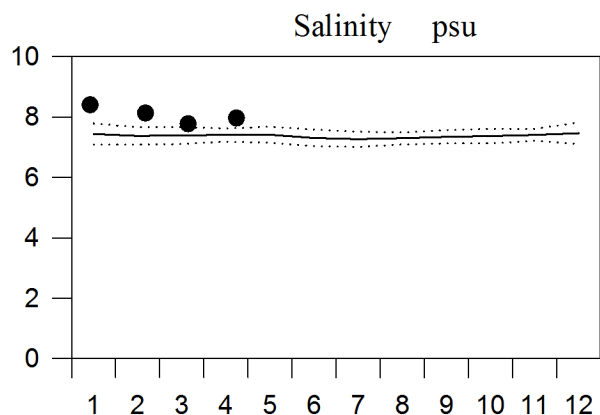
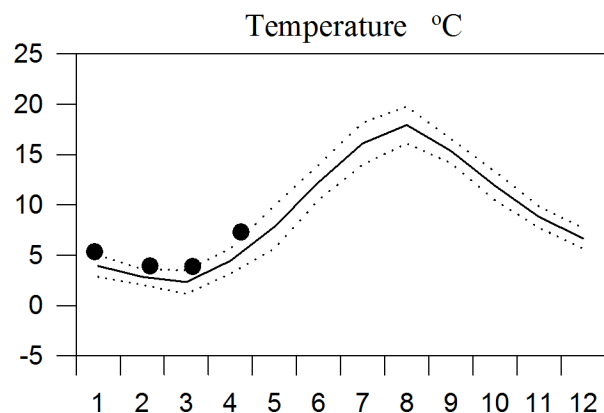
— Mean 1996-2010 St.Dev. ● 2016



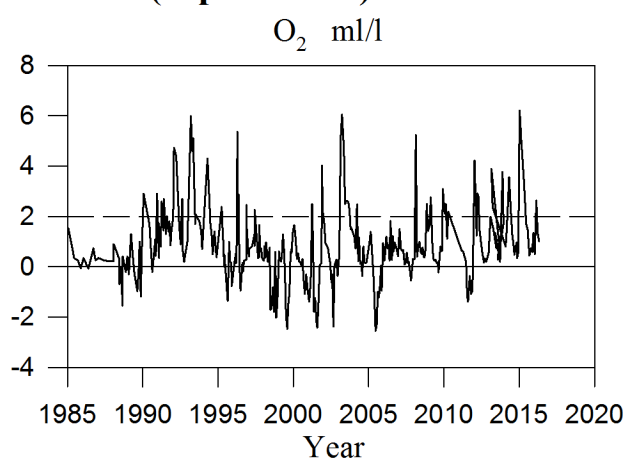
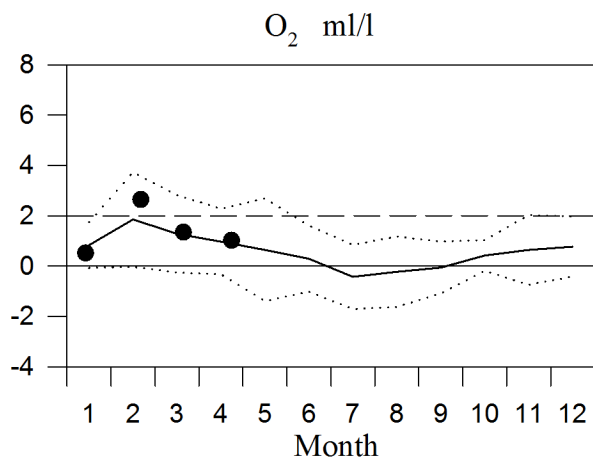
STATION HANÖBUKTEN SURFACE WATER

Annual Cycles

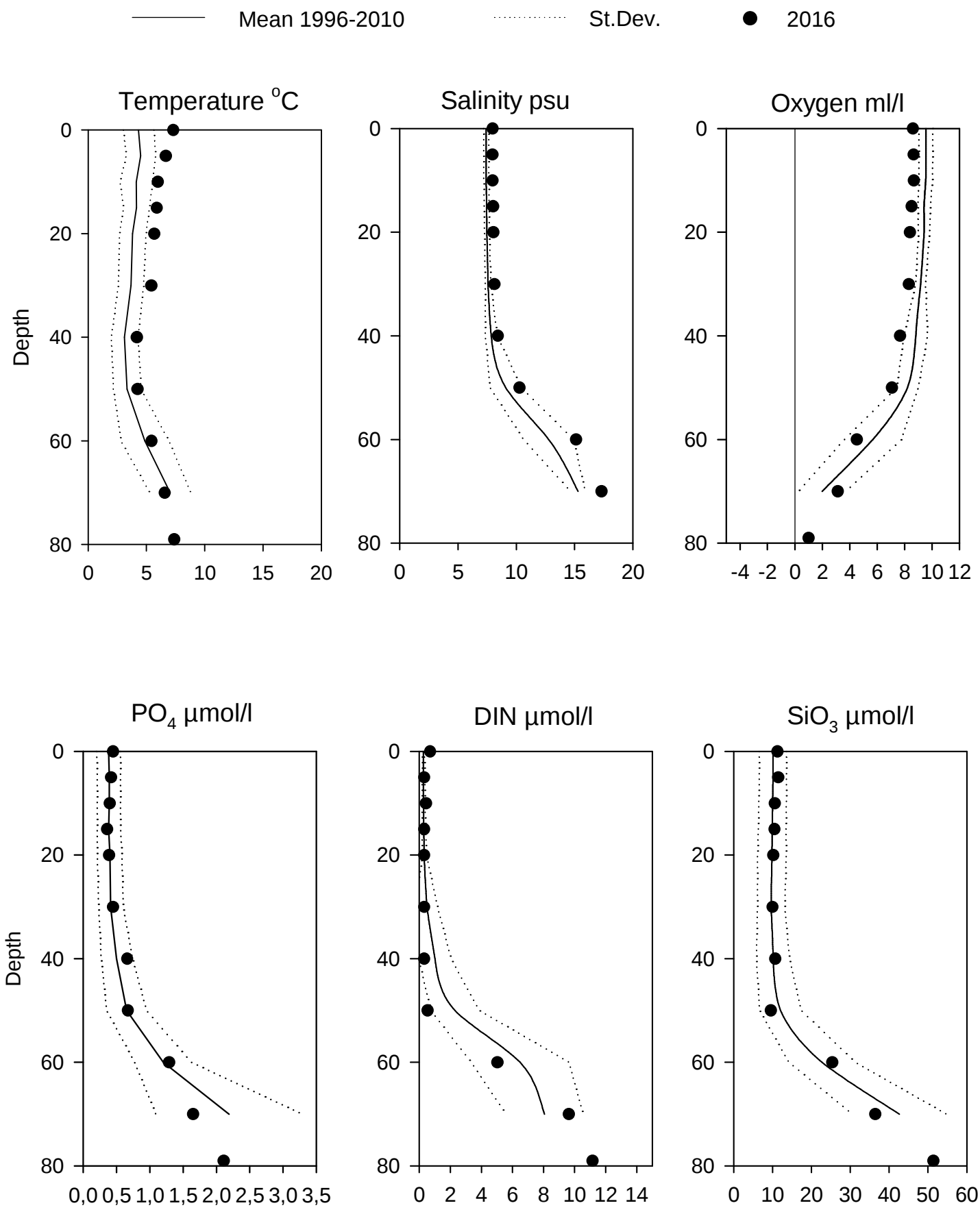
— Mean 1996-2010 St.Dev. ● 2016



OXYGEN IN BOTTOM WATER (depth > 70m)



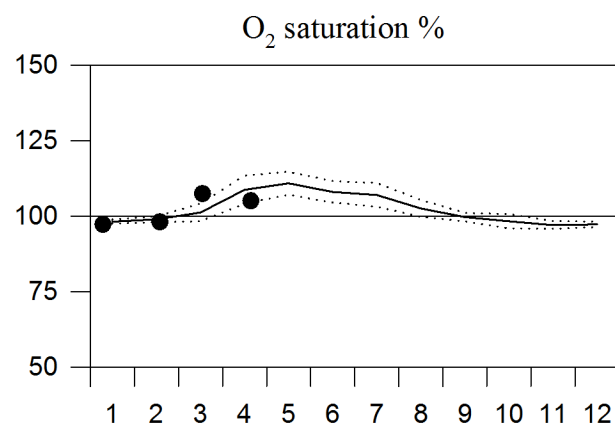
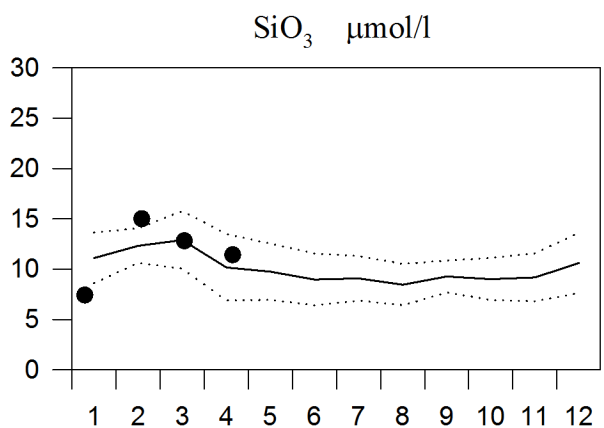
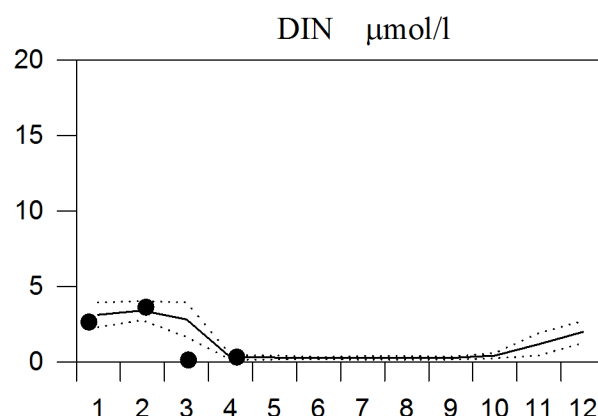
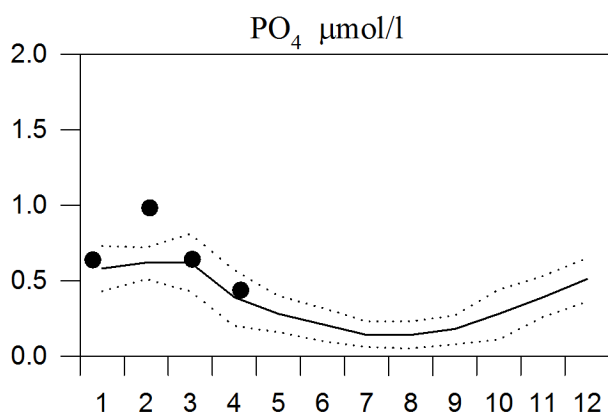
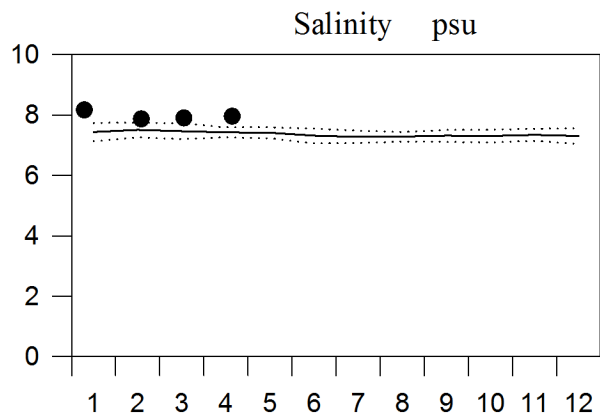
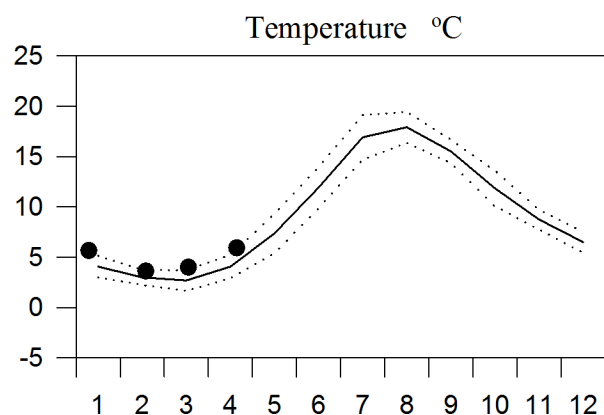
Vertical profiles Hanöbukten April



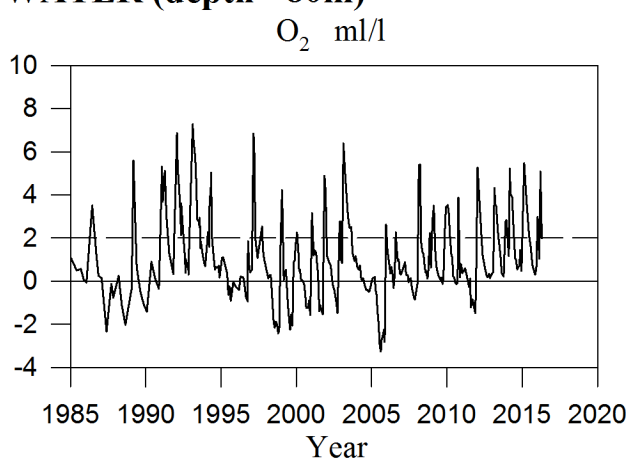
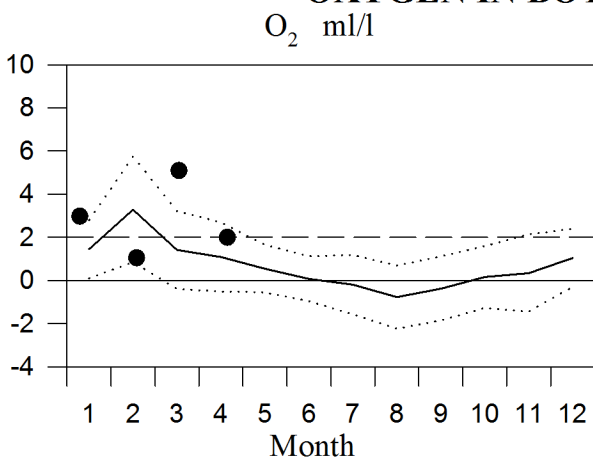
STATION BY4 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2016

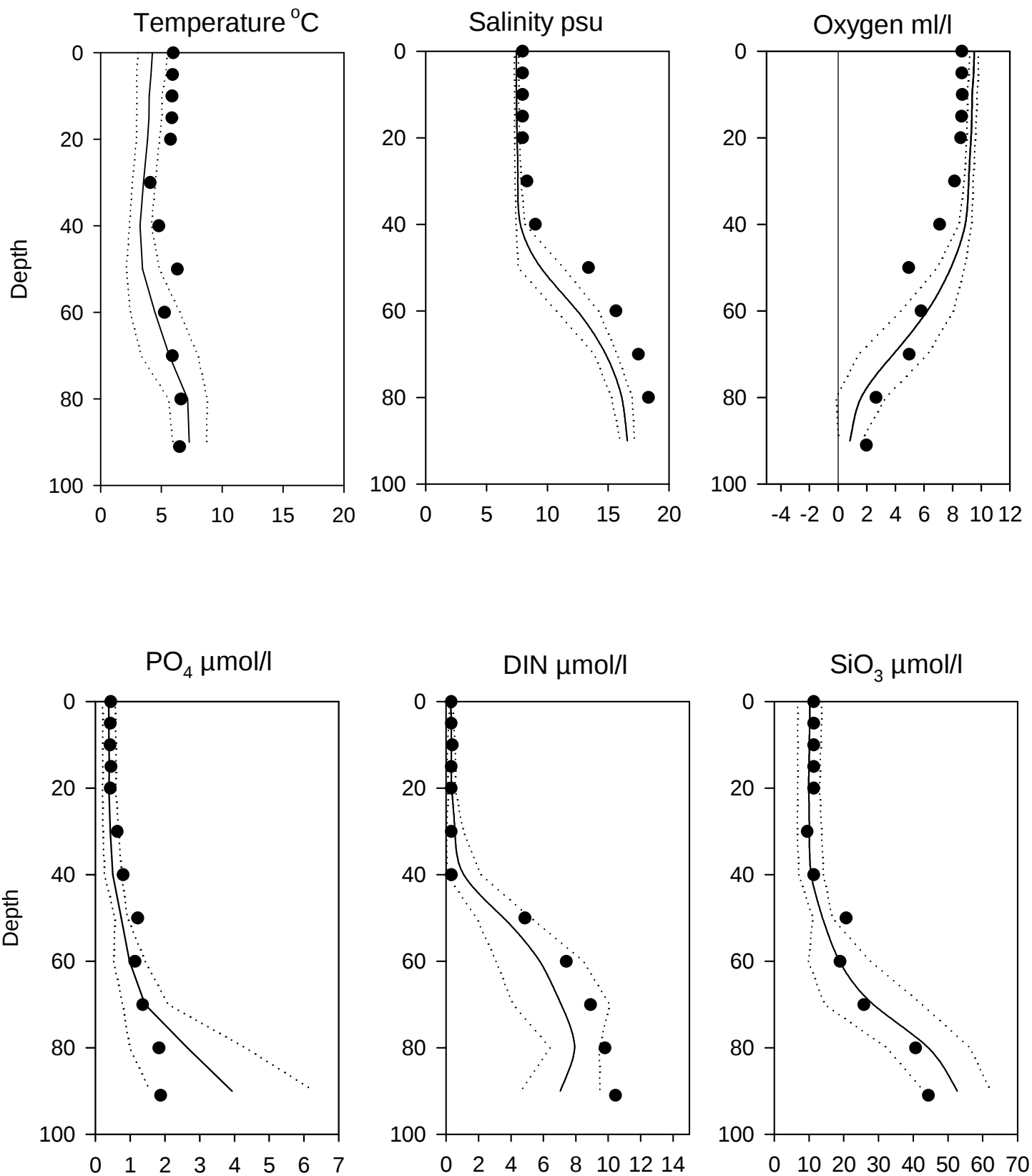


OXYGEN IN BOTTOM WATER (depth >80m)



