Lars Andersson

Swedish Meteorological and Hydrological Institute
Oceanographic Laboratory

2015-11-17
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Report from the SMHI monitoring cruise with R/V Aranda

Survey period: 2015-11-09 - 2015-11-16
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 stratification in the open sea areas of Skagerrak was very weak. In the Kattegat and the Baltic Proper sea surface temperature values was slightly above normal. Surface nutrients showed mainly values typical for the season, except for silicate which had concentrations well above normal in the Eastern Gotland Basin and the levels below normal in the southern parts of the Baltic Proper.
The major inflow during December 2014 had not reached further north than during the previous cruise in October and the oxygen situation in the deep water had deteriorated slightly. Hydrogen sulphide is still present in Western and Northern Gotland Basins.

Plankton activity was generally low.

The next regular cruise is scheduled to start December 7.

Address:
Sven Källfelts gata 15
SE-426 71 Vastra Frolunda
SWEDEN

Telephone:
+46 11 4958000

E-mail:
karin.wesslander@smhi.se
WWW:
http://www.smhi.se/

SMHI

PRELIMINARY RESULTS

The expedition was conducted aboard the Finnish research vessel Aranda and started in Helsinki on November 9 and ended in the same port on November 16. The winds during the expedition varied from fresh up till gale force and were of varying direction. Air temperatures ranged between 6 and 12 °C. An inflow to the Baltic, of about 25 km^3 trough the Sound, took place during the expedition.

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

The Skagerrak

The temperature of the surface water varied between 11.3 and 11.9°C, slightly lower, 10.3°C, at Släggö in the mouth of Gullmarsfjorden. Furthest west a thermocline and halocline were found at 40 metres depth, in other parts of the area the entire water column was almost completely homogeneous, in regards to both temperature and salinity. At the coastal station Släggö a clear stratification in both temperature and salinity were found at a depth of 10 metres and the salinity was just below 26 psu in the surface.
All nutrients in the surface waters had increased slightly since the previous survey and showed concentrations normal for the season. Phosphate concentrations were in the range 0.2-0.3 µmol/l, inorganic nitrogen (nitrite + nitrate) 0.7-1.7 µmol/l and silicate 1.7-2 µmol/l. The lowest oxygen concentration in the bottom water was measured at Släggö, 3.2 ml/l at 72 metres depth, corresponding to a saturation of approximately 50%.

Fluorescence measurements showed low biological activity in the surface layer 0-10 m. For more details on species composition see the separate report on the algae situation.

The Kattegat and the Sound

In the Kattegat, the temperature of the surface water was in the range of 10.7 - 11.0°C, which is normal or slightly above normal for the season. The salinity of the surface layer varied between 26.5 and 28.5 psu in the Kattegat, which is above normal. Salinity data from Öresund is missing. Temperature stratification was very weak. The halocline, also poorly developed, was found at depths between 15 and 30 metres.
Also in Kattegat, as in Skagerrak, nutrient concentrations in surface waters had started to rise. The phosphate content was around 0.24 µmol/l, nitrite + nitrate between 0.5 and 1.2 µmol/l and silicate in the range of 1.9 - 2.3 µmol/l. In the Sound the phosphate content of surface water was 0.23 µmol/l, the content of inorganic nitrogen 0.6 µmol/l and silicate 2.9 µmol/l, all concentrations below normal. The lowest oxygen levels in the bottom water were measured at Anholt E in the Kattegat, about 4 ml/l and at W Landskrona in the Sound, 2.9 ml/l.

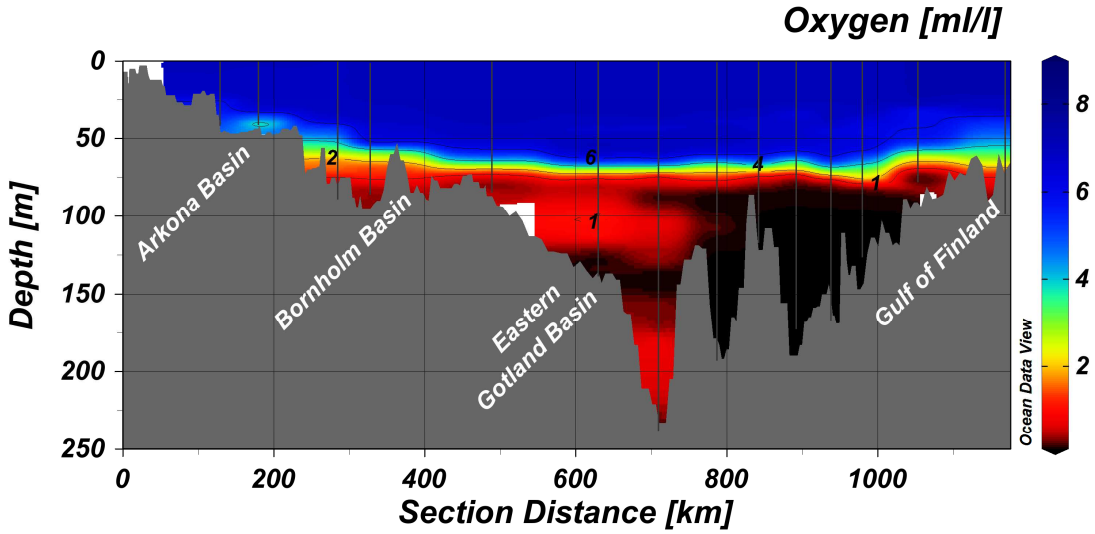
Some plankton activity was present in the surface layer 0-15 m. For details about the species composition see the separate report on the algae situation.

The Baltic Proper

The temperature in the surface layer was normal or slightly above normal for the season and ranged from 9°C in the north to 11.5°C in the southwest. In the northern and central parts the thermocline

was well developed and was found at depths between 30 and 40 metres. In the Bornholm Basin and in the Hanö Bight several different layers with varying temperatures were found below 40 metres. In the Arkona Basin the temperature stratification was very weak. Surface salinity was normal for the season and was in the range of 6.5 to 8.7 psu. The halocline was found at 40-70 metres depth in Western and Northern Gotland Basins, and at 50-80 metres depth in the Eastern Gotland Basin, while it was observed at slightly shallower depths in the south.
The concentrations of phosphate ranged from 0.2 µmol/l in the northern Baltic to 0.4 µmol/l in the south, which is normal. However, the station BY31 in the northwest deviated, the concentration was above normal, 0.5 µmol/l. Concentrations of inorganic nitrogen, also normal, ranged from about 0.2 µmol/l in the south, to about 1 µmol/l in the north. Here the station BY31 also deviated, where levels were at 1.7 µmol/l. The concentrations of silicate increased from 4 µmol/l in the southwest to 10 µmol/l in north (at BY31 13 µmol/l), levels were elevated in the Eastern Gotland Basin, normal in the west and below normal in the Bornholm and Arkona Basins and Hanö Bight.
Just like during the last cruise in October effects of the major inflow were seen at BY20, but not at BY21, further north. At BY20 hydrogen sulphide was now present at 90 metres depth, underneath was found a layer of oxygenated water down to about 130 metres, where the water was again completely oxygen-free down to the bottom.
In Western and Northern Gotland Basins the oxygen situation remains very serious. In the Western Gotland Basin completely oxygen-free conditions were found with hydrogen sulphide from 80-90 m while acute hypoxia, <2 ml/l, was measured from 80 metres. In the northern part completely oxygen-free conditions were found from 70-80 metres and acute hypoxia from 70 metres.
In the Gotland Deep, in the Eastern Gotland Basin, acute hypoxia (<2 ml / l) occurred at depths exceeding 70 metres. The entire water column was now oxygenated, and no hydrogen sulphide was measured. Concentration of oxygen, however, had further declined slightly since the previous expedition in October and was now, in the bottom water, around 0.1 ml/l. In the Bornholm Basin and Hanö Bight, acute hypoxia prevailed at depths exceeding 60 to 70 metres.

Fluorescence measurements showed low biological activity. For more details on species composition see the separate report on the algae situation.



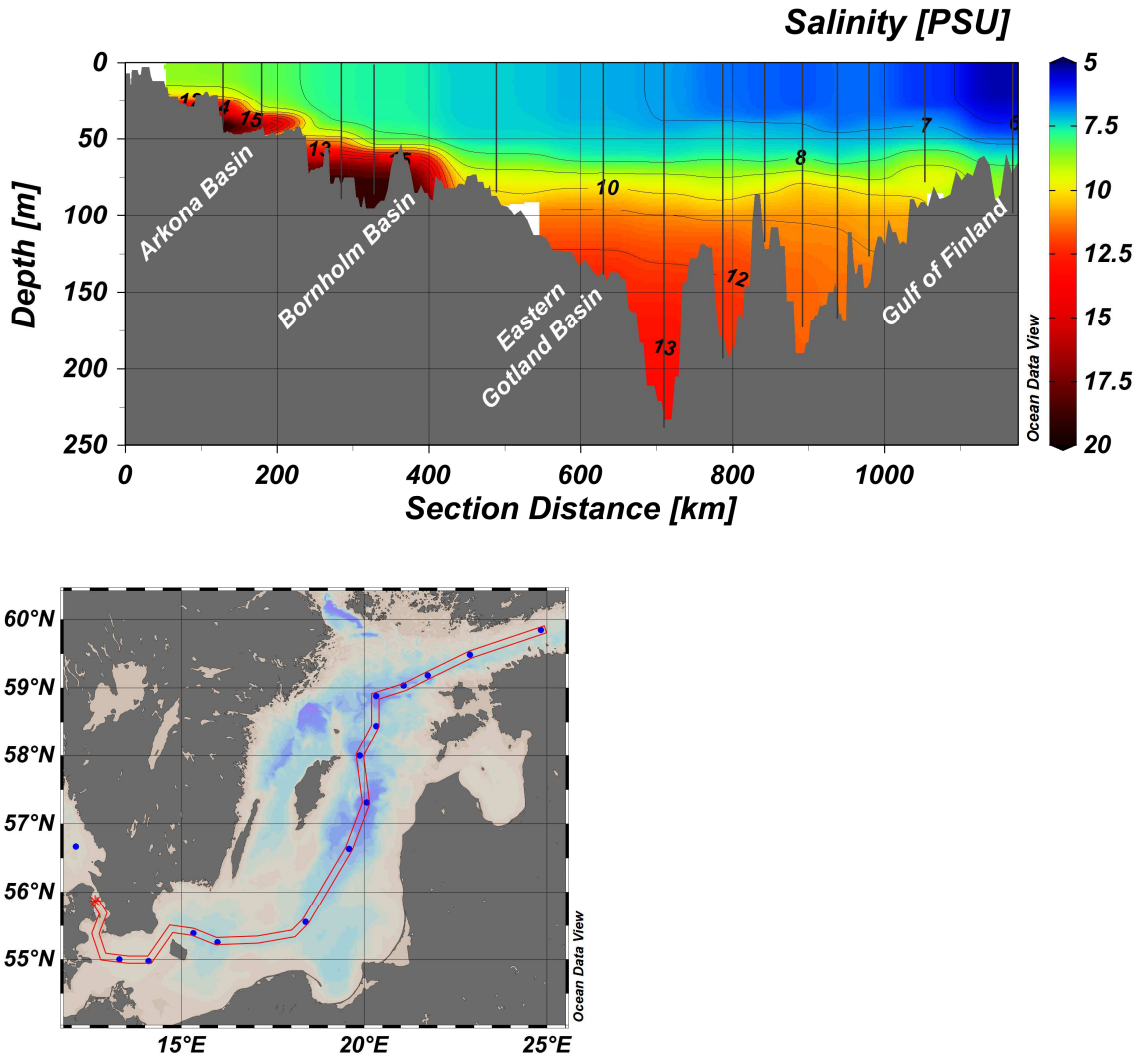


Figure 1. Transect showing the oxygen and salinity from the Sound to the Gulf of Finland.