Vertical profiles BY4 April

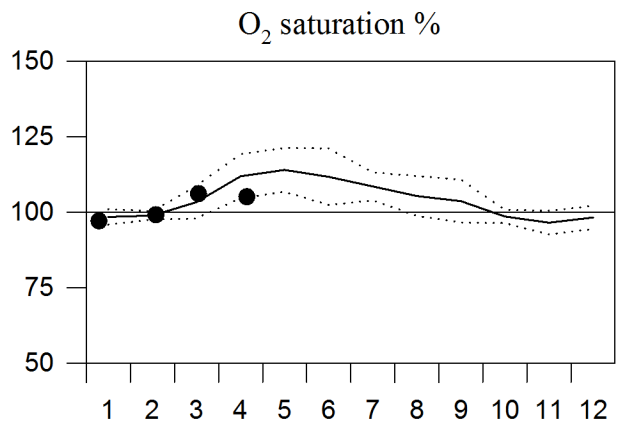
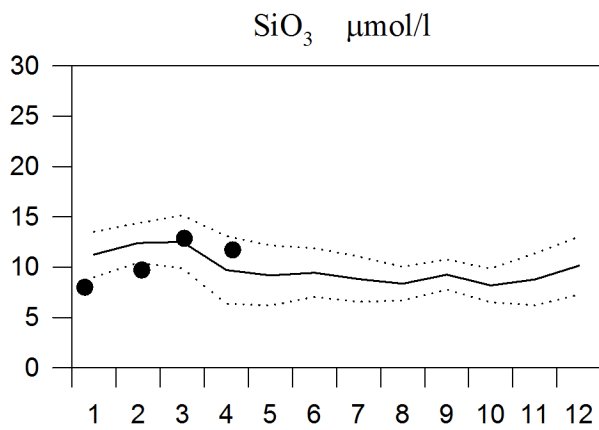
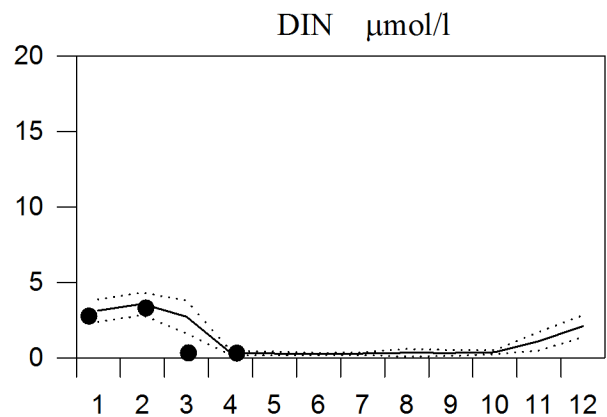
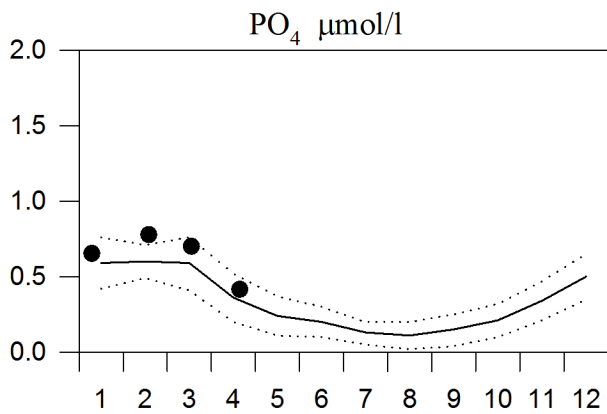
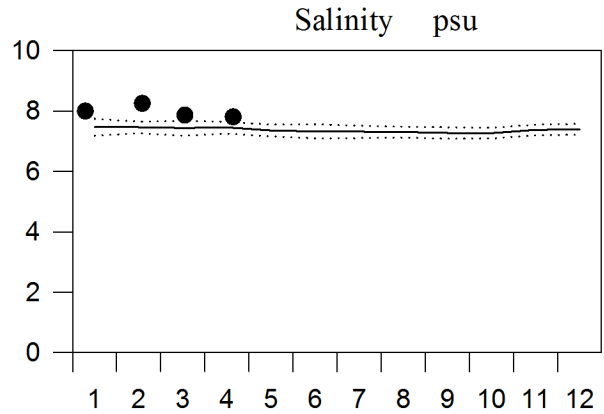
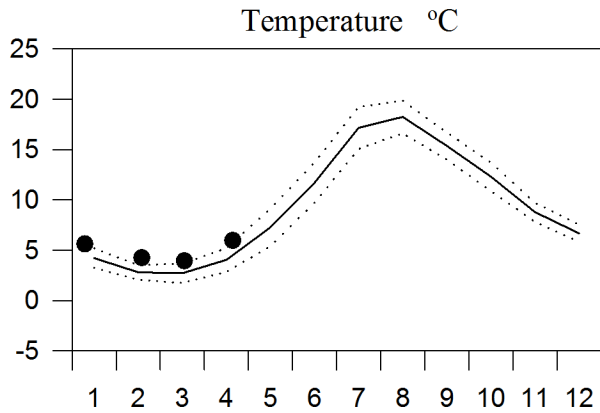
— Mean 1996-2010 St.Dev. ● 2016



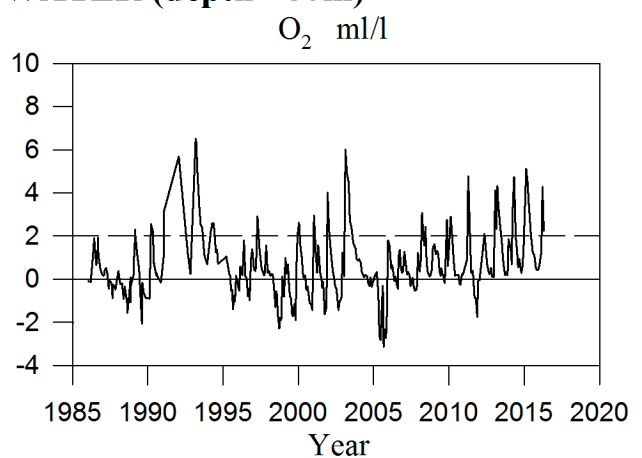
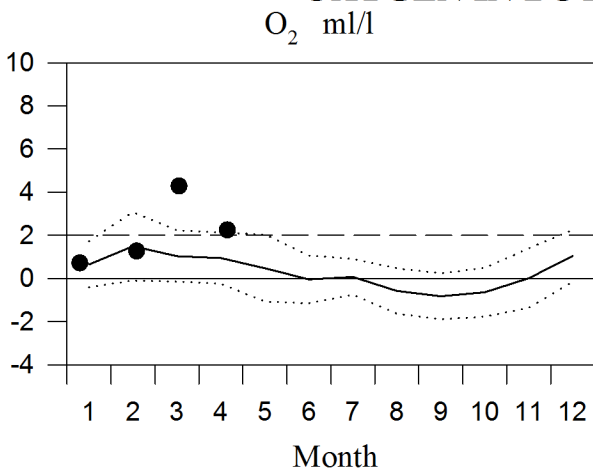
STATION BY5 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2016

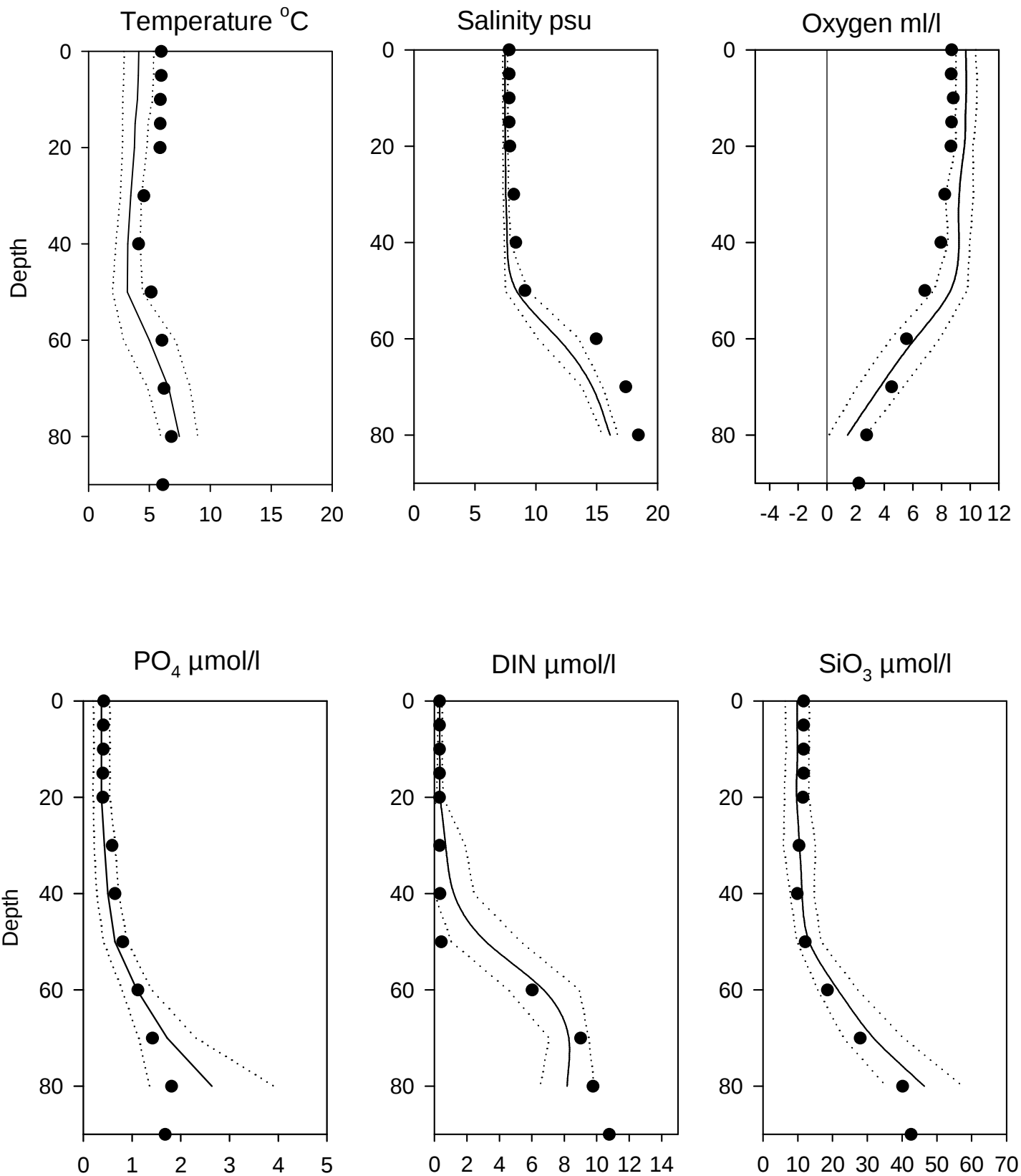


OXYGEN IN BOTTOM WATER (depth >80m)



Vertical profiles BY5 April

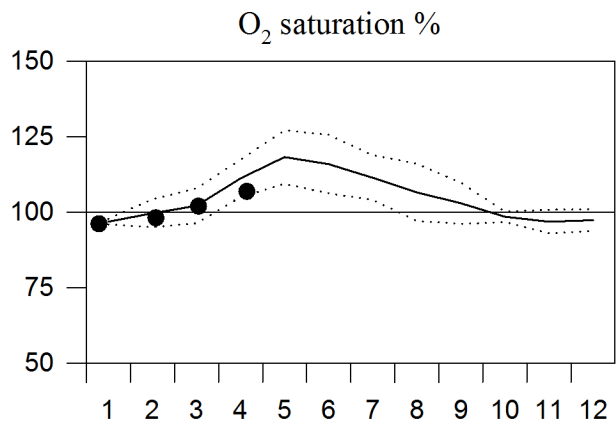
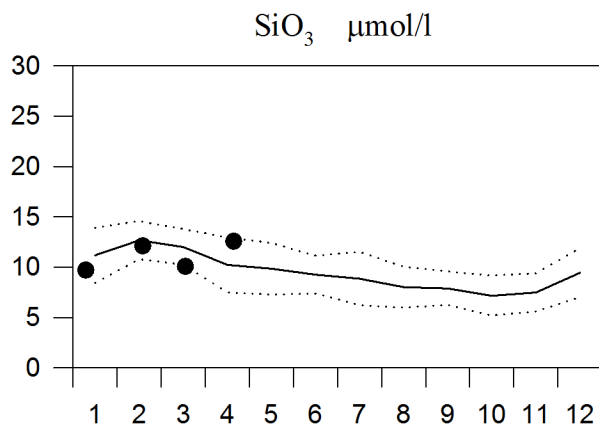
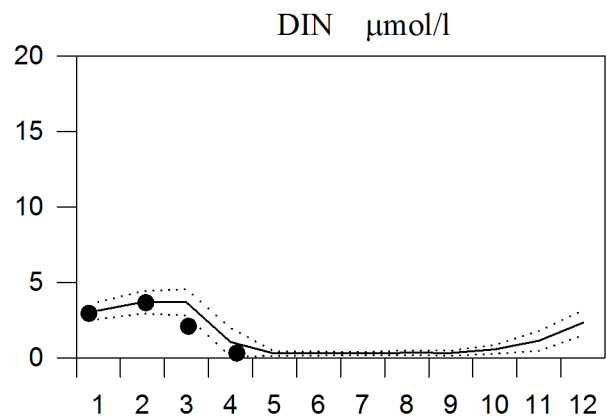
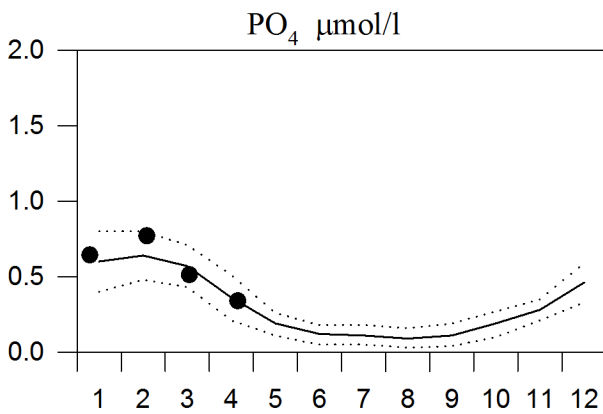
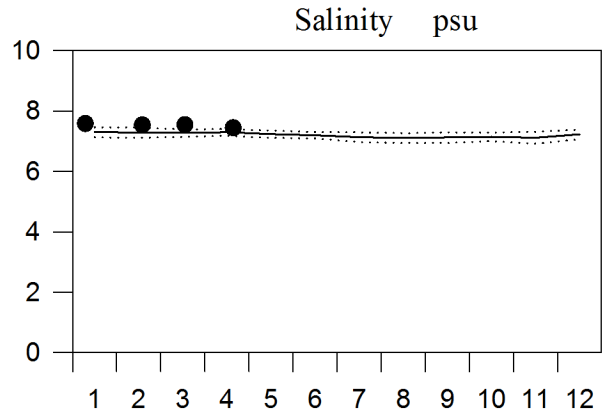
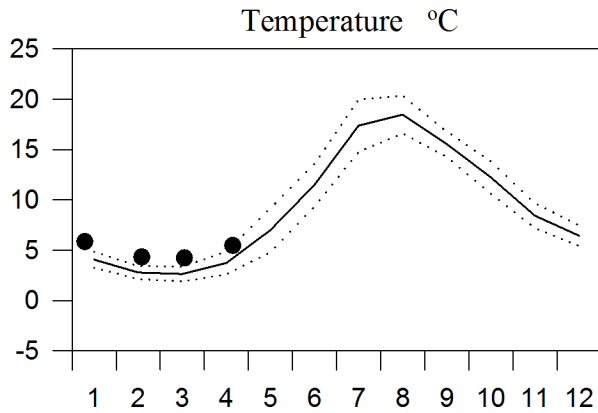
— Mean 1996-2010 St.Dev. ● 2016