PARTICIPANTS

Name		**Institute**
Daniel Bergman-Sjöstrand	Chief scientist	SMHI
Örjan Bäck		SMHI
Sara Johansson		SMHI
Daniel Simonsson		SMHI
Anna-Kerstin Thell		SMHI
Magnus Wenzer	Helsinki-Lysekil	SMHI

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

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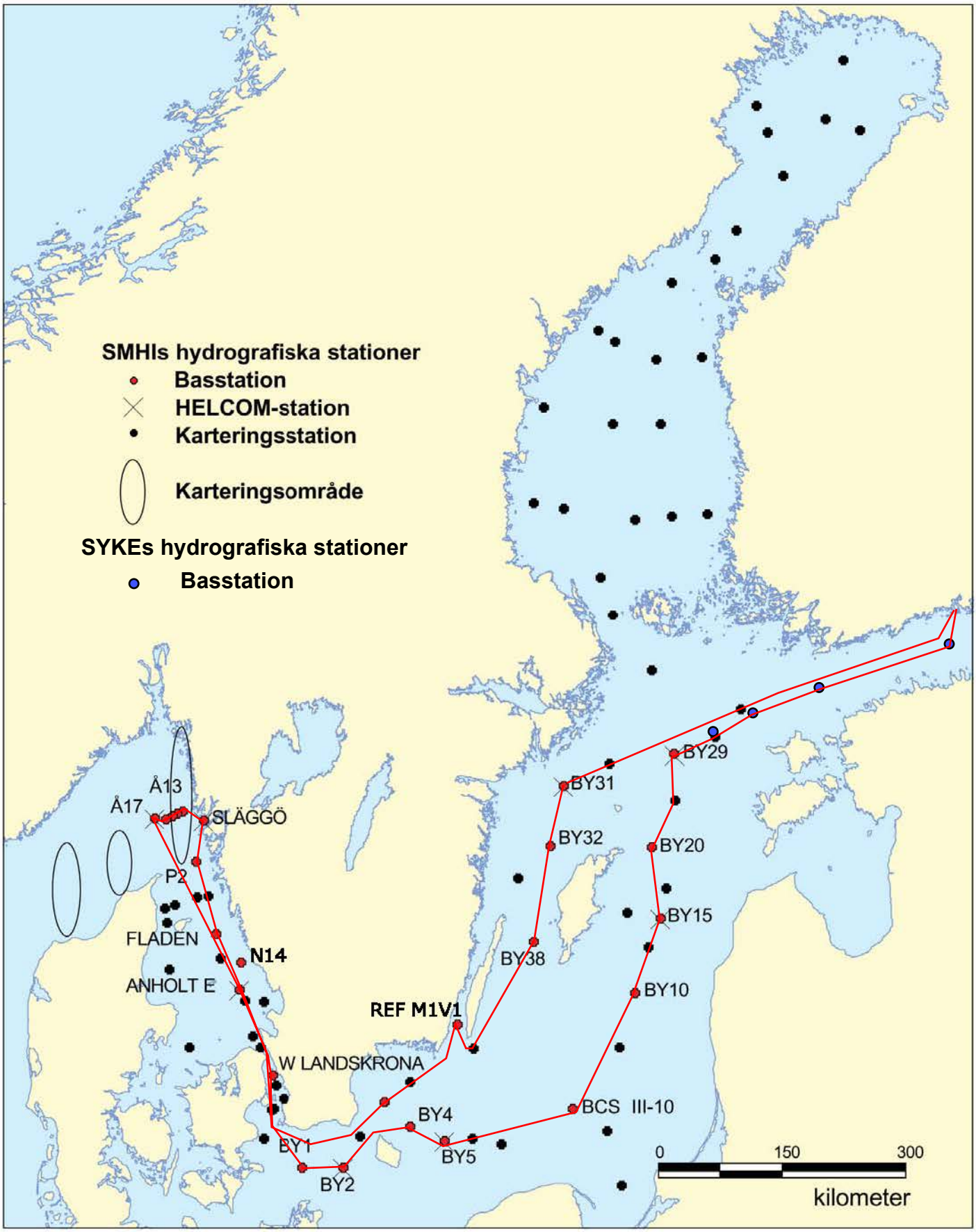
Ship: R/V ARANDA
Date: 20151109-20151116
Series: 0637-0665



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Ocean enh ***** series Year: 2015 ****** Time: 16:44

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0637	GFXX29EXT		BY23/LL7	N5950.5	E2450.3	20151109	1255	102		19	7	7.3	1005	2830	x	--x----	13	x	x	-	x	-	x	x	x	x	x	x	-	x	-	-	-	-	-	x
0638	BPNX60EXT		LL12	N5929.0	E2254.0	20151109	1910	84		27	12	9.5	995	9990	x	--x----	11	x	x	-	x	x	x	x	x	x	x	x	-	x	-	-	-	-	-	-
0639	BPNX00EXT		LL15	N5911	E2144	20151109	2355	131		25	8	9.0	991	9990	x	--x----	15	x	x	-	x	x	x	x	x	x	x	x	-	x	-	-	-	-	-	-
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0642	BPNX27EXT		BY21	N5826.5	E2020	20151110	0915	121		30	10	9.6	995	2750	x	-------	14	x	x	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0643	BPEX26BAS		BY20 FÅRÖDJ	N5800	E1953	20151110	1220	196		28	13	10.3	996	1450	x	--x----	17	x	x	-	x	x	x	x	x	x	x	x	-	x	-	-	-	-	-	x
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0651	SOCX39BAS		W LANDSKRONA	N5552.0	E1245.0	20151112	1035	50		28	13	12.1	1014	1630	-	--x----	8	x	x	-	x	-	x	x	x	x	x	x	-	x	-	-	-	-	-	x
0652	KAEX29BAS		ANHOLT E	N5640.0	E1207.0	20151112	1555	64		28	12	11.1	1017	1340	x	--xxx--	10	x	x	x	x	-	x	x	x	x	x	x	x	-	x	-	-	-	-	-	x
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0663	BPWX45BAS		BY38 KARLSÖDJ	N5707	E1740	20151115	0715	110		25	7	6.7	1000	1640	x	--x----	14	x	x	-	x	x	x	x	x	x	x	x	-	x	-	-	-	-	-	x

SMHI
Ocean enh

***** Hydrographic series ***** Ship: 01-Aranda Year: 2015 ****** ******

Date: 2015-11-16
Time: 16:44

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 aoae tu hd	C t d	PPCPZZT Hrhhoor Cilyooa motPBw PrP l	No de	T e m p	S a l i n	P h	O x y g	H 2 S	P o 4 P	T o t P	N o 2 N	N o 3 N	N h 4 N	T o t N	A l k a l	S i O 3	H u m u s	L i g n i	P O N	P O C	T O C	C o m m
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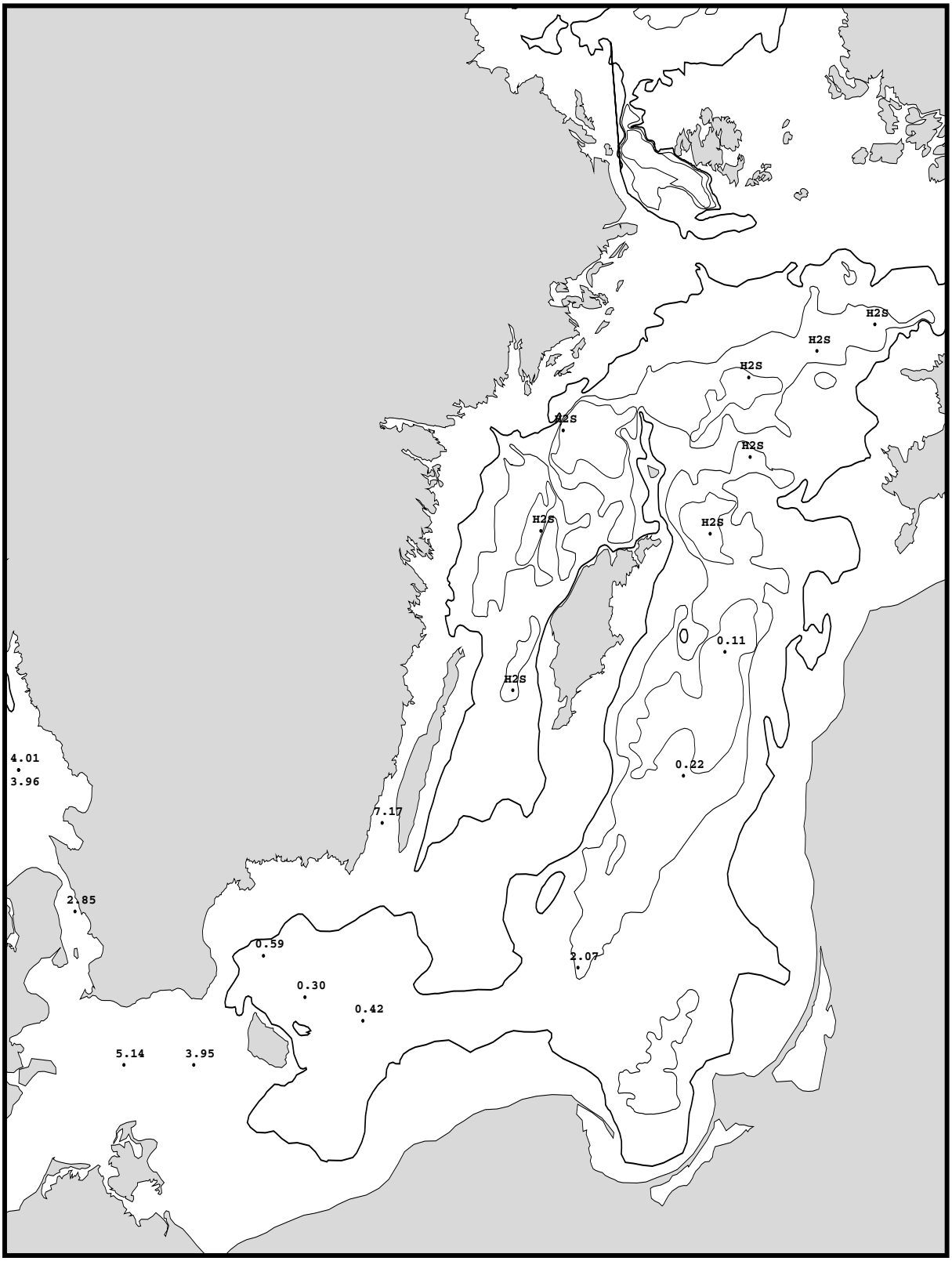
Bottom water oxygen concentration (ml/l)