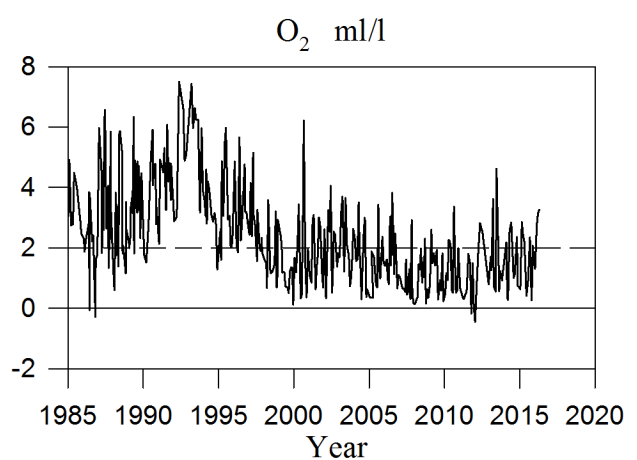
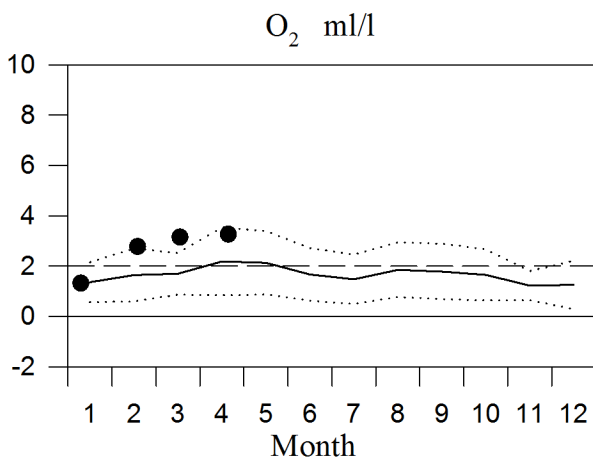
STATION BCS III-10 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2016

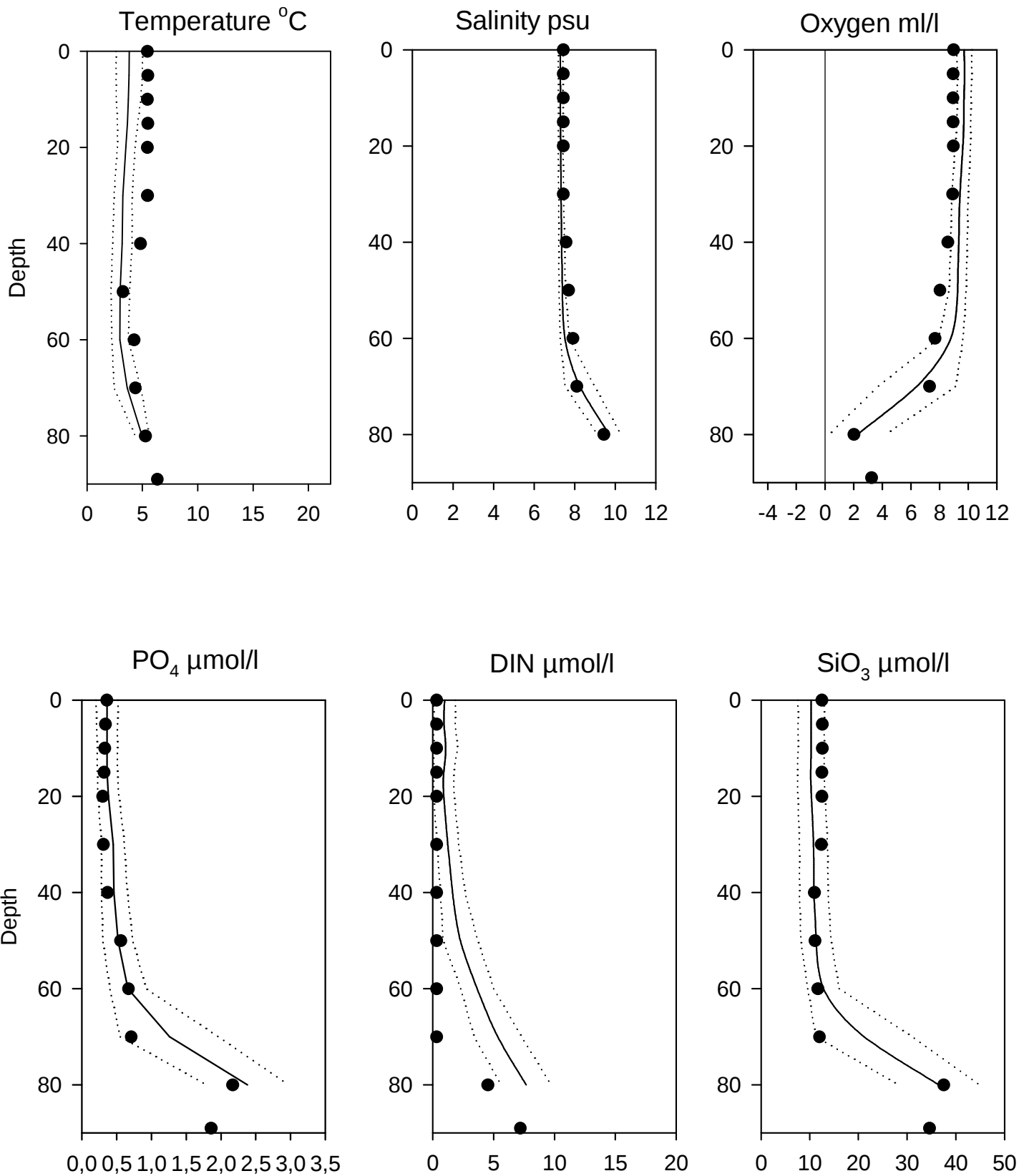


OXYGEN IN BOTTOM WATER (depth > 80m)



Vertical profiles BCS III-10 April

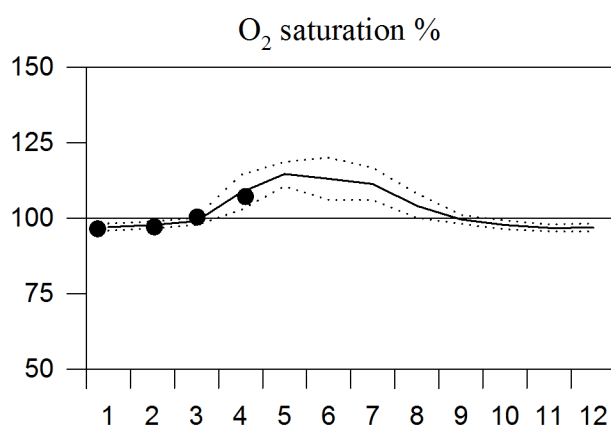
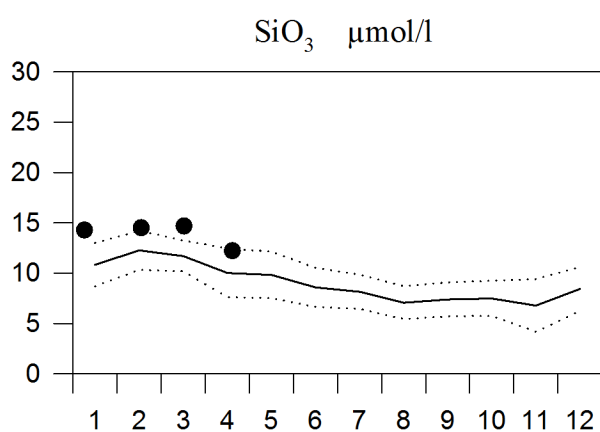
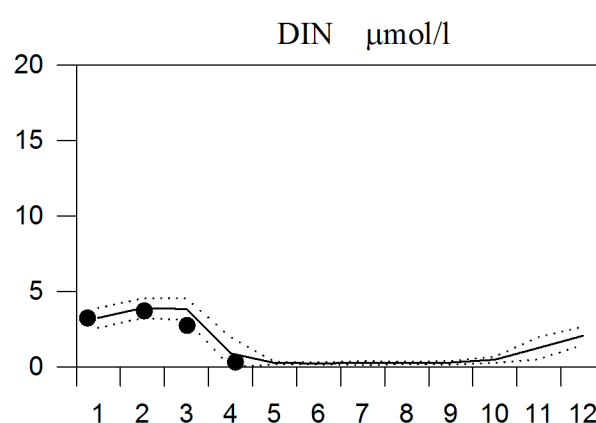
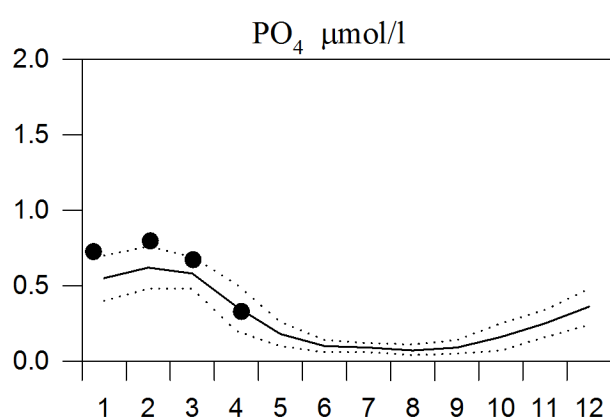
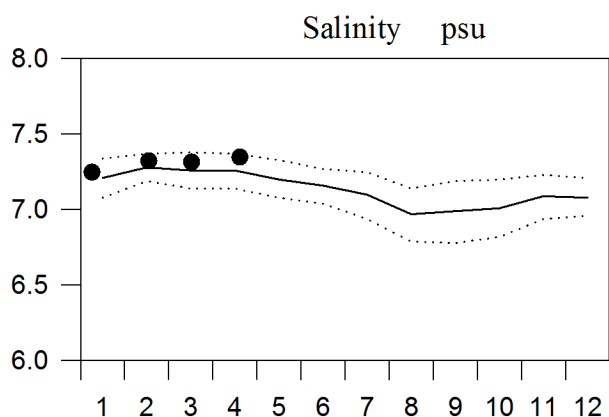
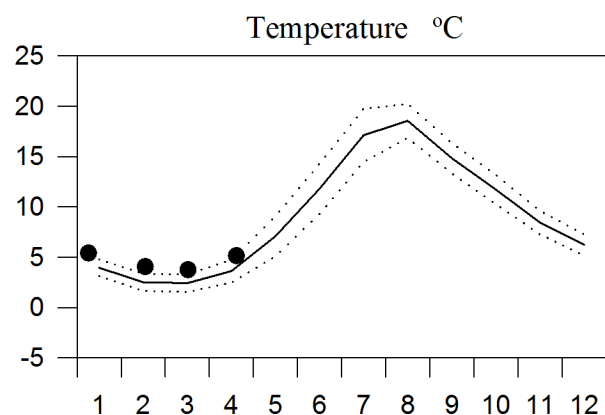
— Mean 1996-2010 St.Dev. ● 2016



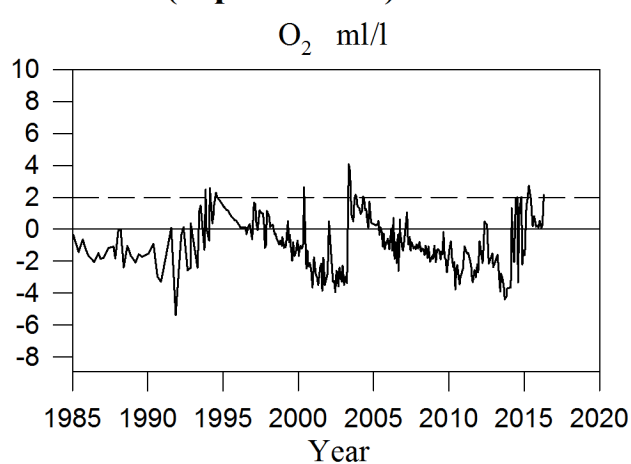
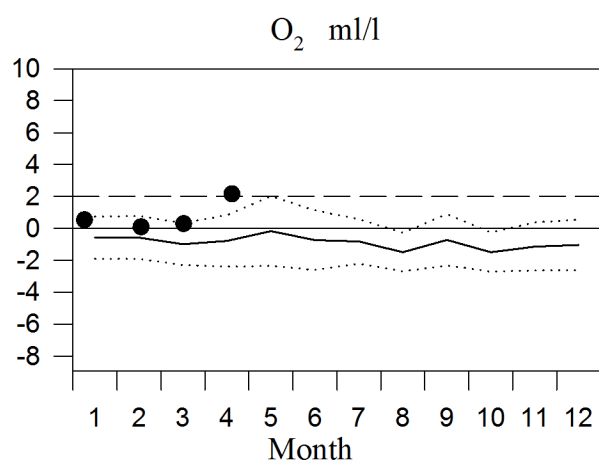
STATION BY10 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2016

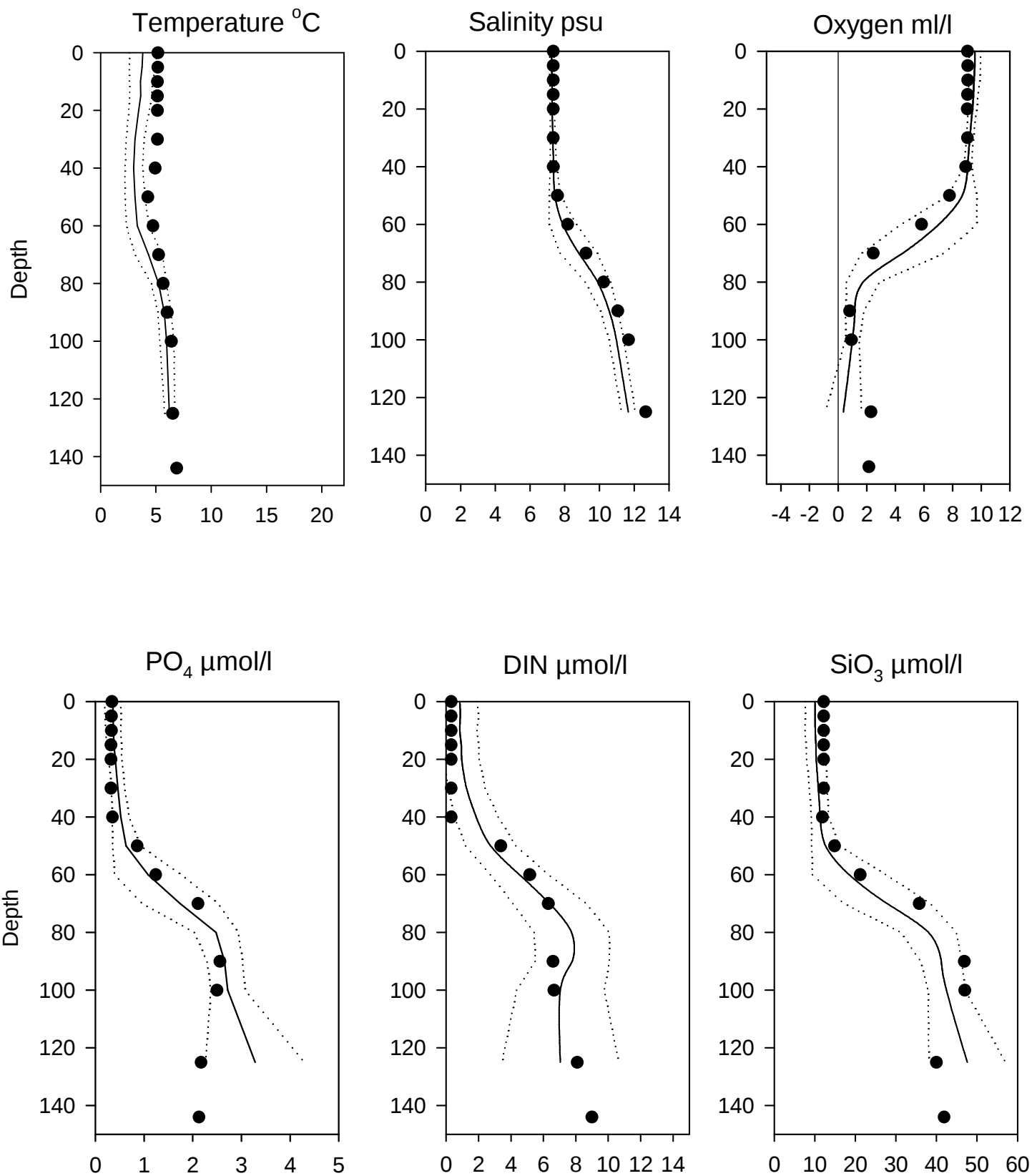


OXYGEN IN BOTTOM WATER (depth >125m)