Country: Finland
Ship : Aranda
Date : 20151109-20151115
Series : 0637-0665

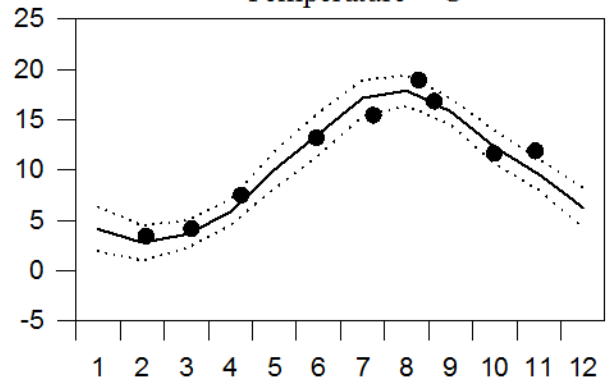


STATION P2 SURFACE WATER

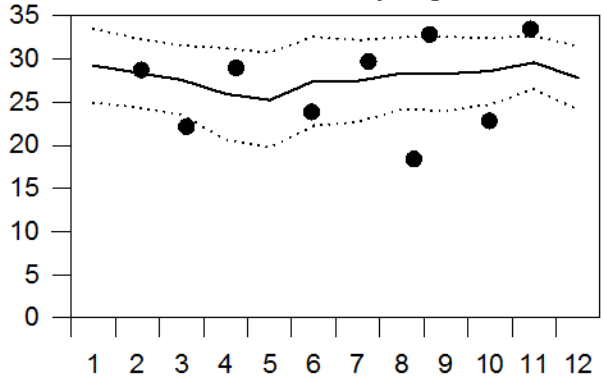
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

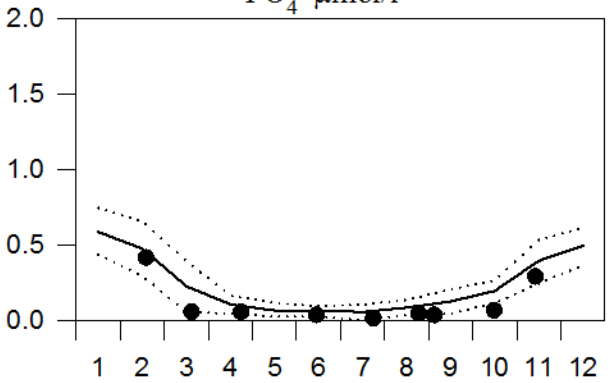
Temperature °C



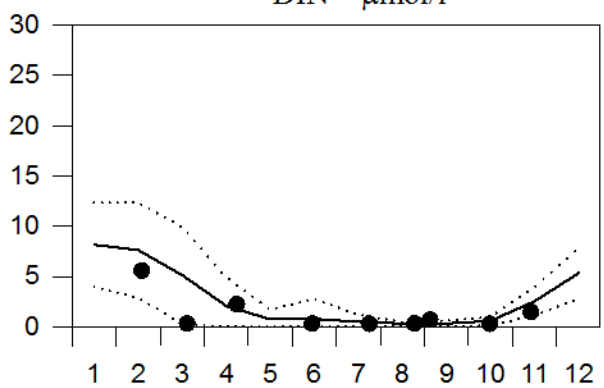
Salinity psu



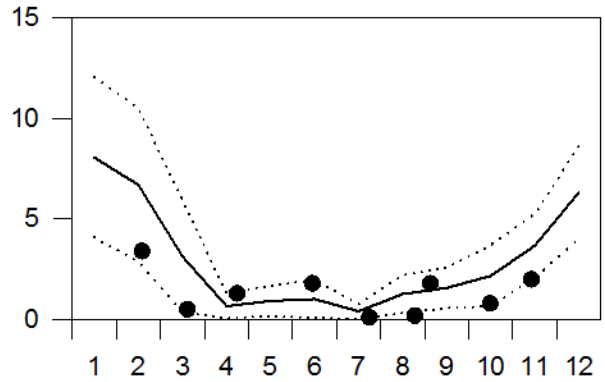
PO_4 µmol/l



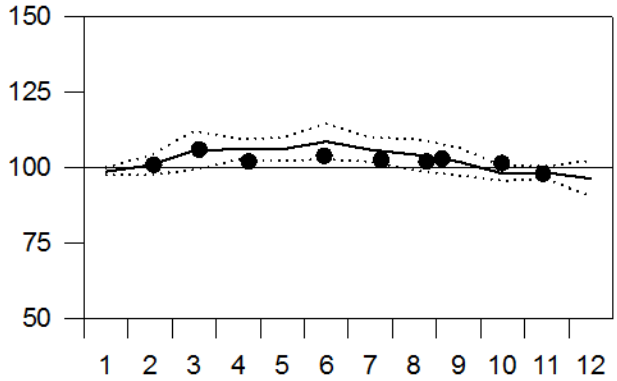
DIN µmol/l



SiO_3 µmol/l

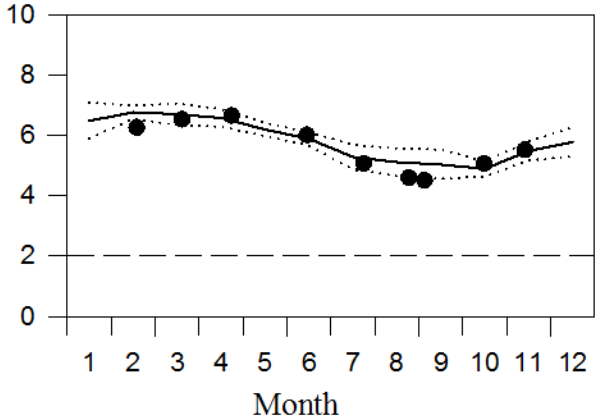


O_2 saturation %



OXYGEN IN BOTTOM WATER (depth >75m)

O_2 ml/l



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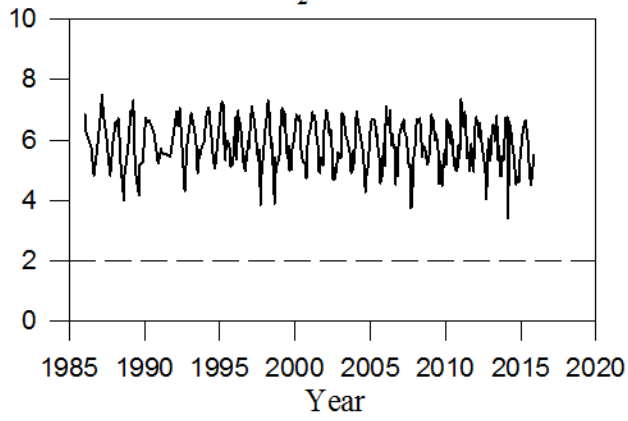
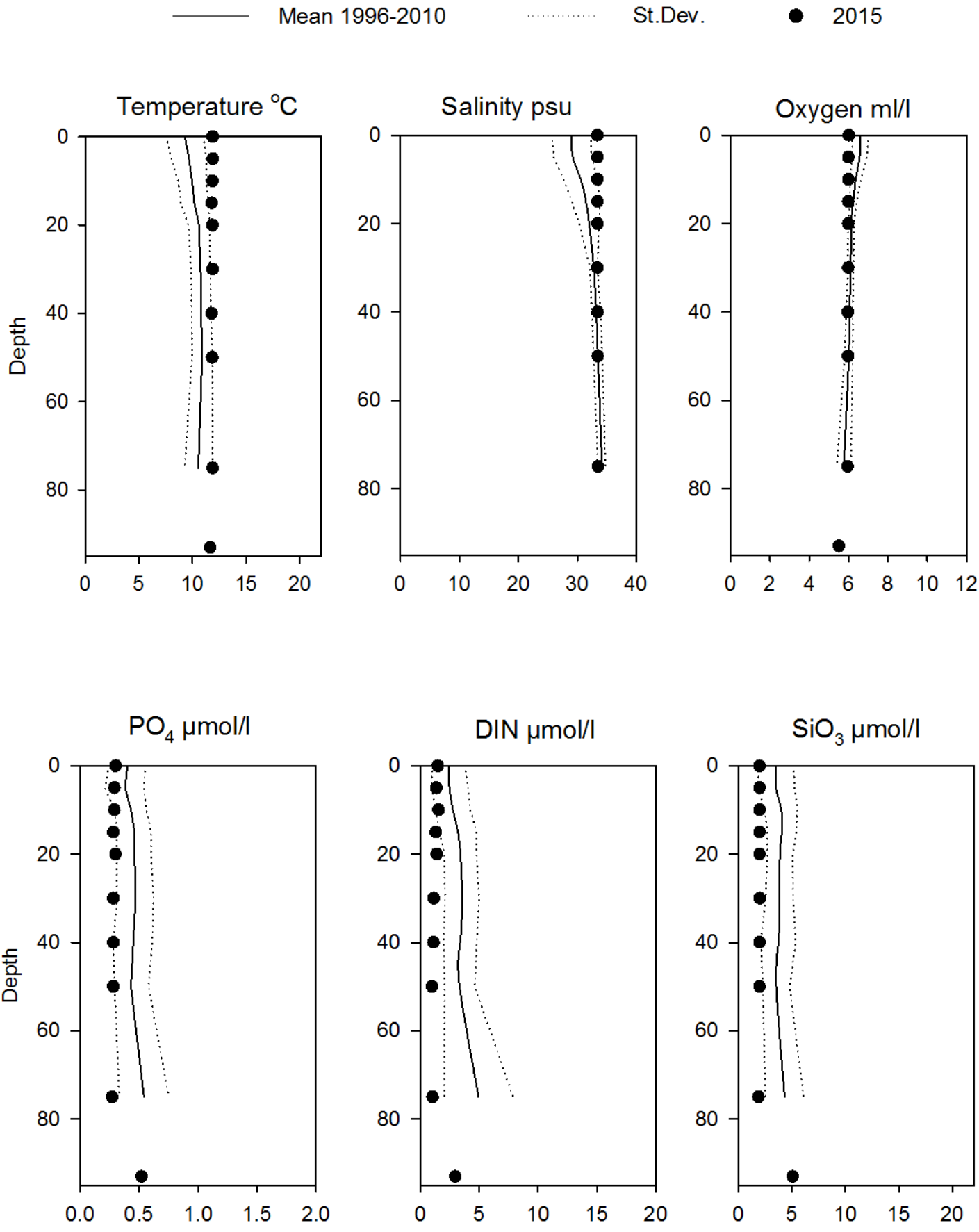


Vertical profiles P2 November

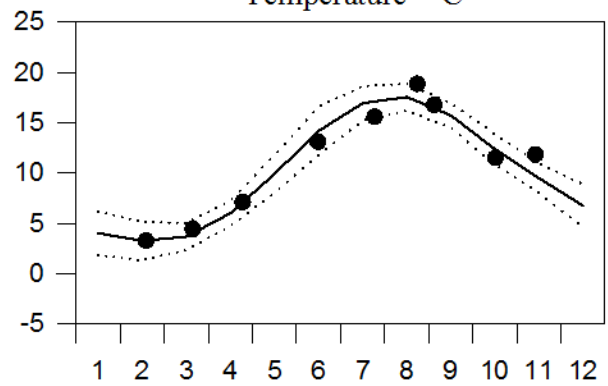


STATION Å13 SURFACE WATER

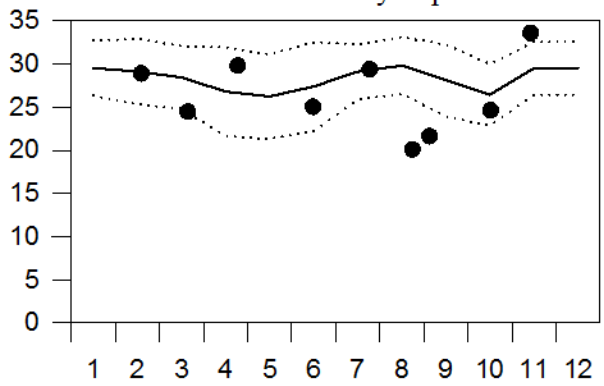
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

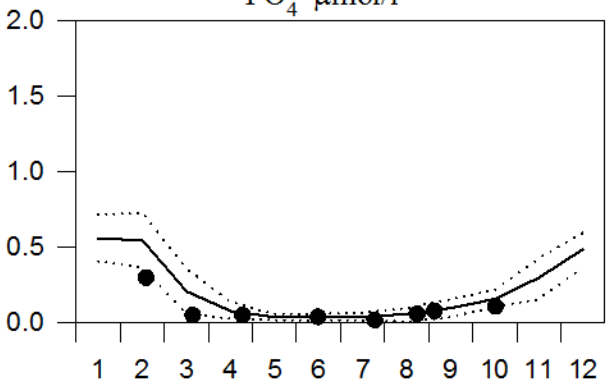
Temperature °C



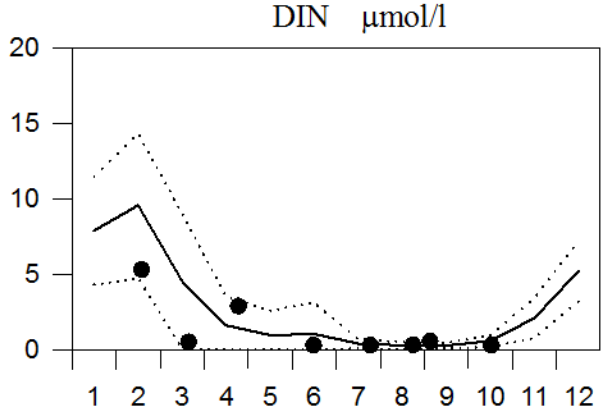
Salinity psu



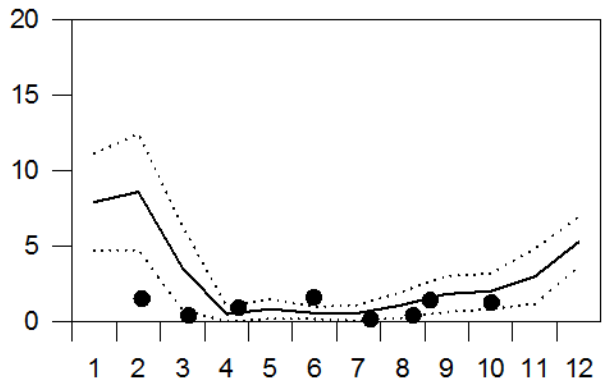
PO_4 µmol/l



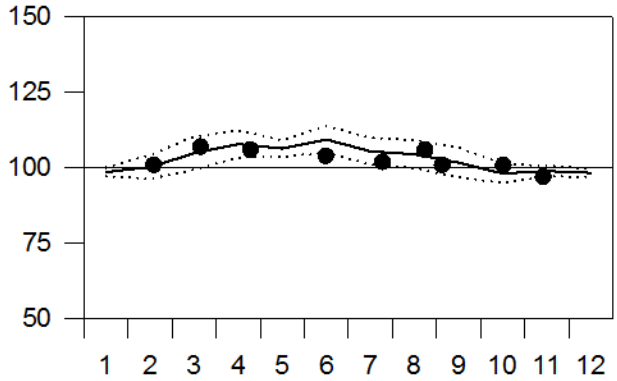
DIN µmol/l



SiO_3 µmol/l

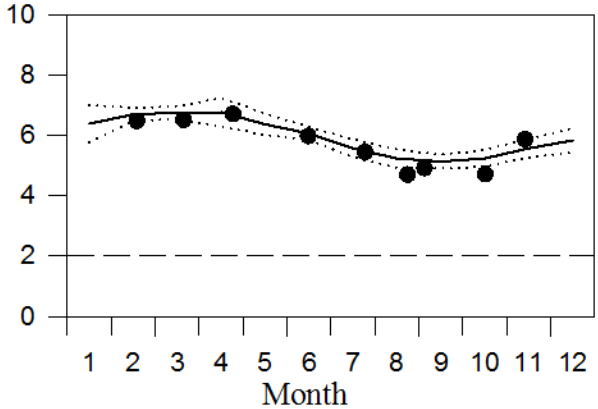


O_2 saturation %



OXYGEN IN BOTTOM WATER (depth >=75m)

O_2 ml/l



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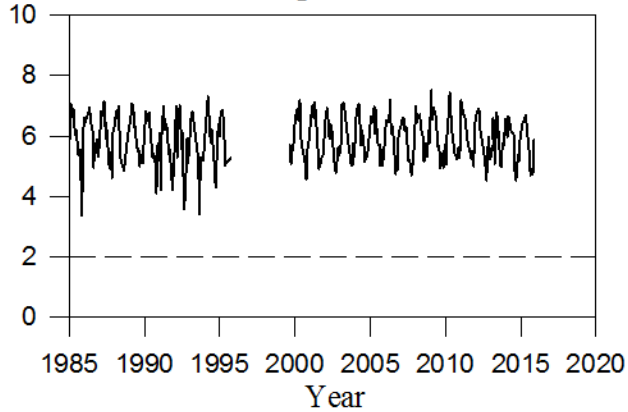
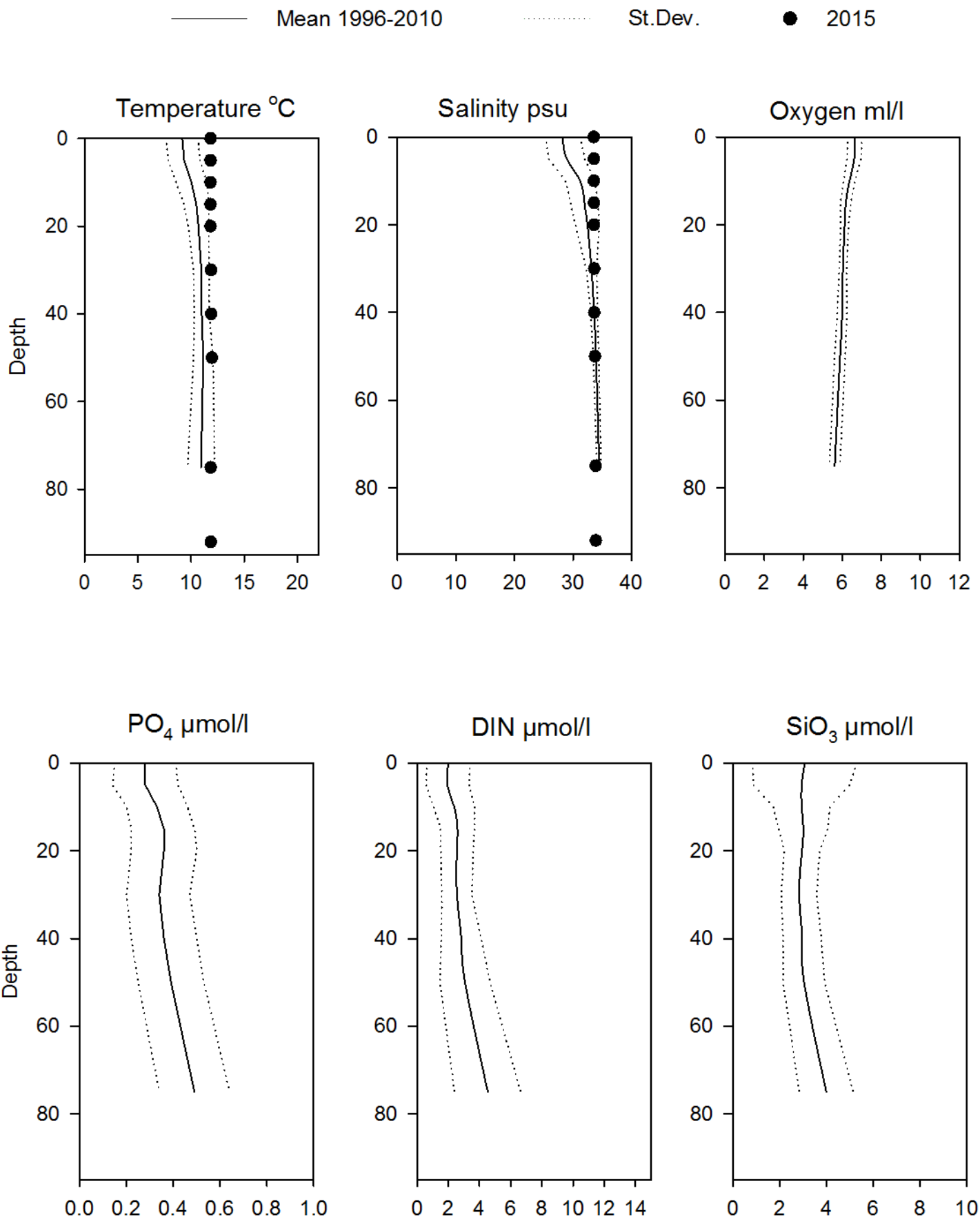


Vertical profiles Å13 November

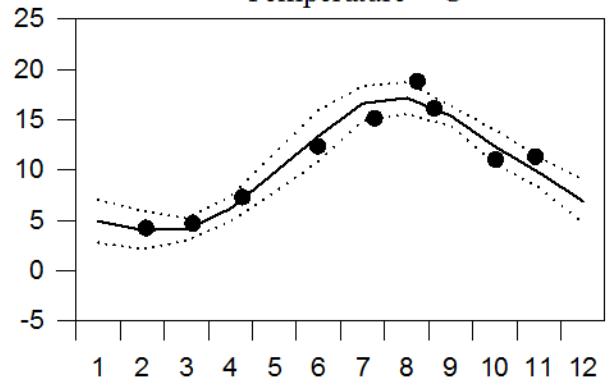


STATION Å15 SURFACE WATER

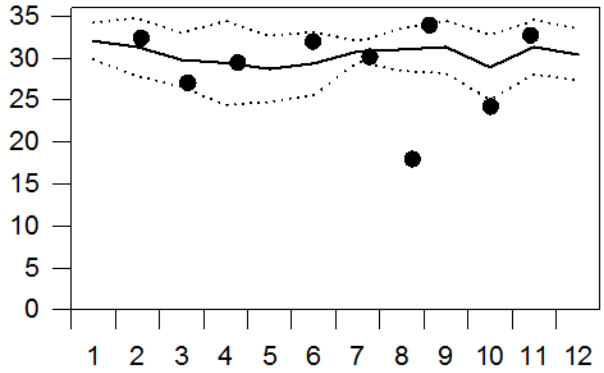
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