Vertical profiles BY10 April

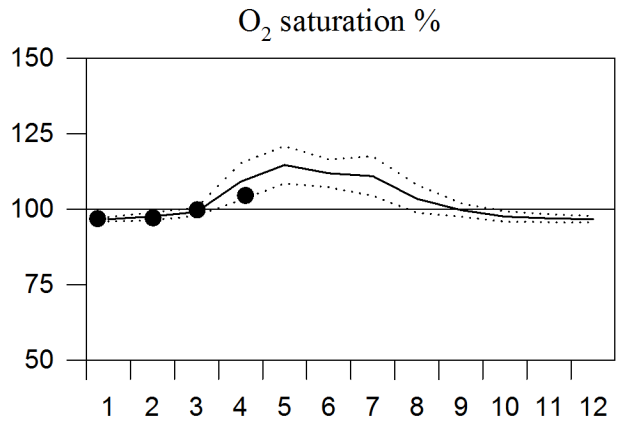
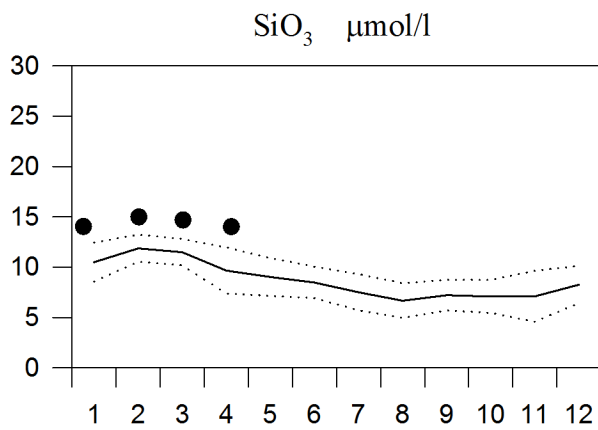
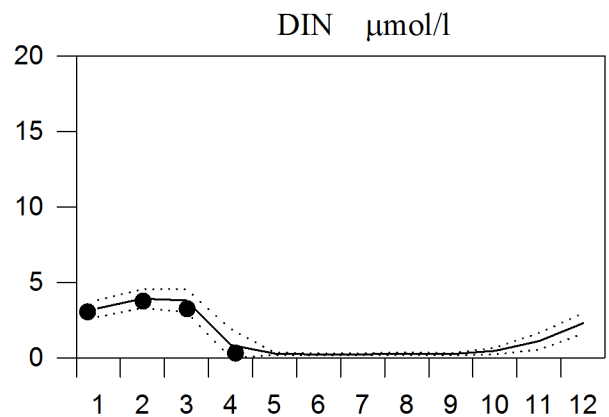
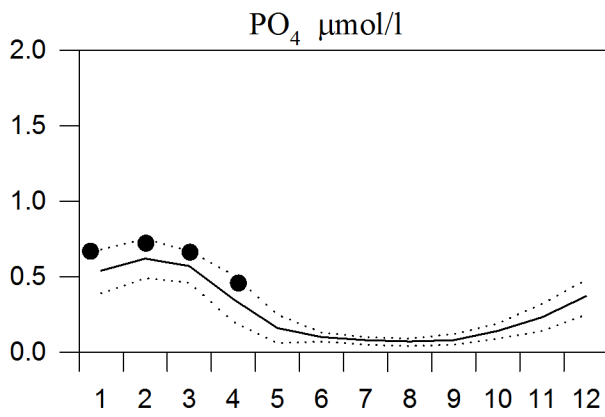
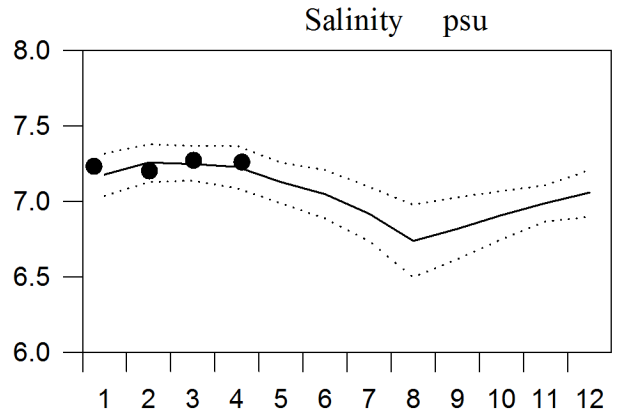
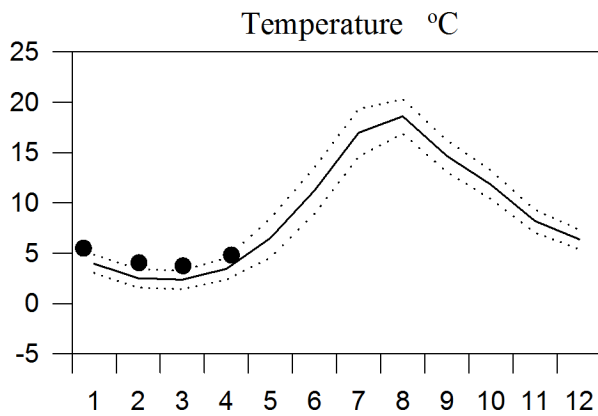
— Mean 1996-2010 St.Dev. ● 2016



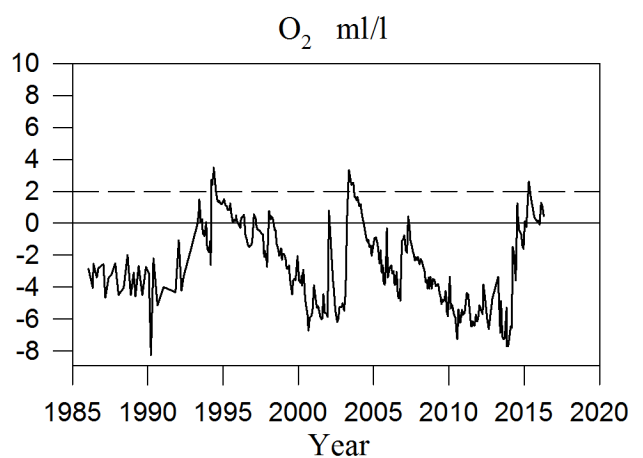
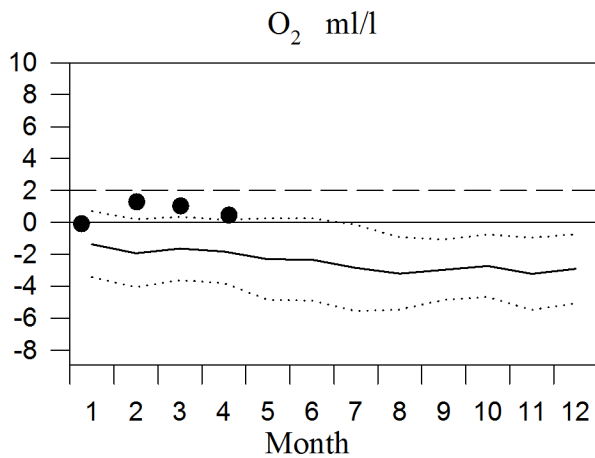
STATION BY15 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2016

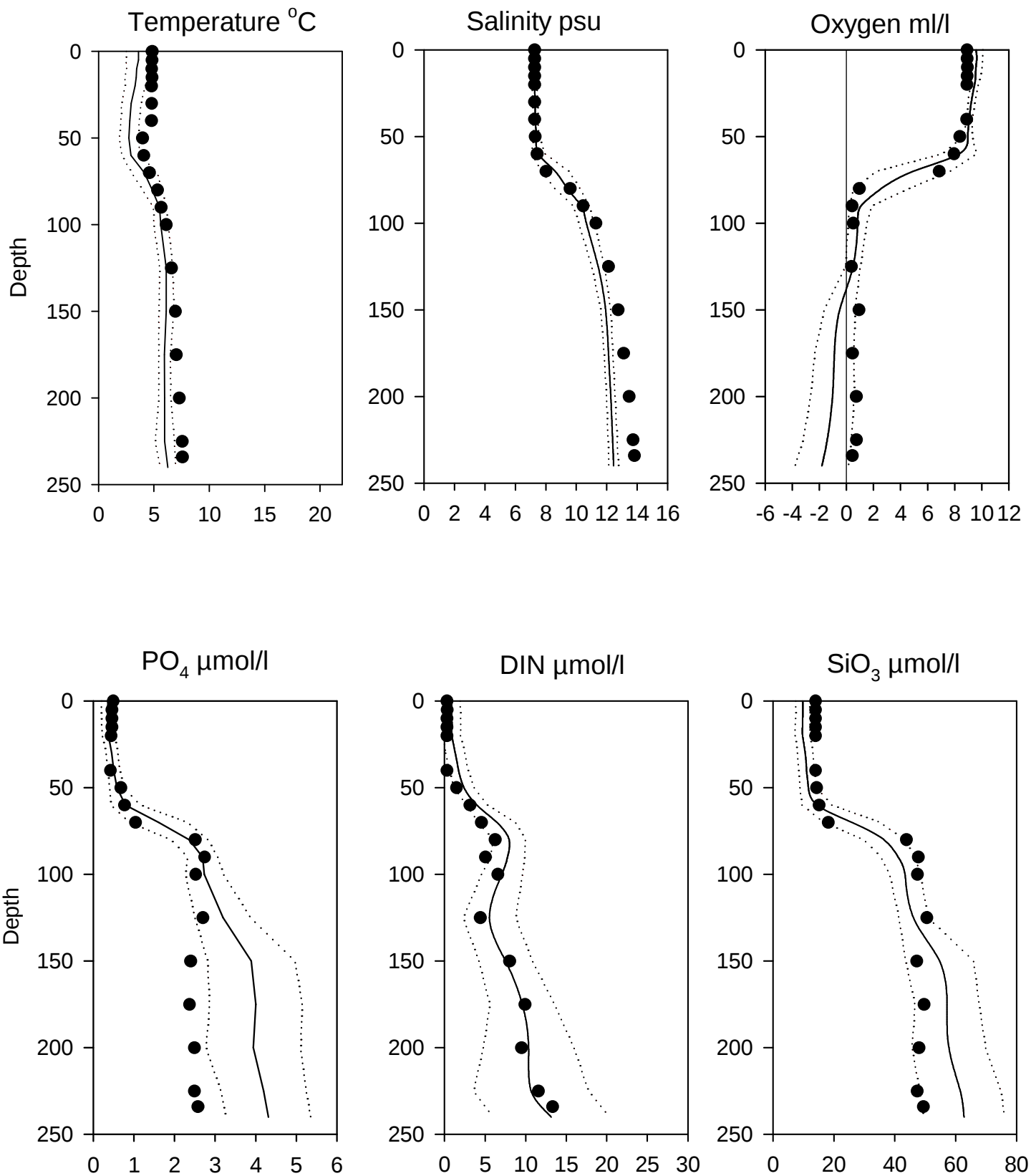


OXYGEN IN BOTTOM WATER (depth >225m)



Vertical profiles BY15 April

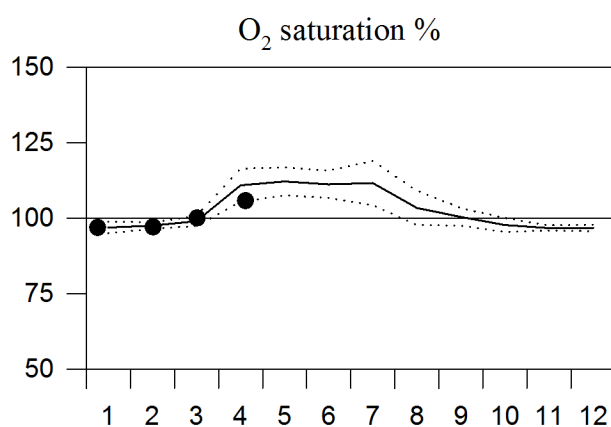
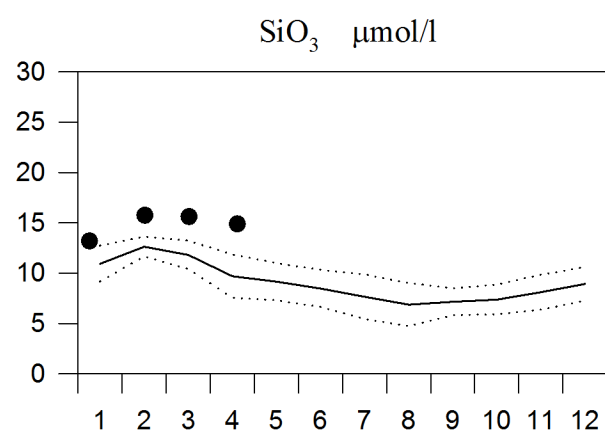
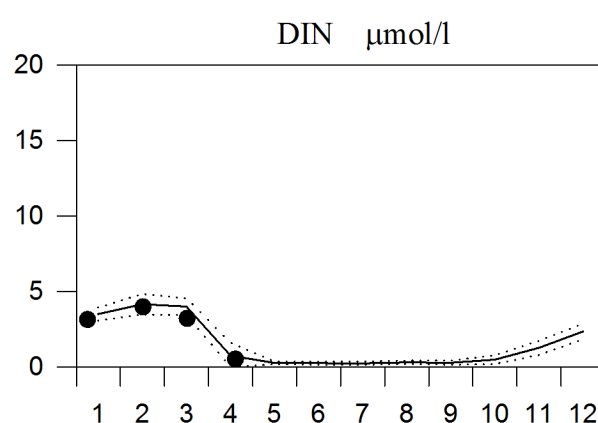
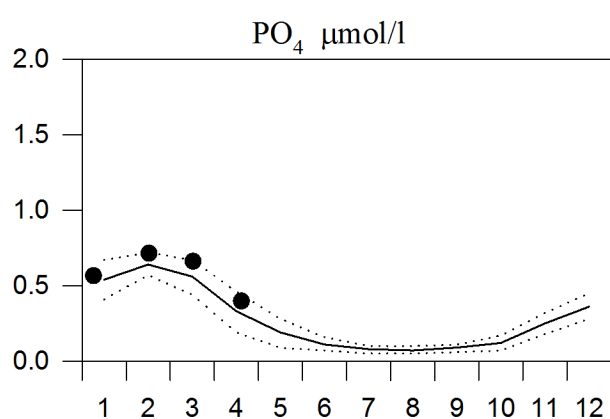
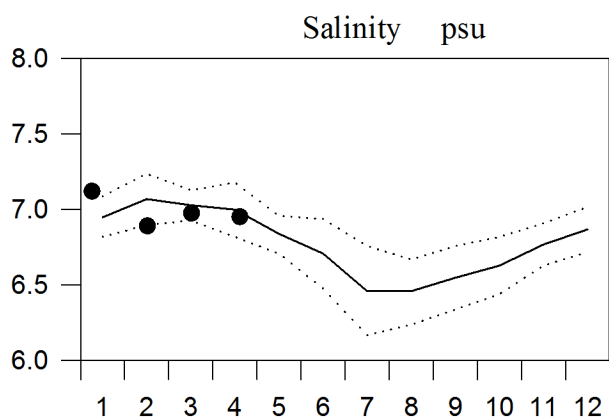
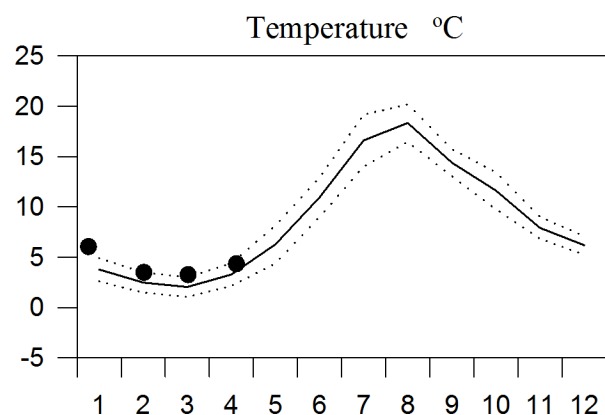
— Mean 1996-2010 St.Dev. ● 2016



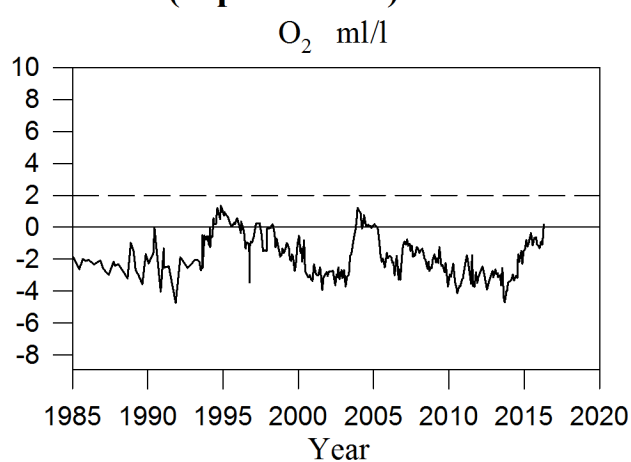
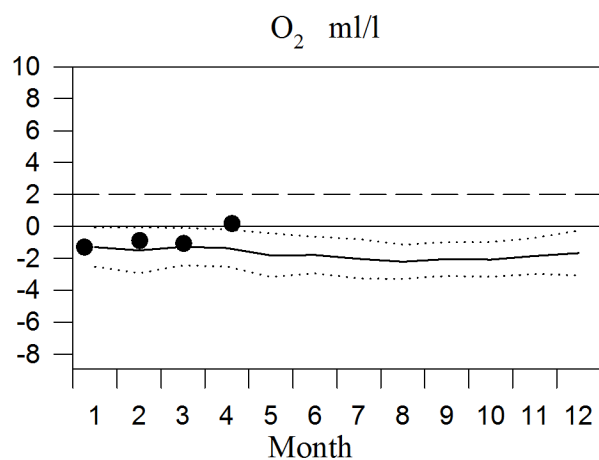
STATION BY20 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2016



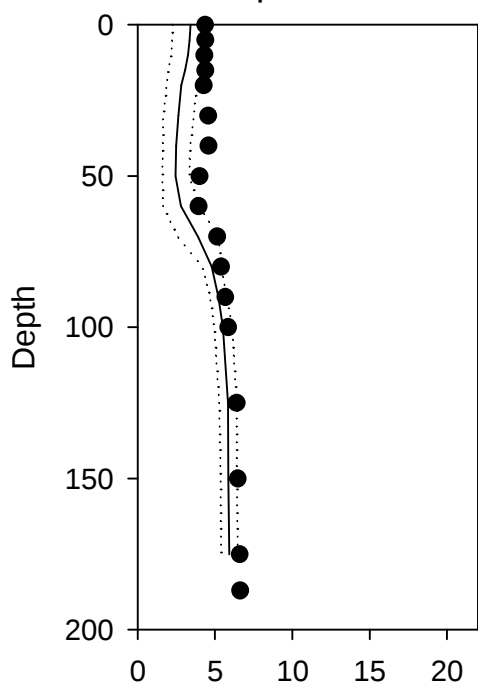
OXYGEN IN BOTTOM WATER (depth >175m)