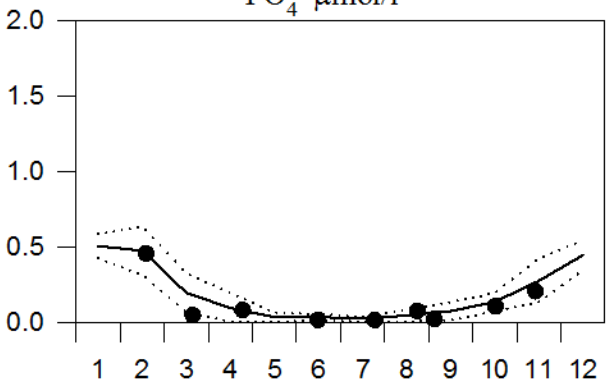
Temperature °C



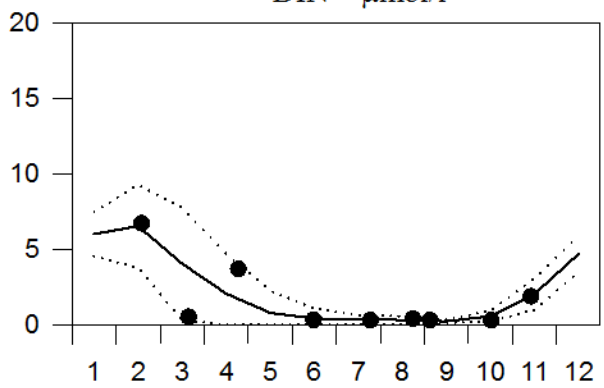
Salinity psu



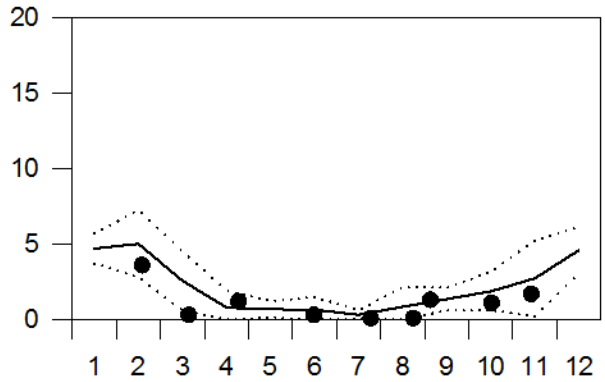
PO_4 µmol/l



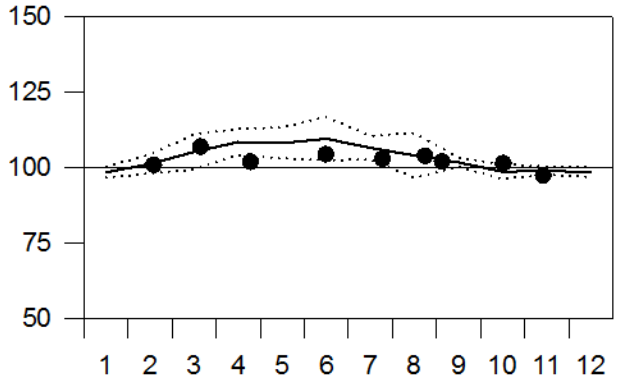
DIN µmol/l



SiO_3 µmol/l

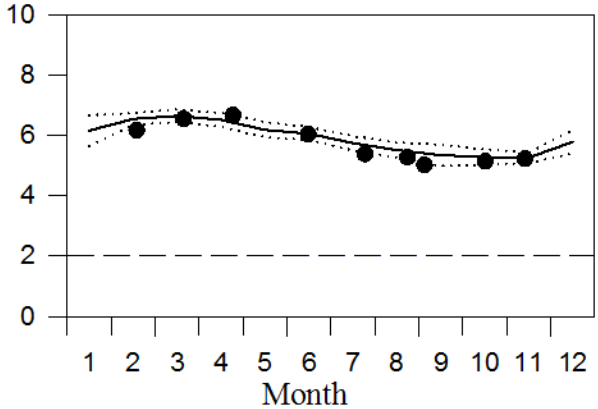


O_2 saturation %

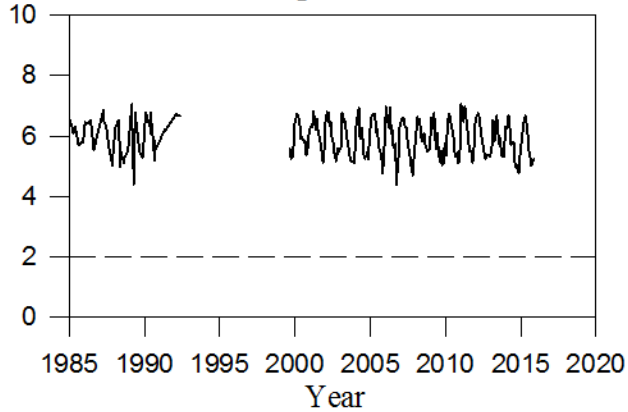


OXYGEN IN BOTTOM WATER (depth >=125m)

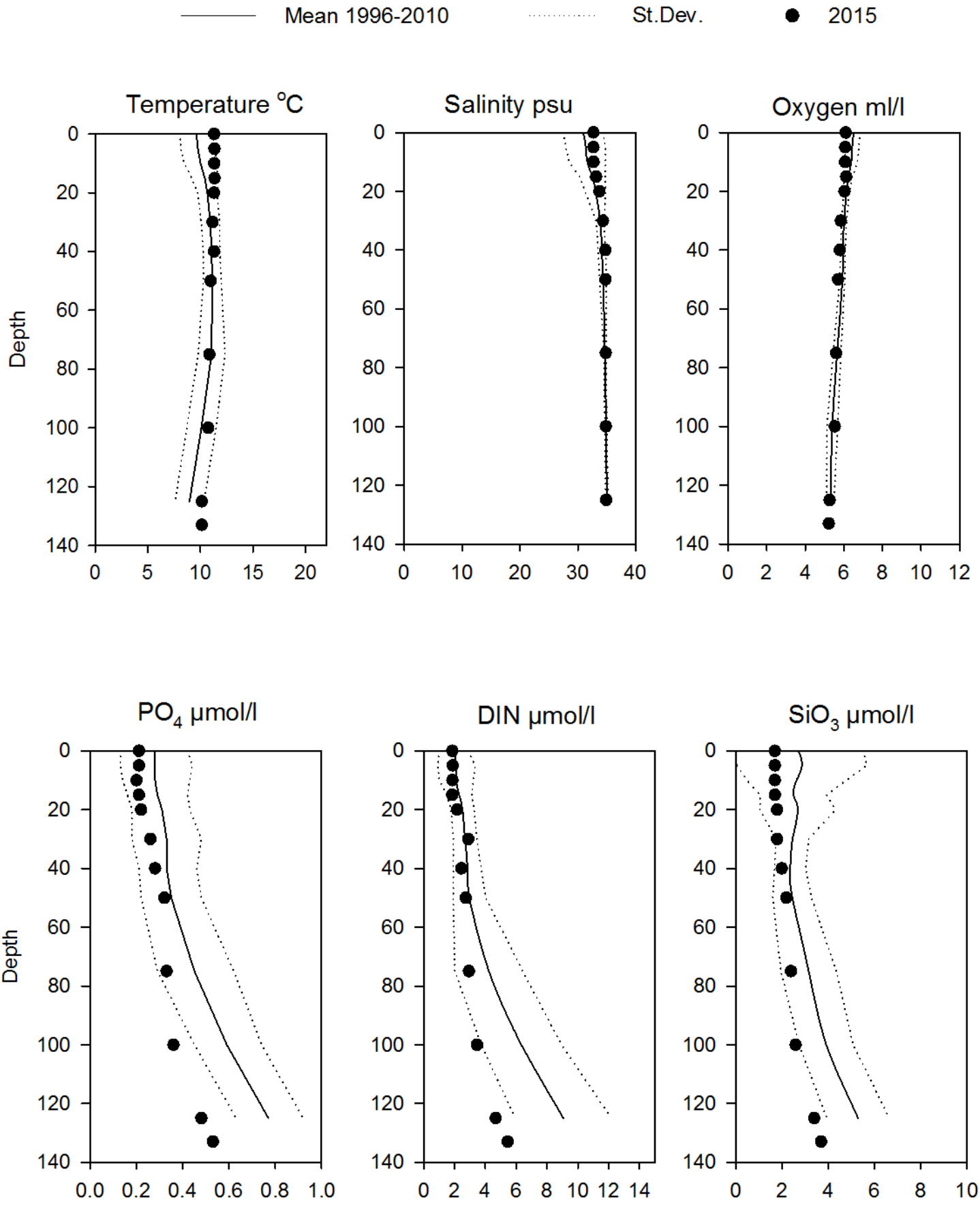
O_2 ml/l



O_2 ml/l



Vertical profiles Å15 November

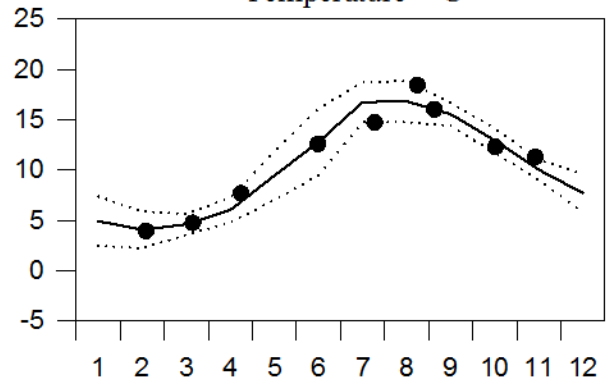


STATION Å17 SURFACE WATER

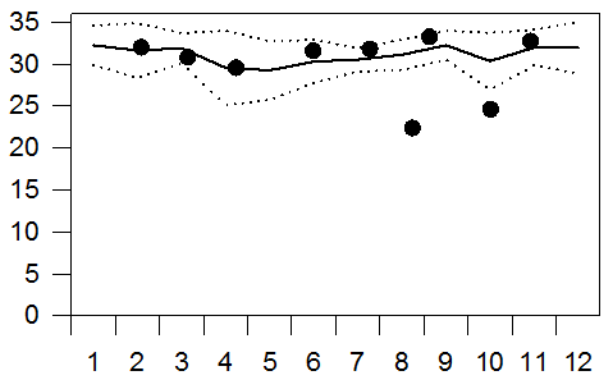
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