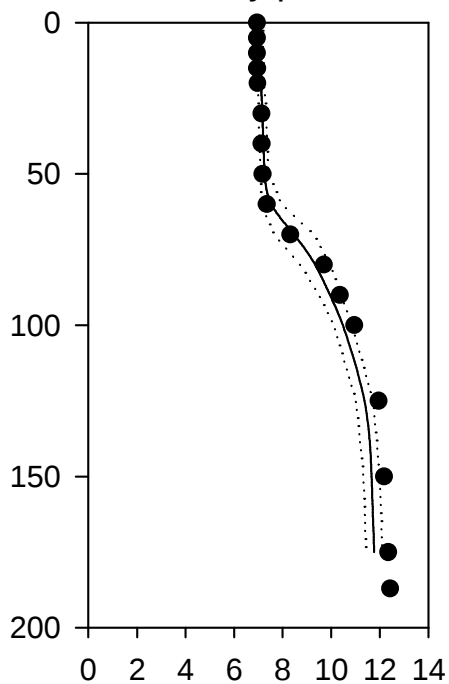
Vertical profiles BY20 April

— Mean 1996-2010 St.Dev. ● 2016

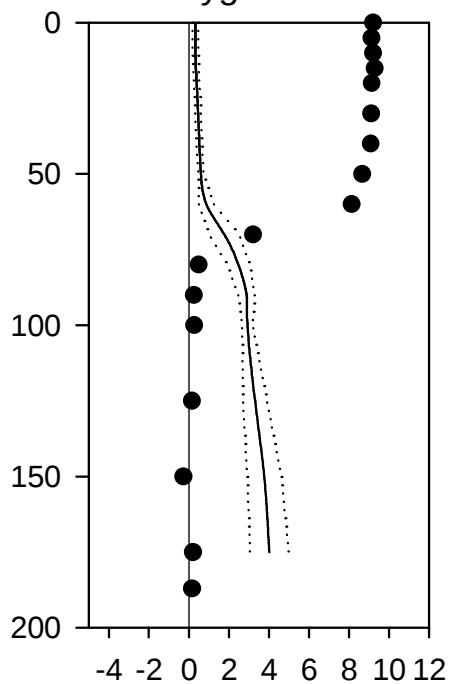
Temperature °C



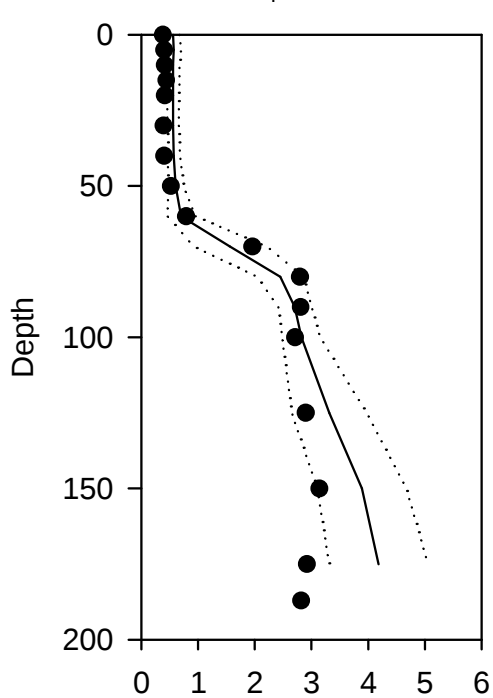
Salinity psu



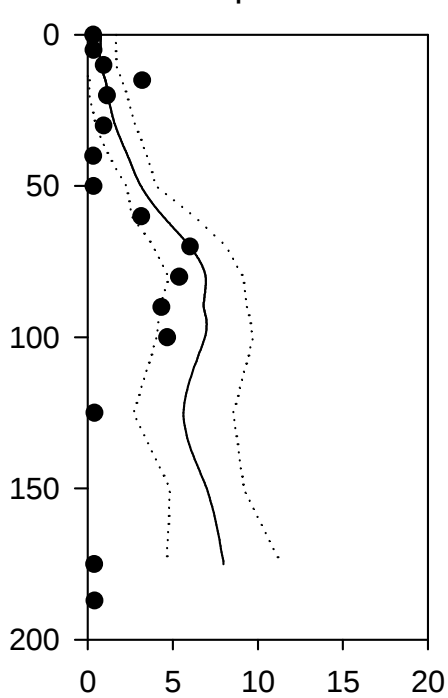
Oxygen ml/l



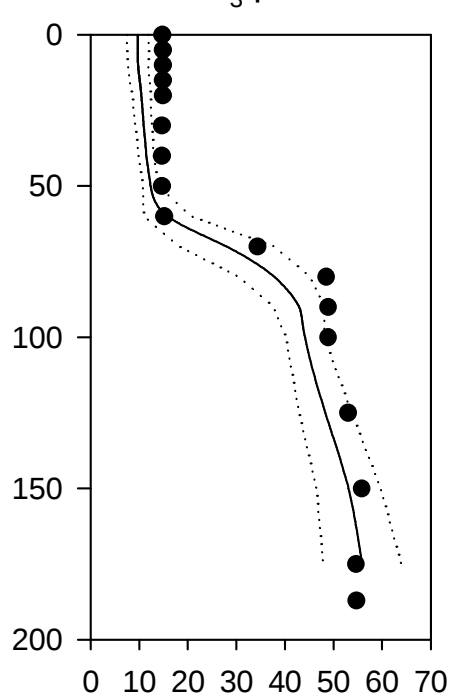
PO₄ μmol/l



DIN μmol/L



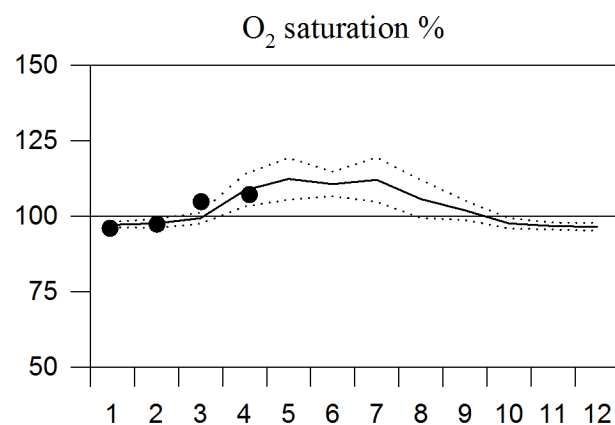
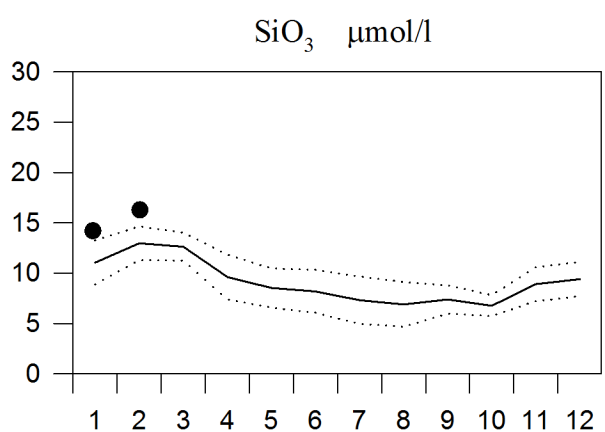
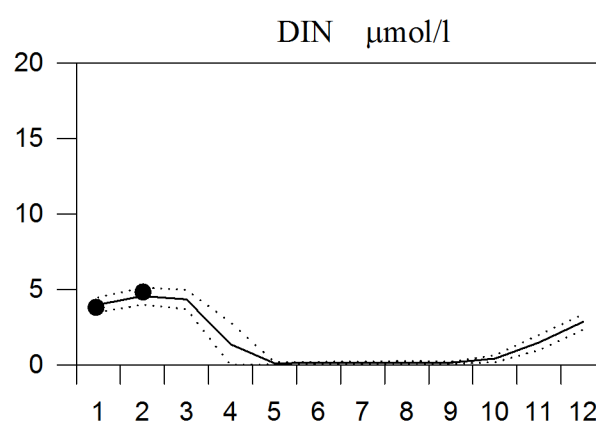
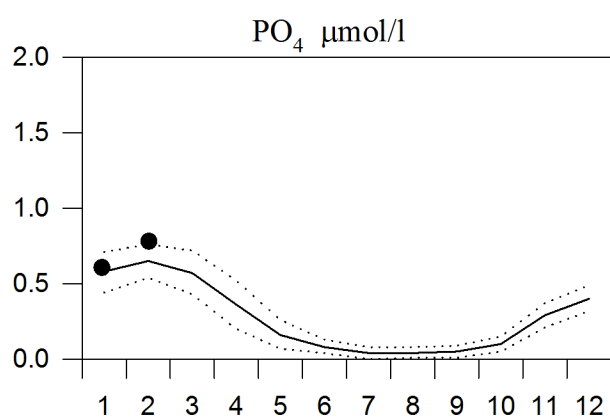
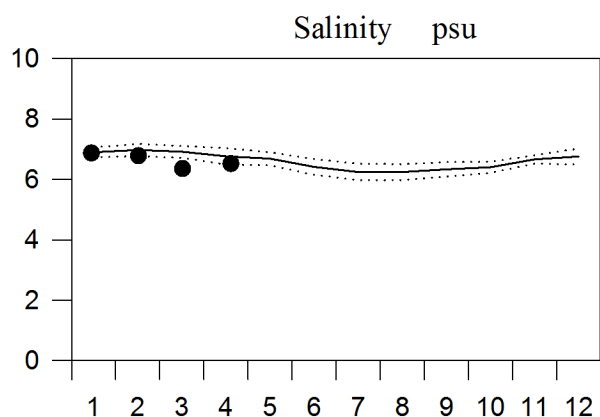
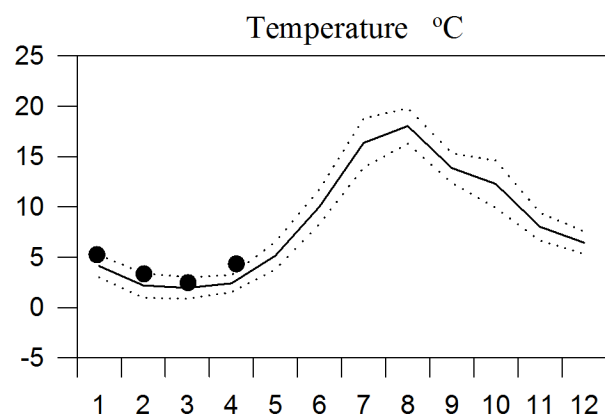
SiO₃ μmol/l



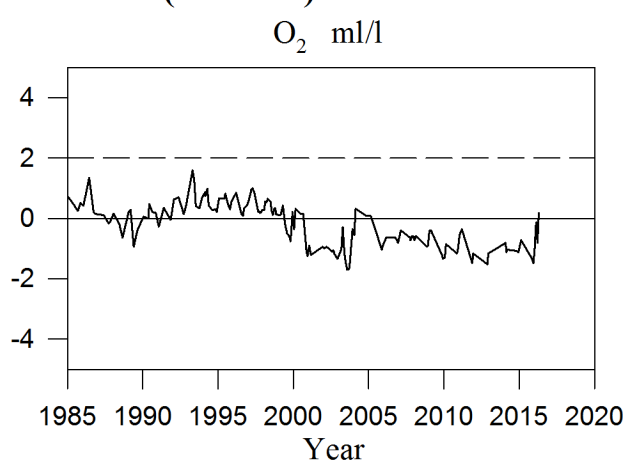
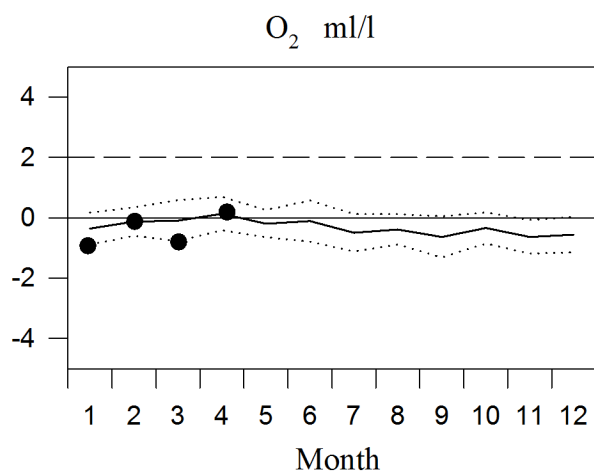
STATION BY29 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2016

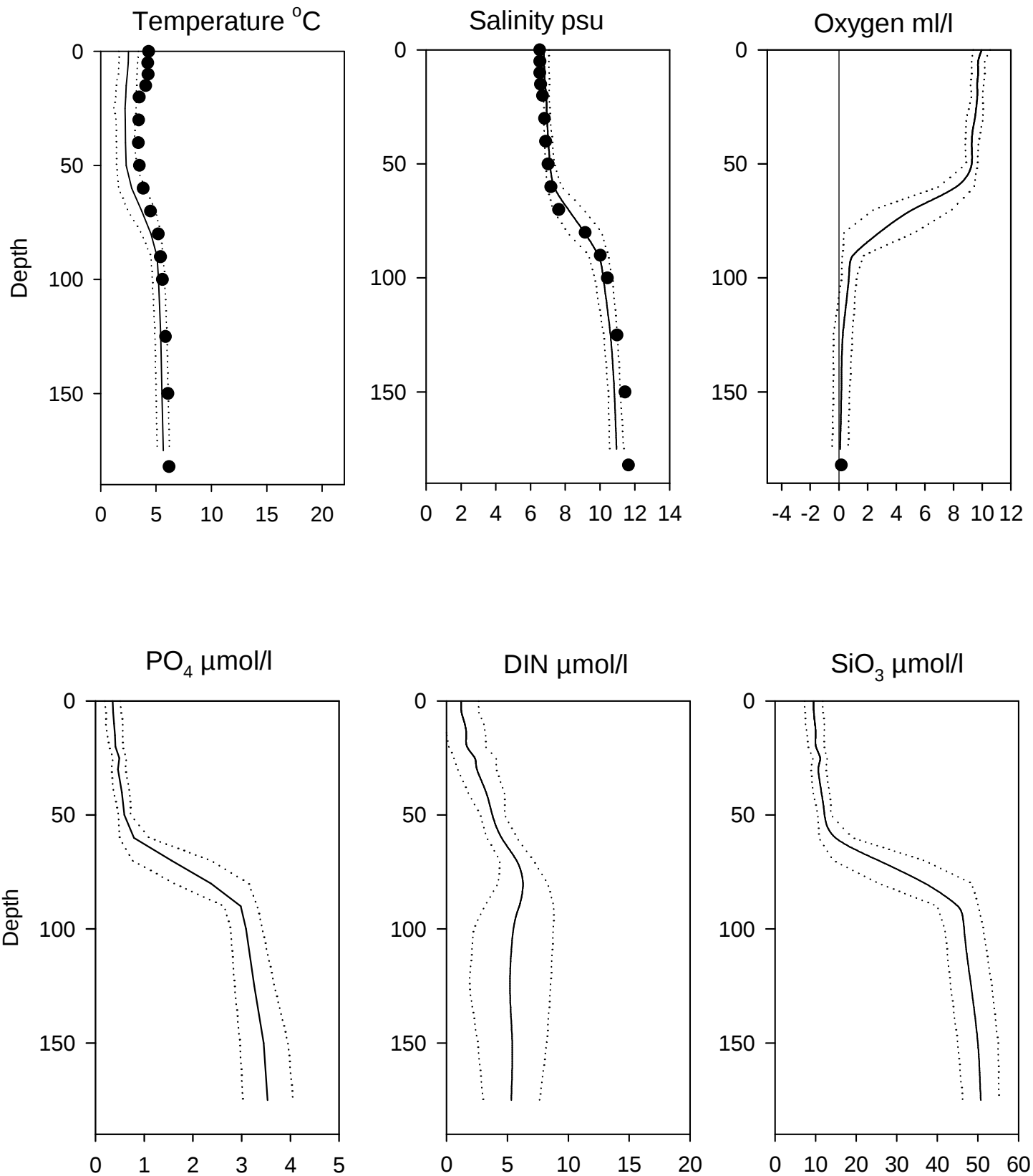


OXYGEN IN BOTTOM WATER (>=150m)