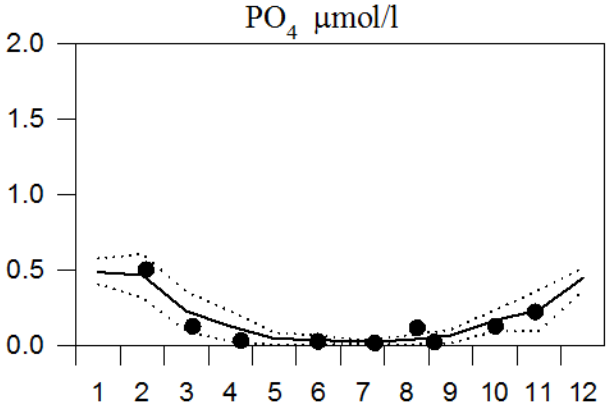
Temperature °C



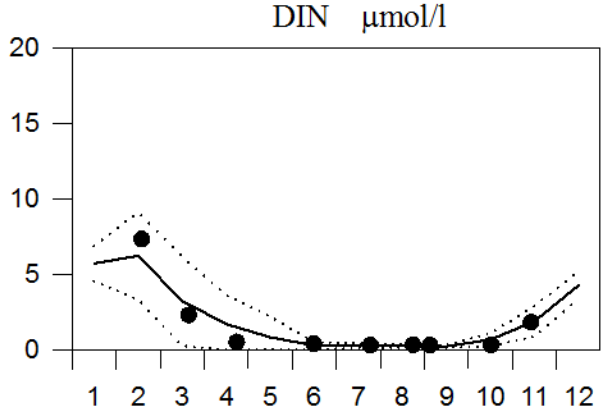
Salinity psu



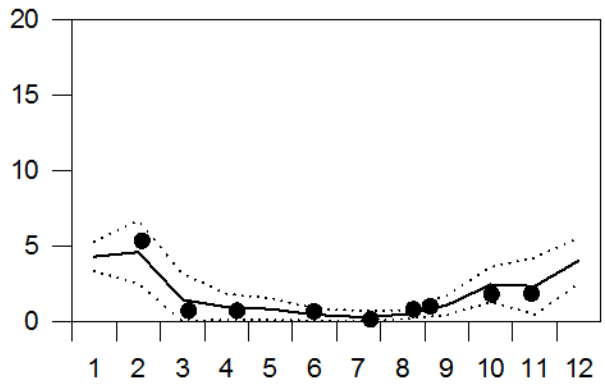
PO_4 µmol/l



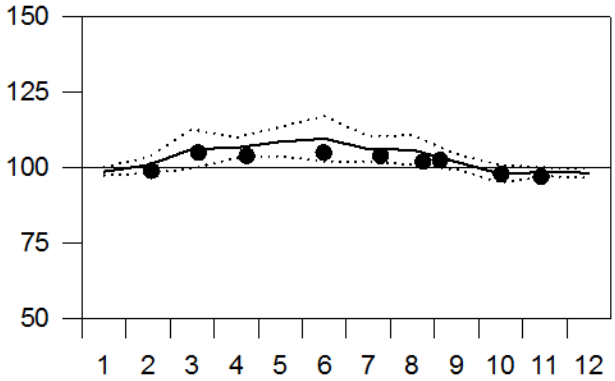
DIN µmol/l



SiO_3 µmol/l

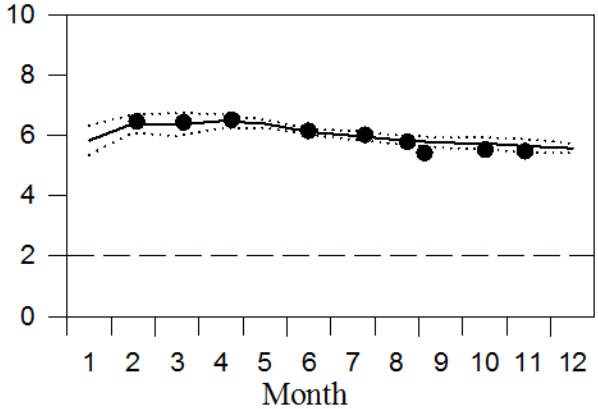


O_2 saturation %

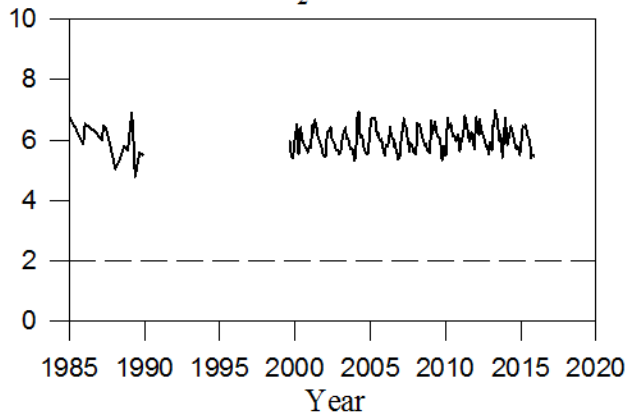


OXYGEN IN BOTTOM WATER (depth = 300m)

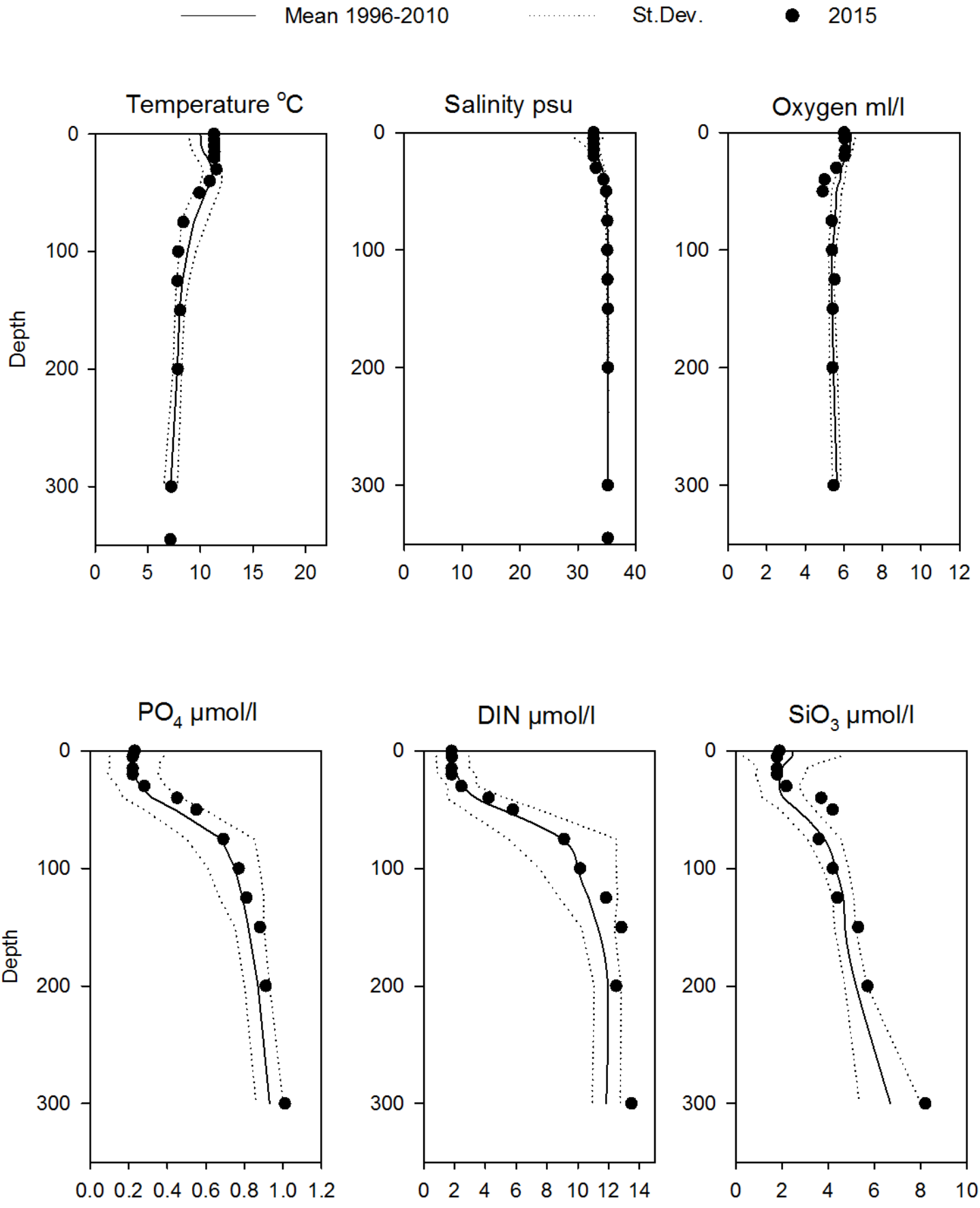
O_2 ml/l



O_2 ml/l



Vertical profiles Å17 November

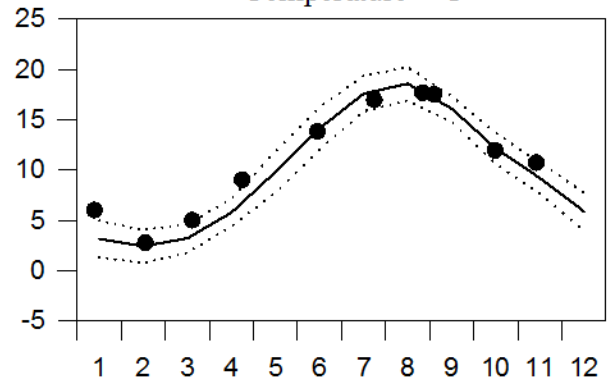


STATION FLADEN SURFACE WATER

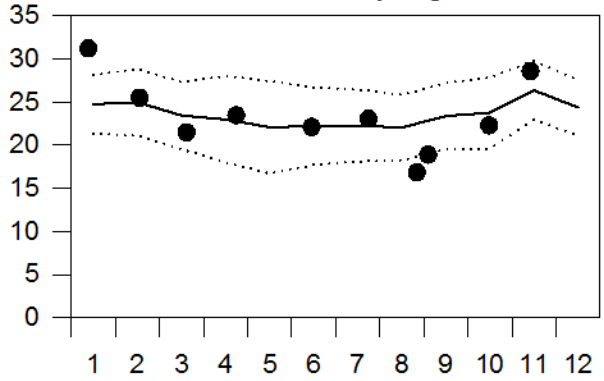
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