Vertical profiles BY29 April

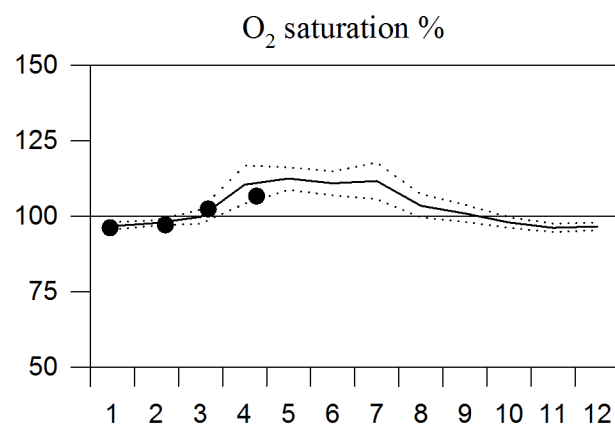
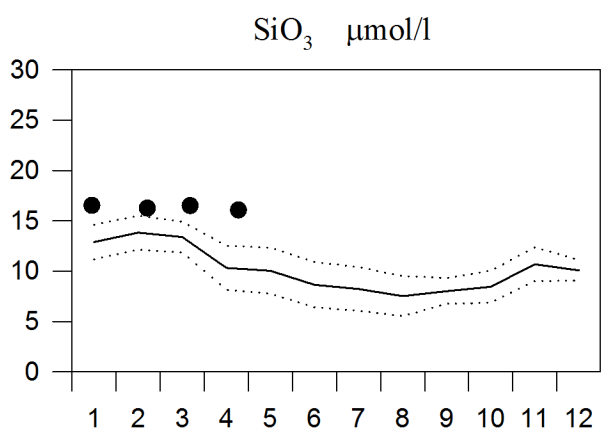
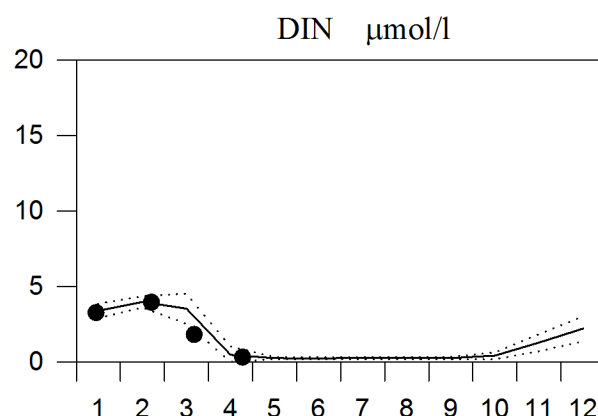
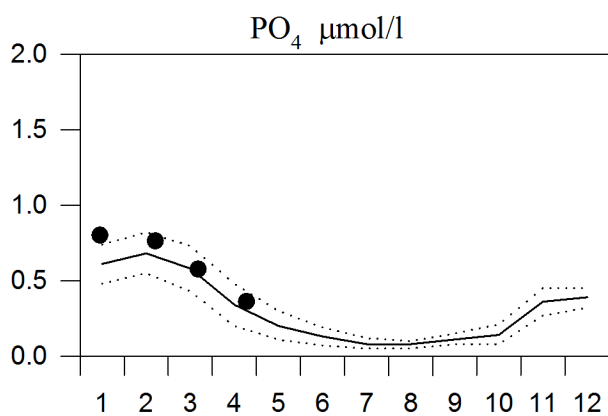
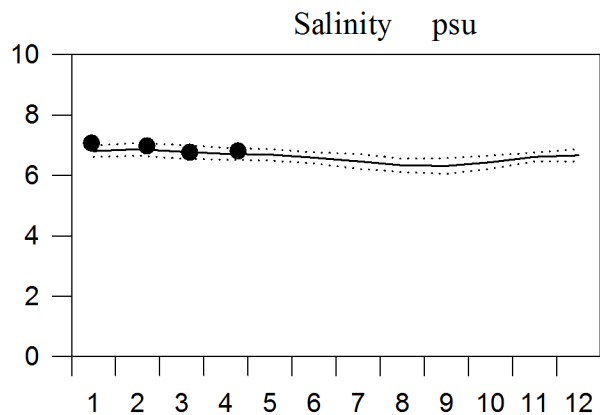
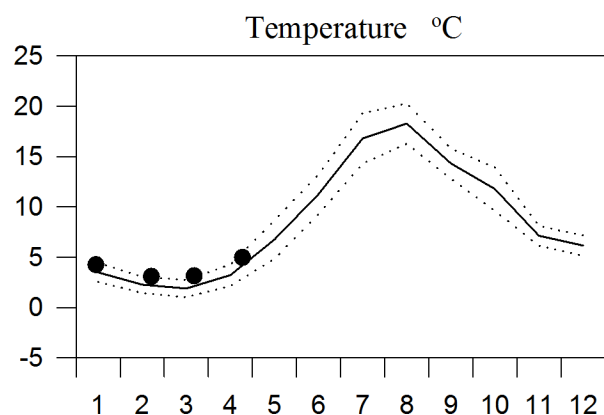
— Mean 1996-2010 St.Dev. ● 2016



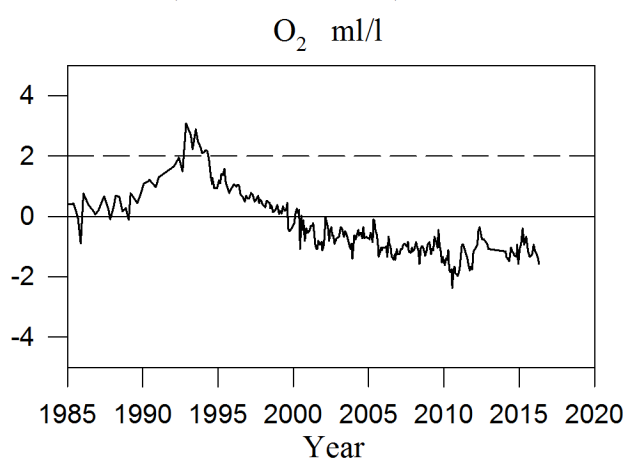
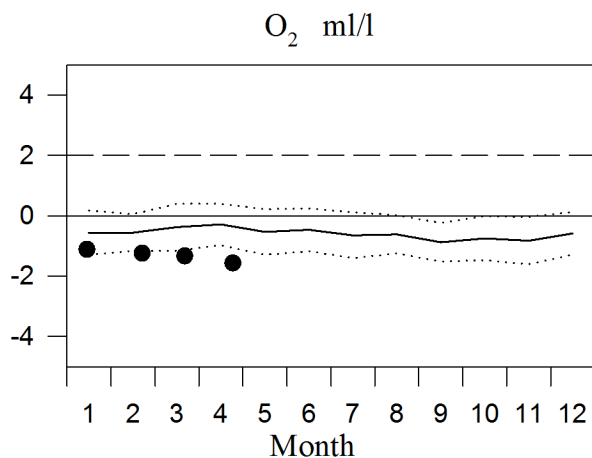
STATION BY32 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2016



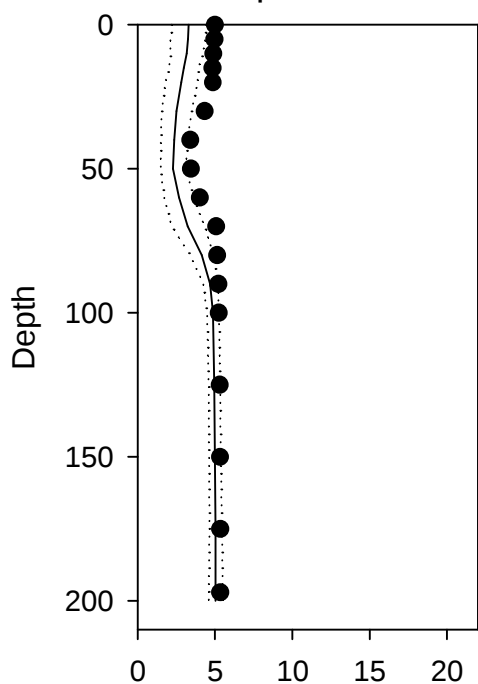
OXYGEN IN BOTTOM WATER (depth > 175m)



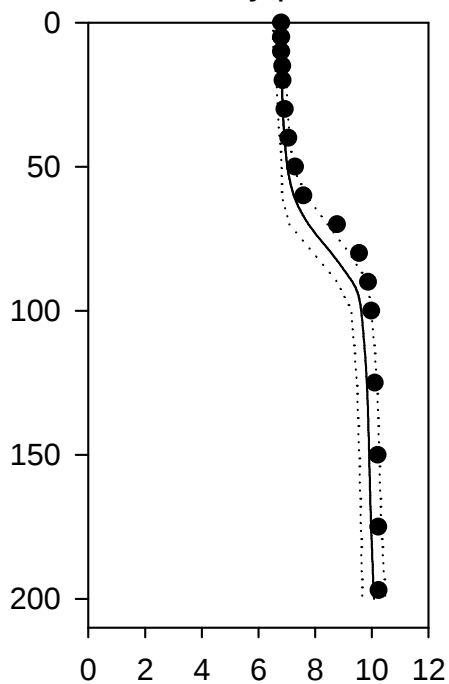
Vertical profiles BY32 April

— Mean 1996-2010 St.Dev. ● 2016

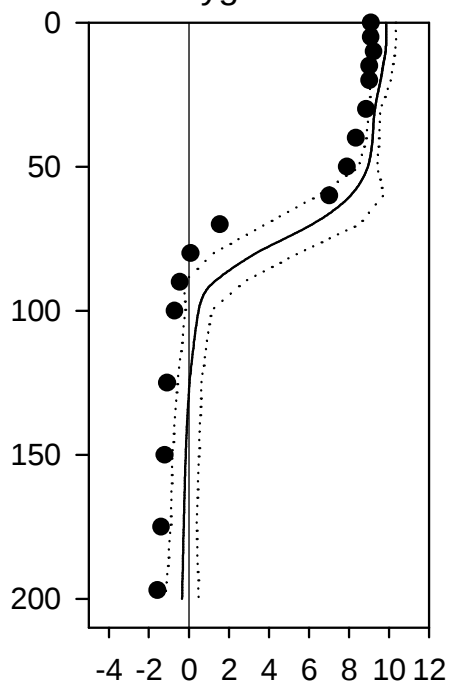
Temperature °C



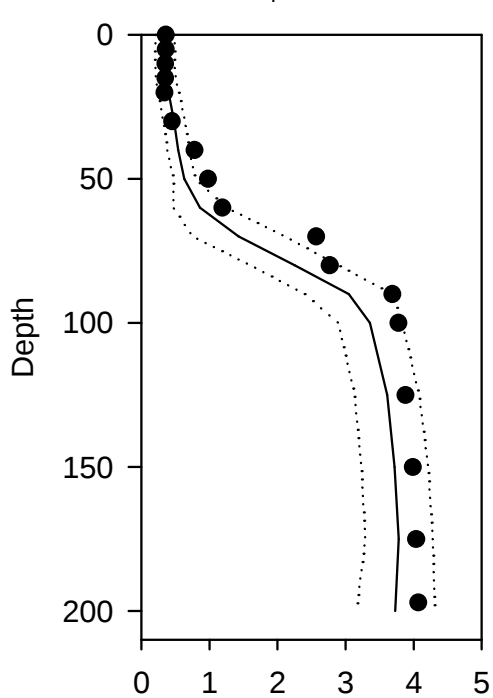
Salinity psu



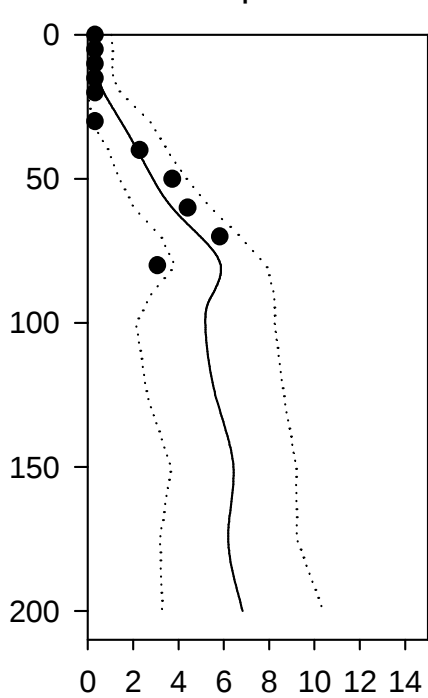
Oxygen ml/l



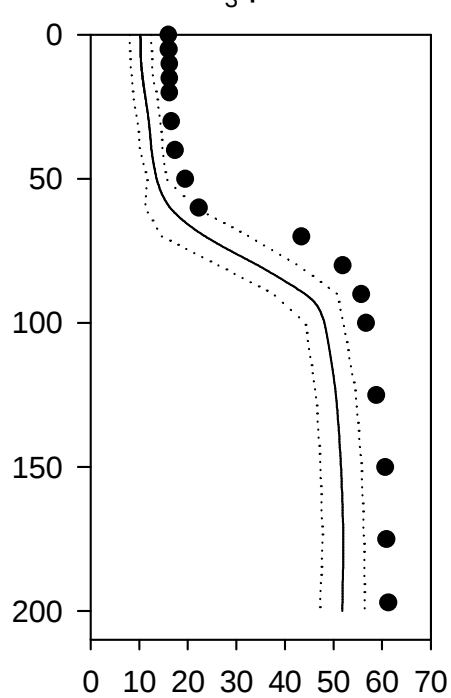
PO₄ μmol/l



DIN μmol/l



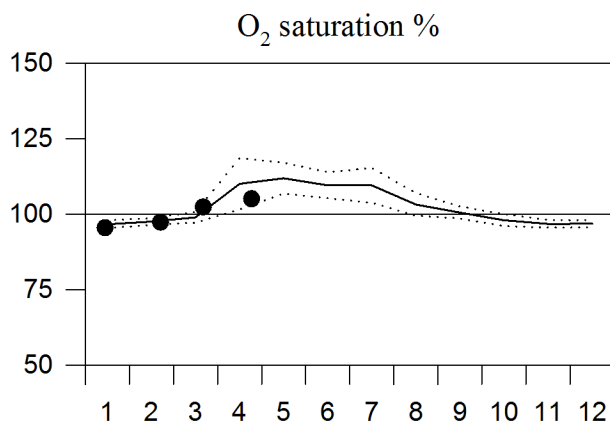
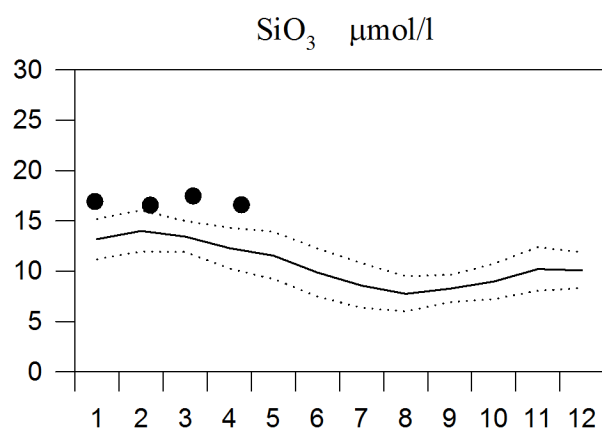
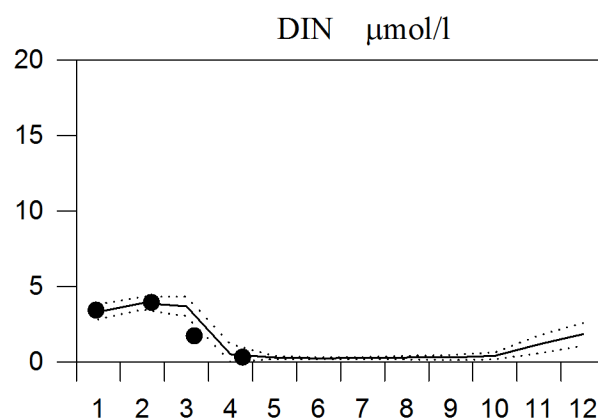
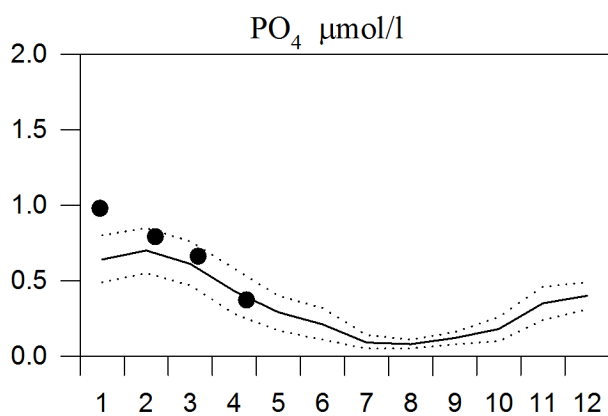
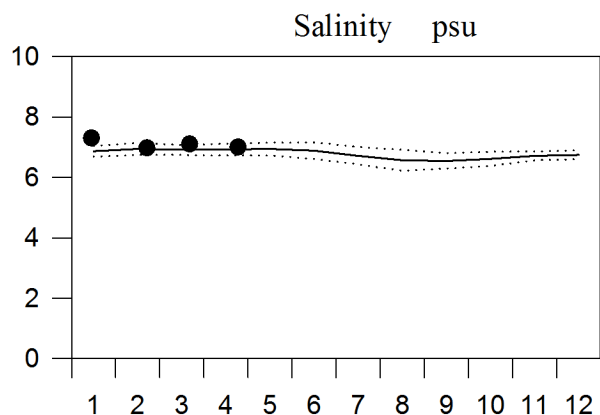
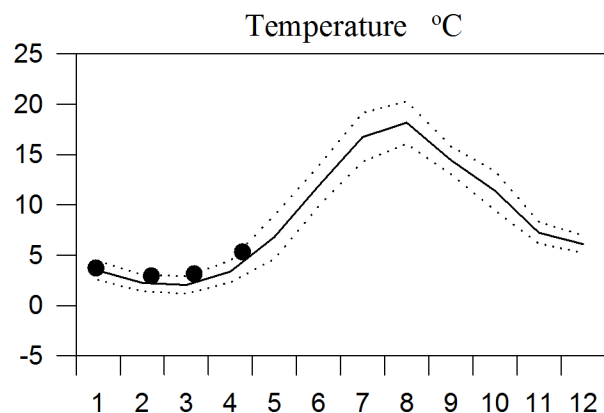
SiO₃ μmol/l



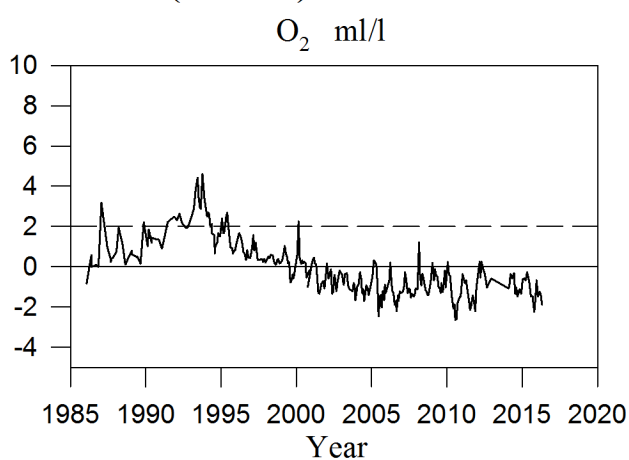
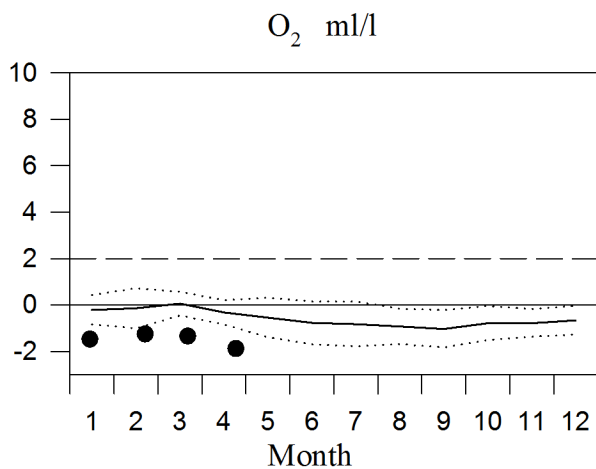
STATION BY38 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2016

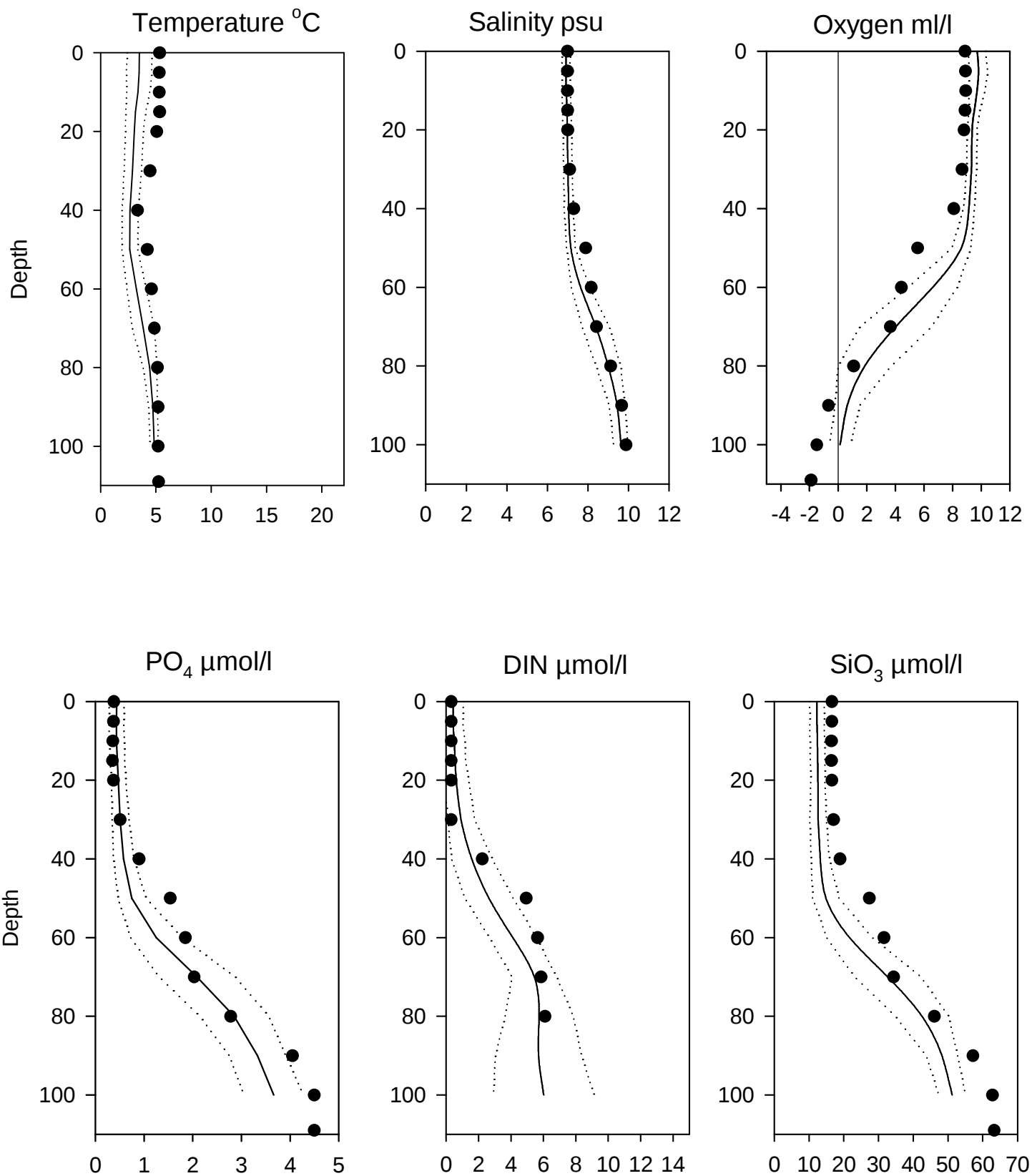


OXYGEN IN BOTTOM WATER (> 100m)



Vertical profiles BY38 April

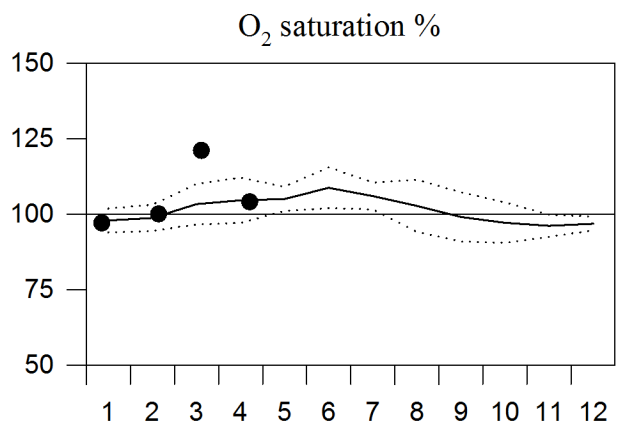
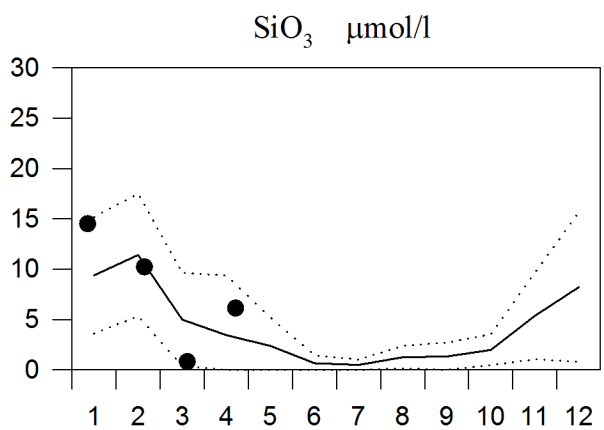
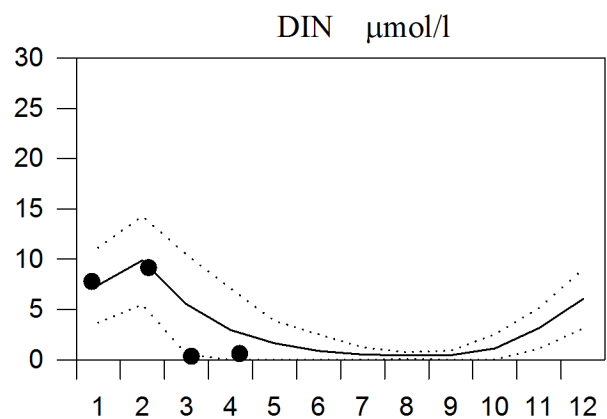
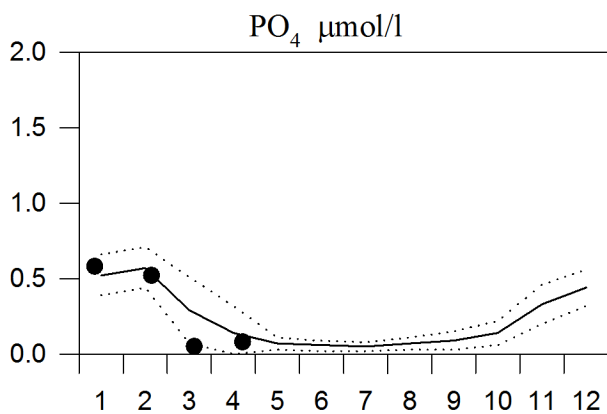
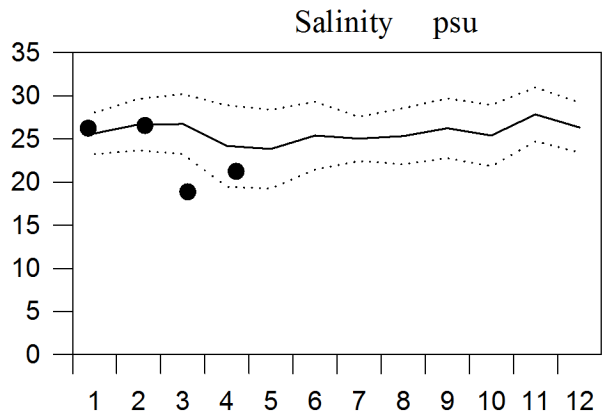
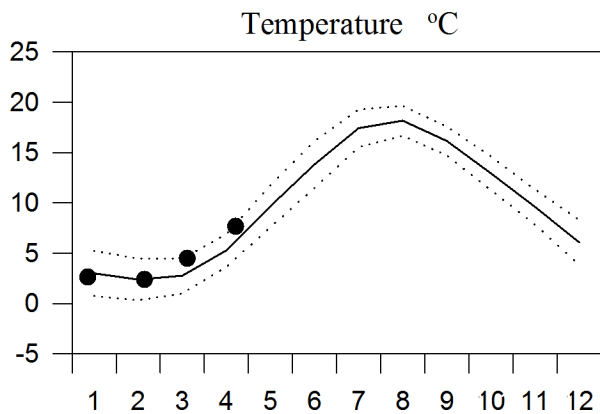
— Mean 1996-2010 St.Dev. ● 2016



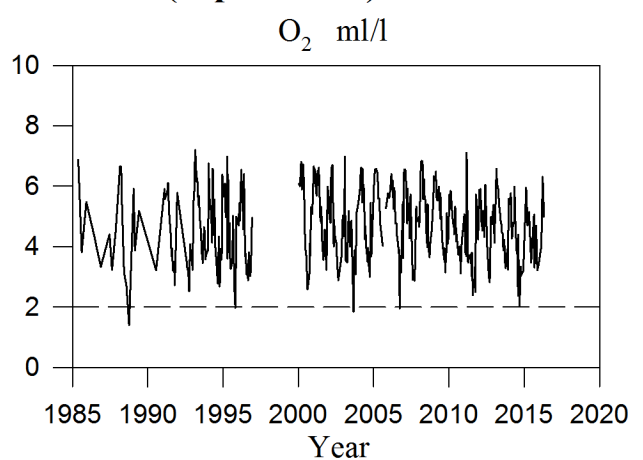
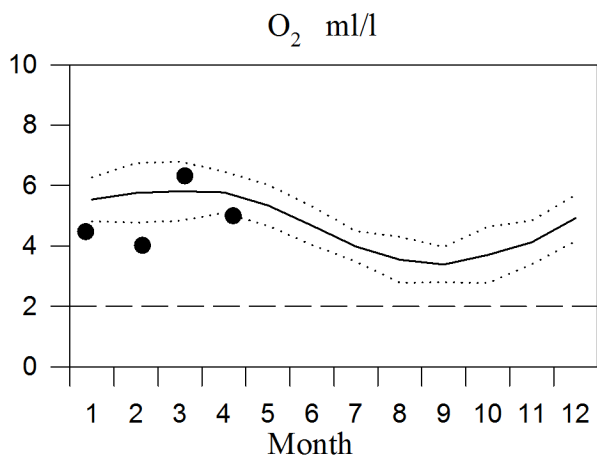
STATION SLÄGGÖ SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2016

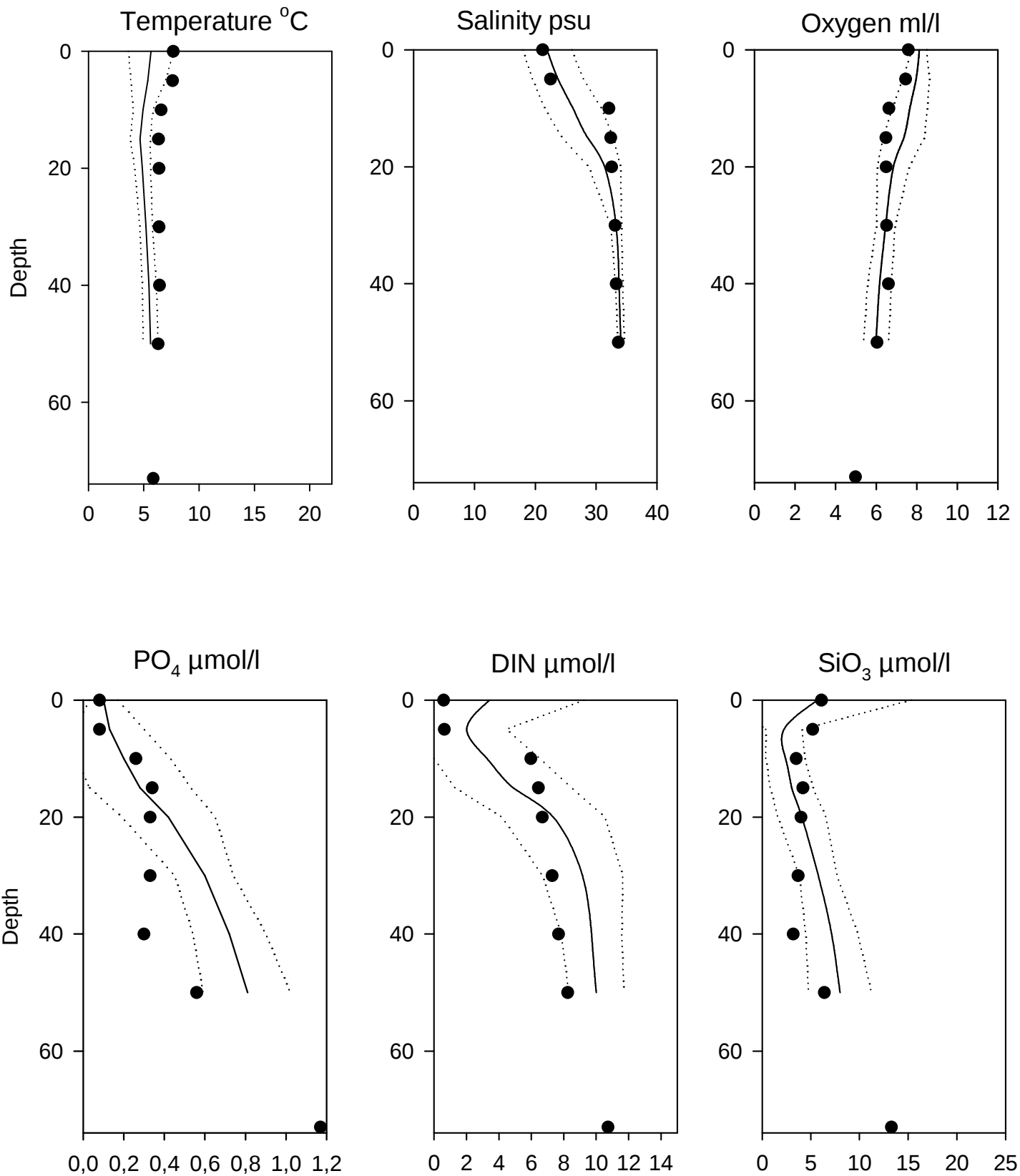


OXYGEN IN BOTTOM WATER (depth >50m)