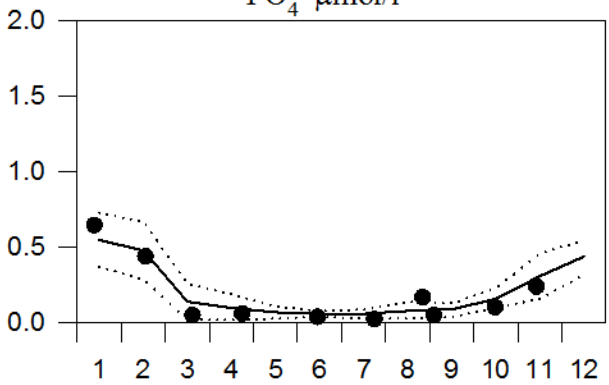
Temperature °C



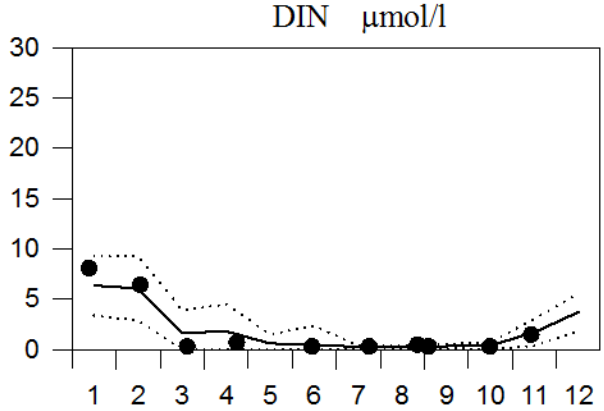
Salinity psu



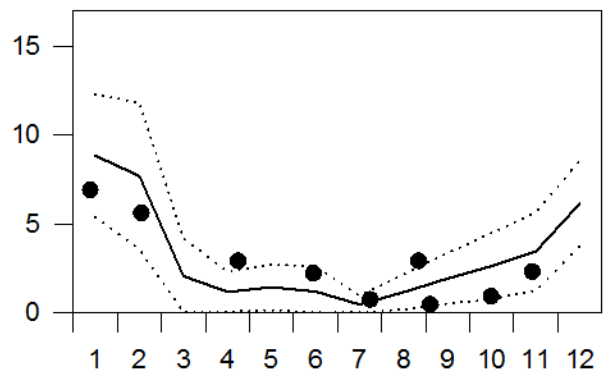
PO_4 µmol/l



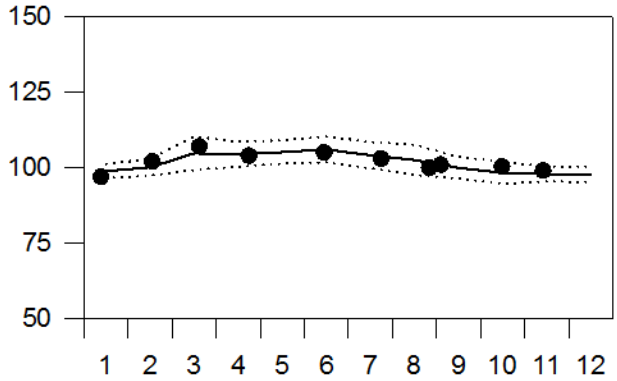
DIN µmol/l



SiO_3 µmol/l

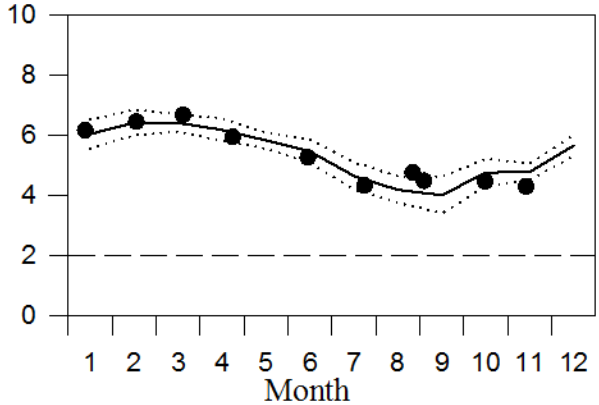


O_2 saturation %

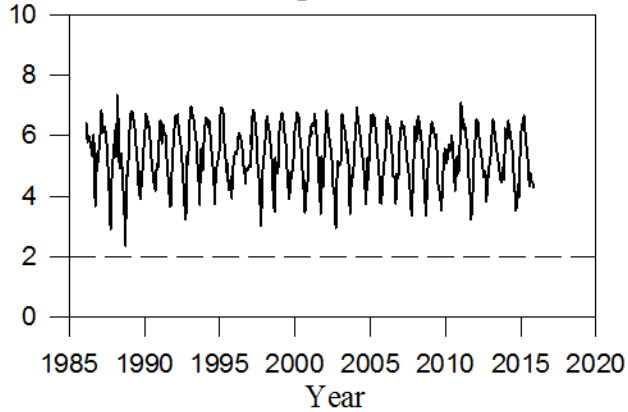


OXYGEN IN BOTTOM WATER (depth > 70m)

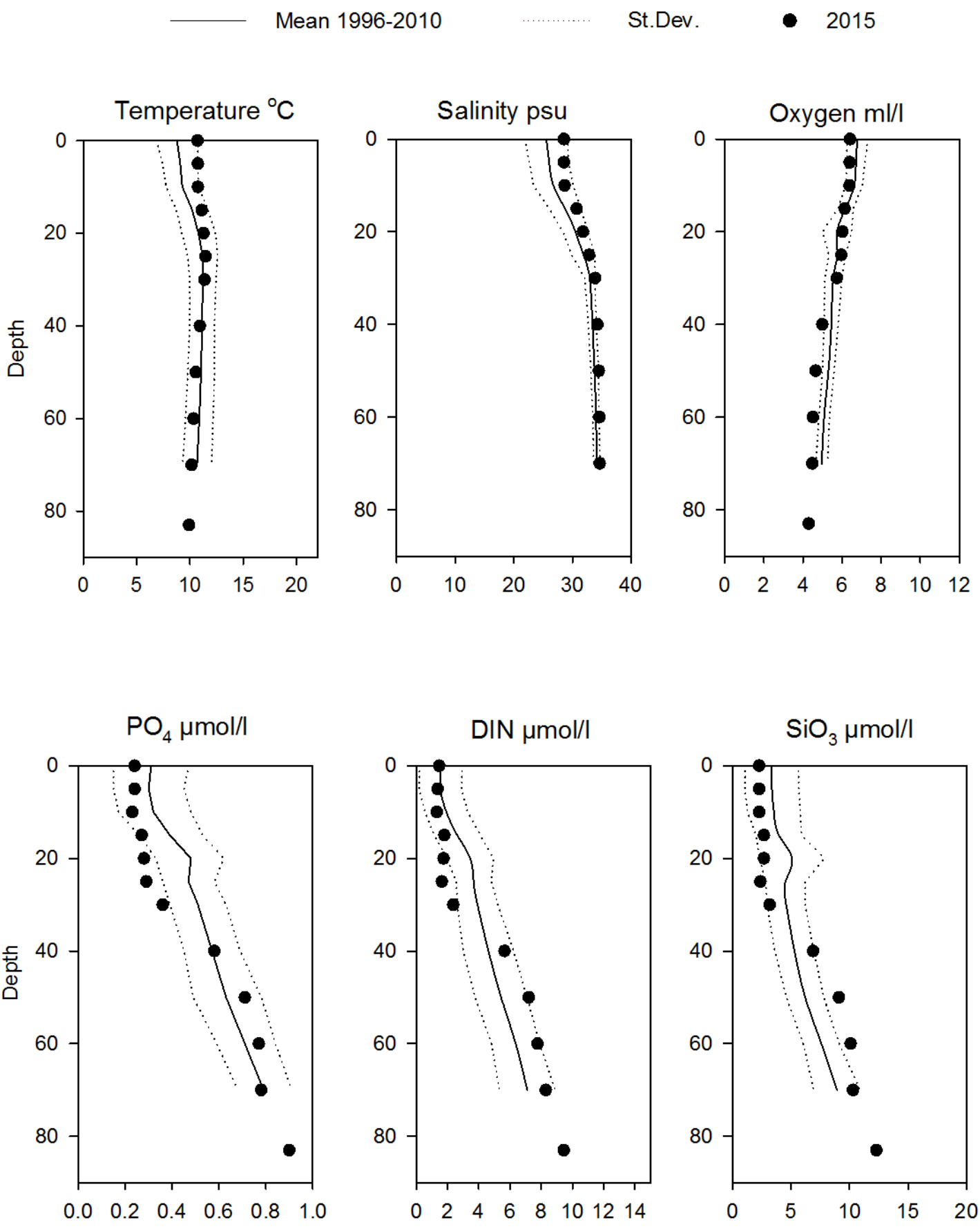
O_2 ml/l



O_2 ml/l



Vertical profiles Fladen November

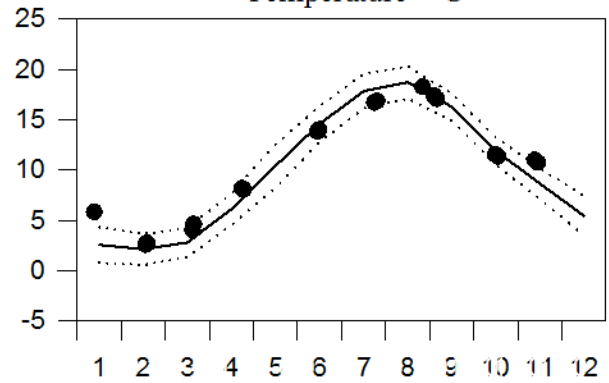


STATION ANHOLT E SURFACE WATER

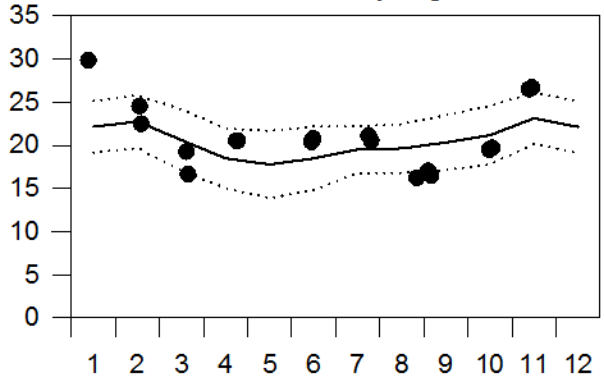
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