Vertical profiles Släggö April

— Mean 1996-2010 St.Dev. ● 2016



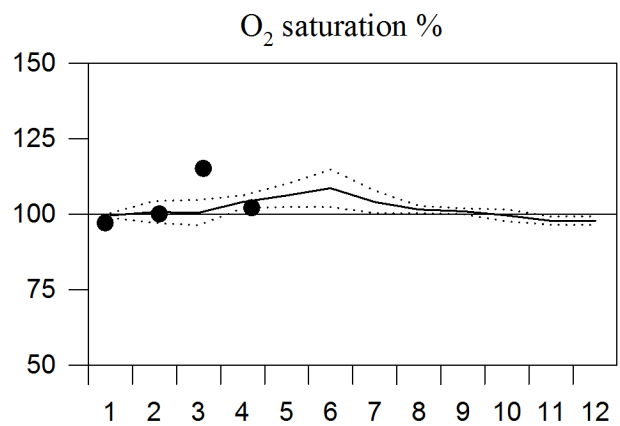
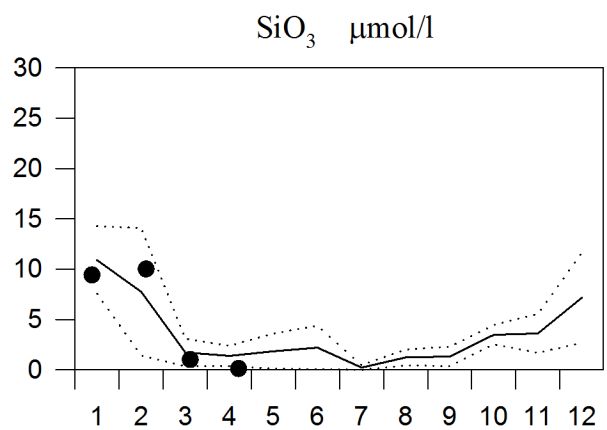
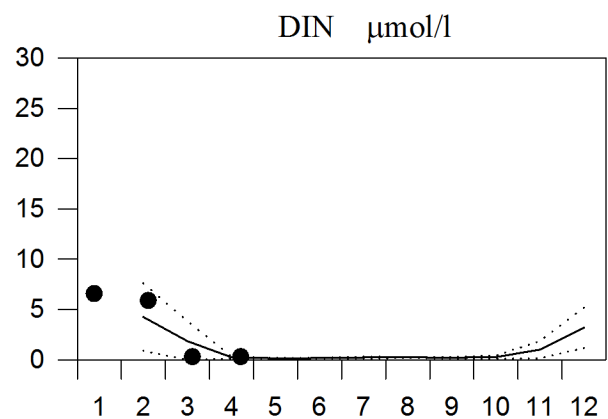
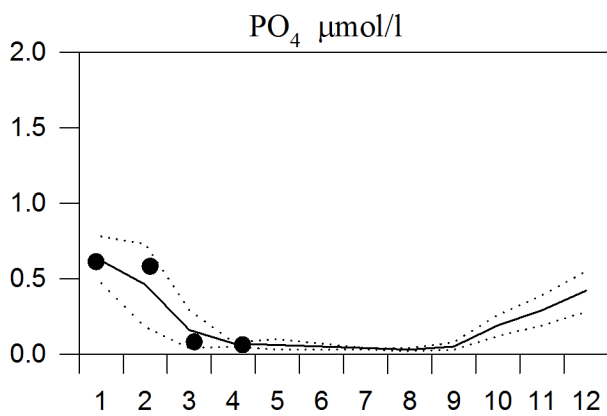
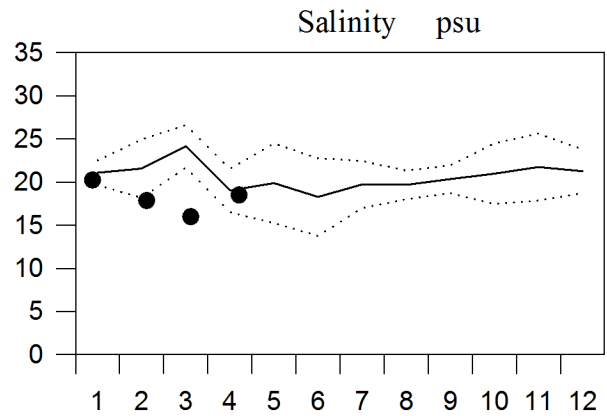
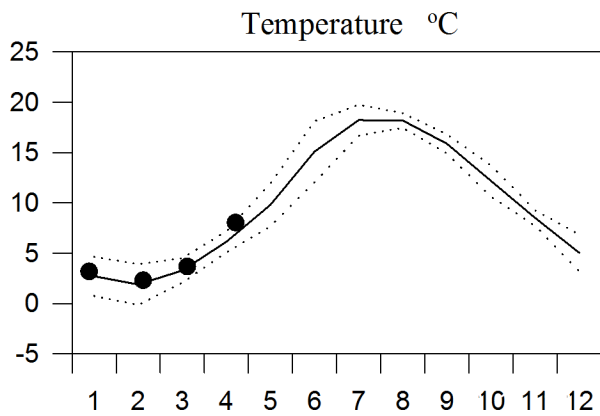
STATION N14 Falkenberg SURFACE WATER

Annual Cycles

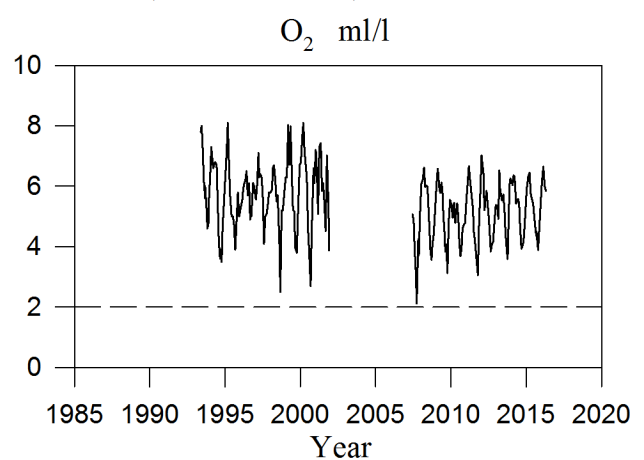
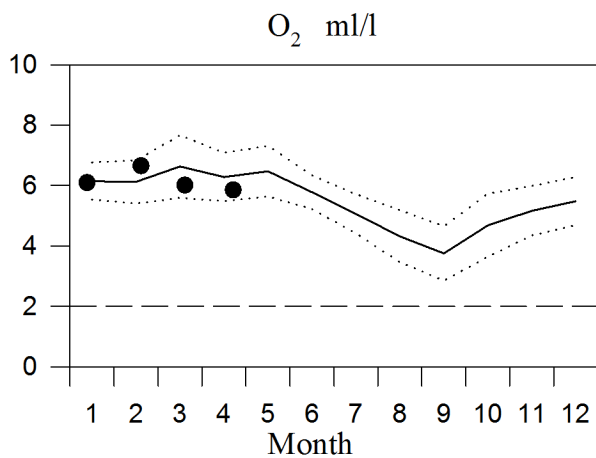
— Mean 2007-2010

..... St.Dev.

● 2016

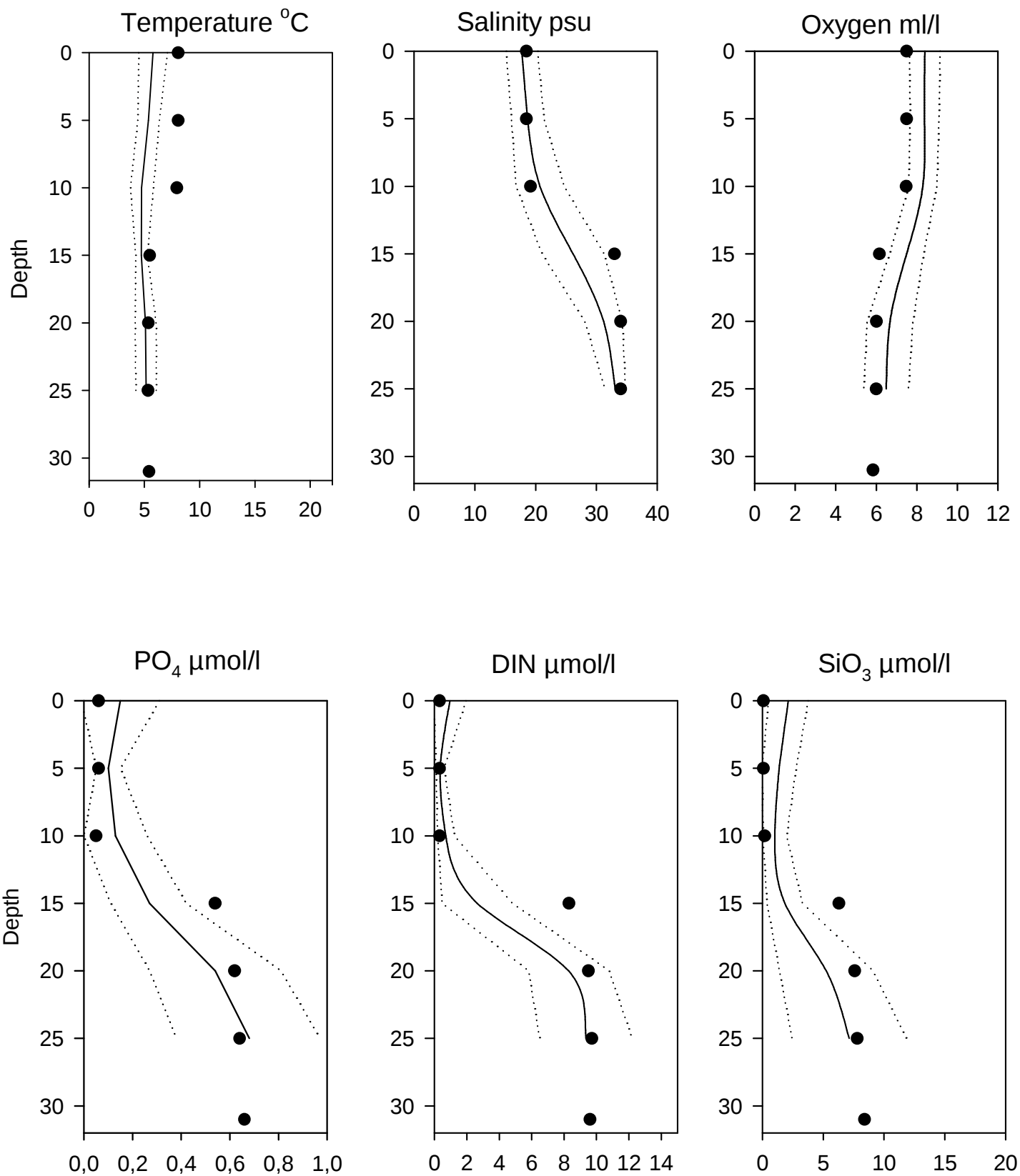


OXYGEN IN BOTTOM WATER (depth > 25m)



Vertical profiles N14 Falkenberg April

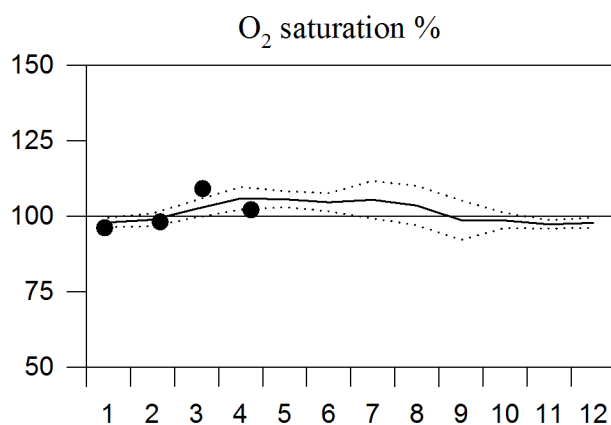
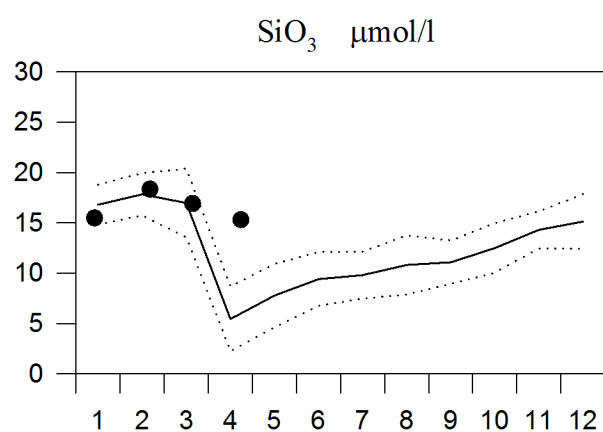
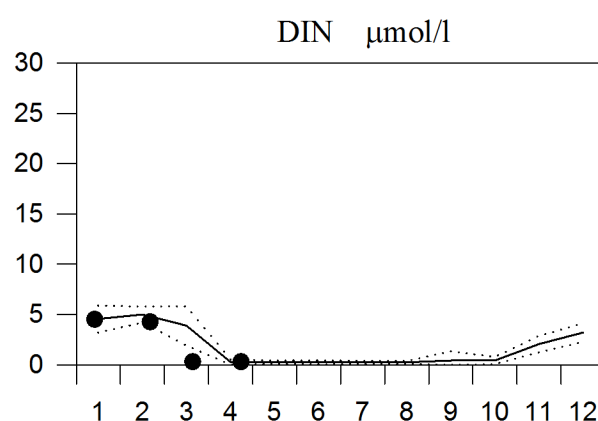
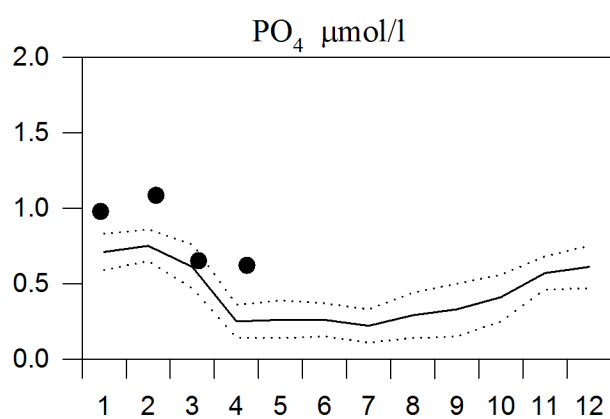
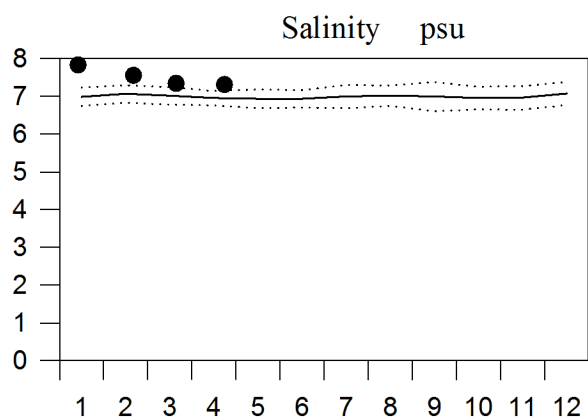
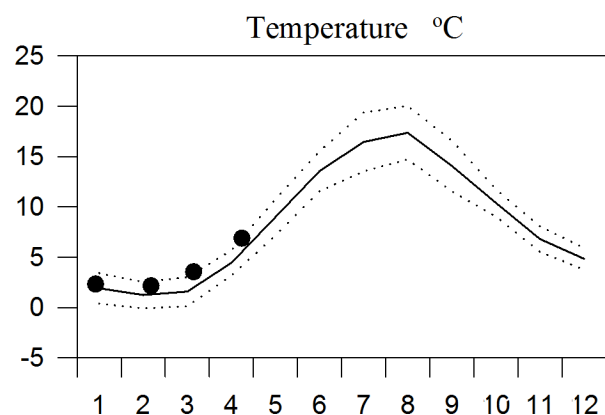
— Mean 1996-2010 St.Dev. ● 2016



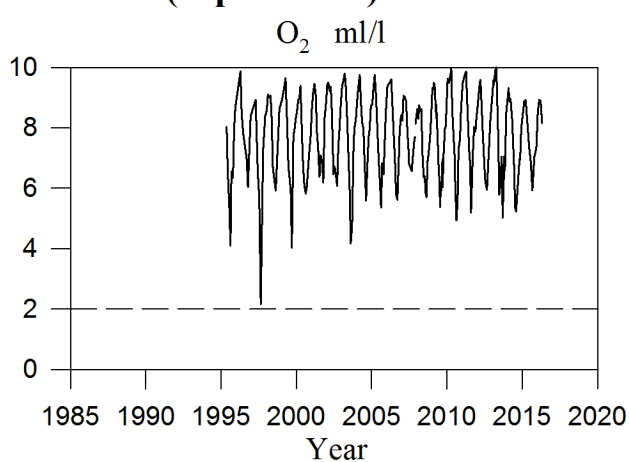
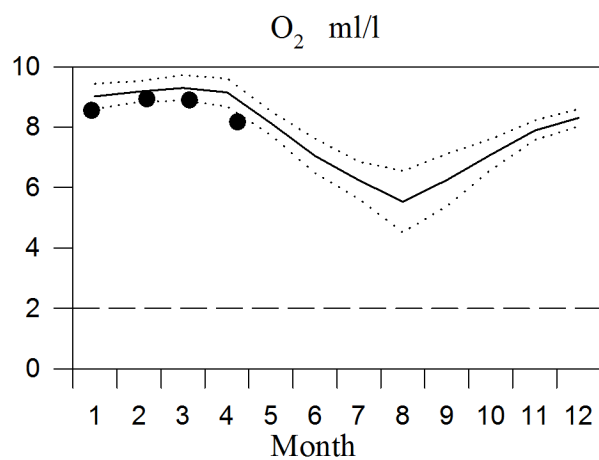
STATION REF M1V1 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2016



OXYGEN IN BOTTOM WATER (depth >15m)



Vertical profiles Ref M1V1 April

— Mean 1996-2010 St.Dev. ● 2016