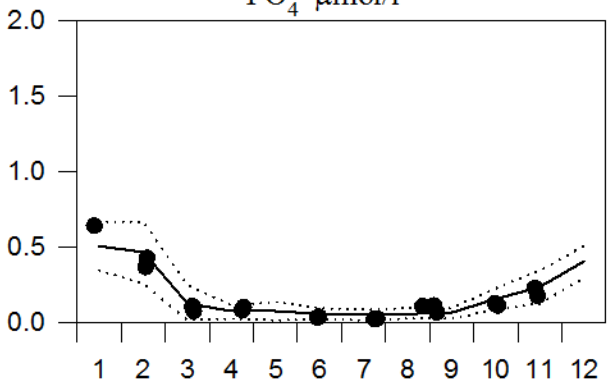
Temperature °C



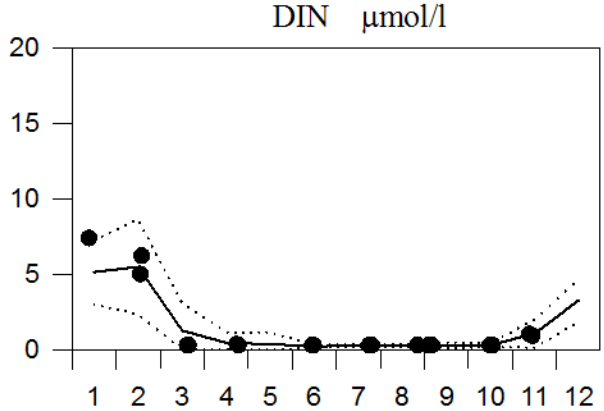
Salinity psu



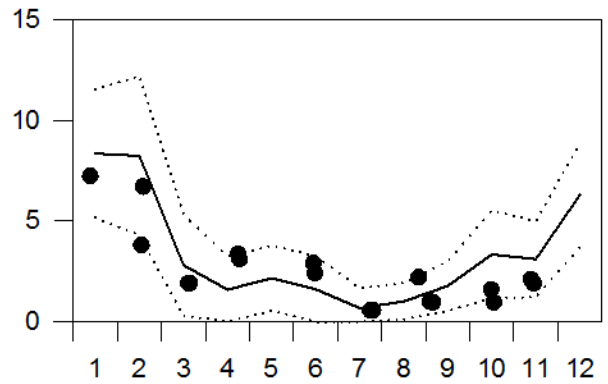
PO_4 µmol/l



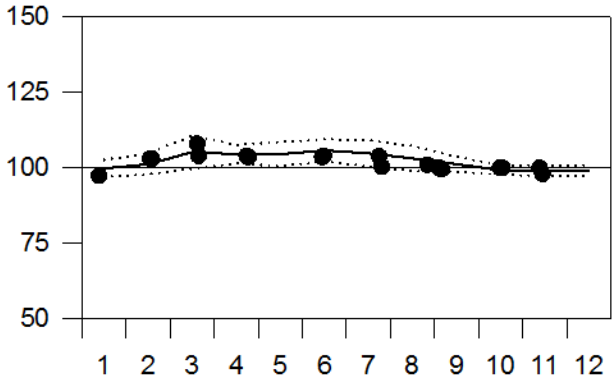
DIN µmol/l



SiO_3 µmol/l

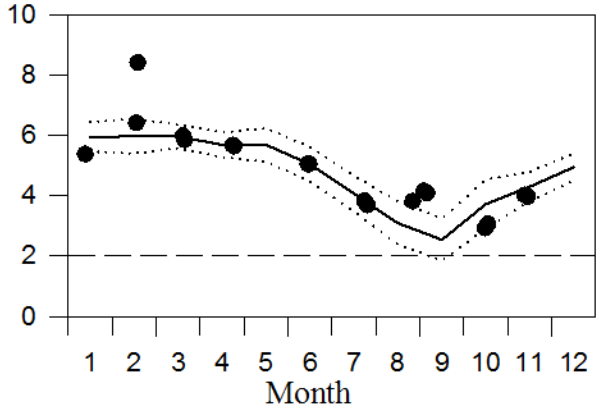


O_2 saturation %

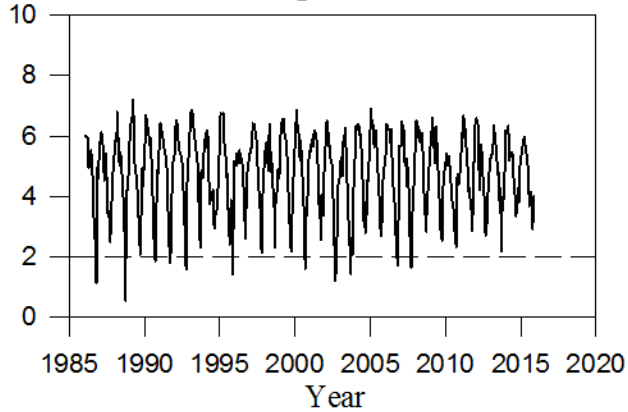


OXYGEN IN BOTTOM WATER (depth > 50m)

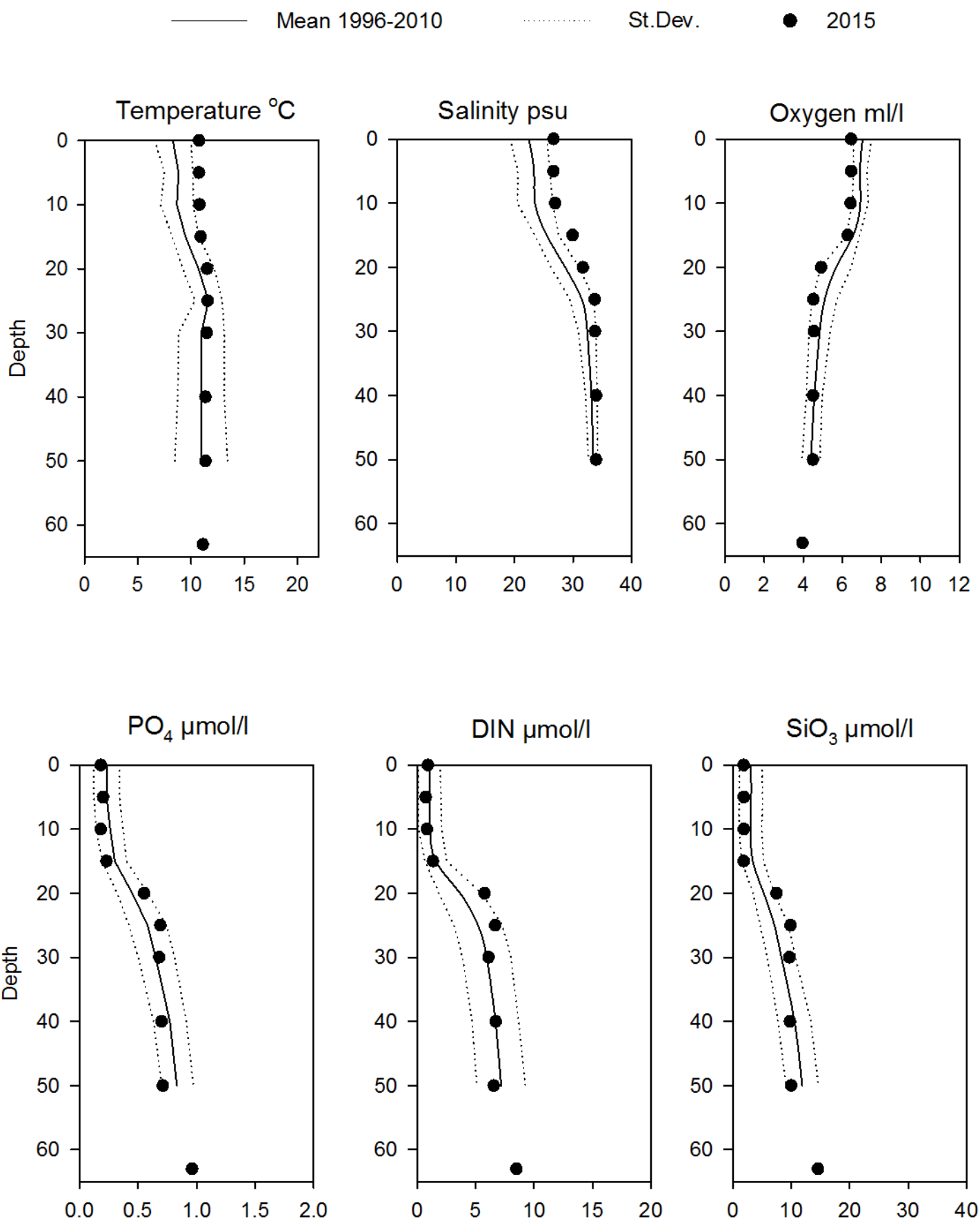
O_2 ml/l



O_2 ml/l



Vertical profiles Anholt E November

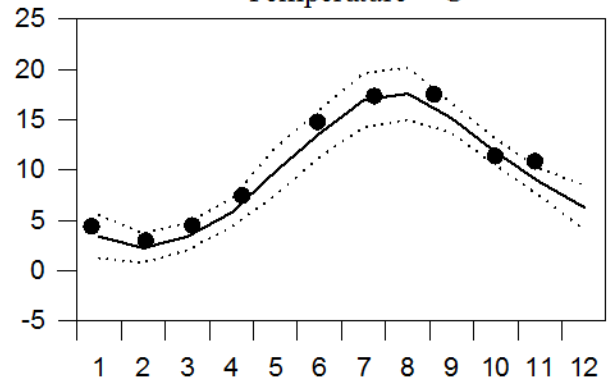


STATION W LANDSKRONA SURFACE WATER

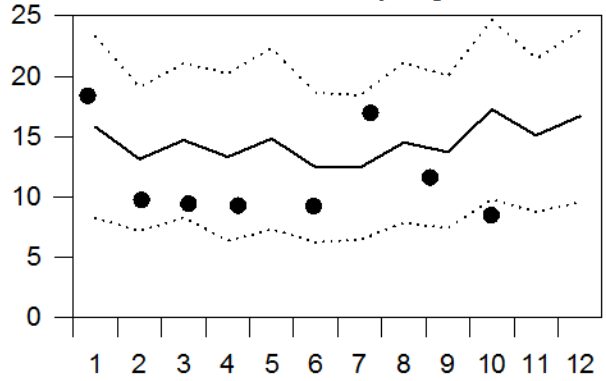
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

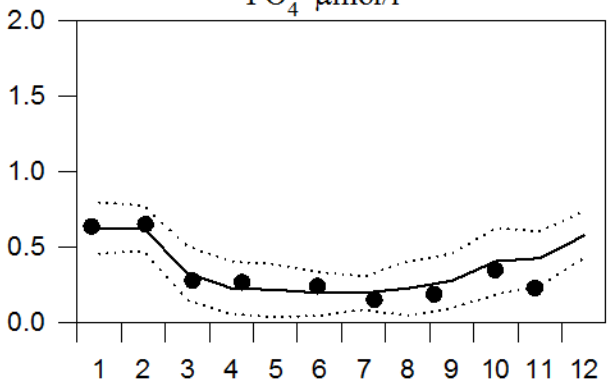
Temperature °C



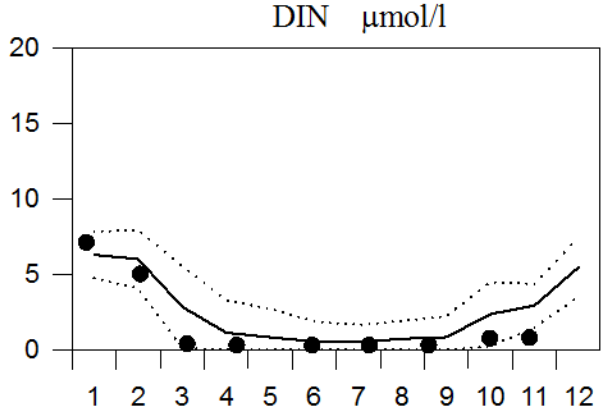
Salinity psu



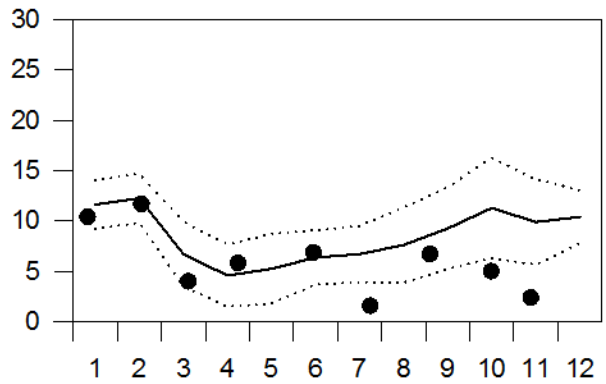
PO_4 µmol/l



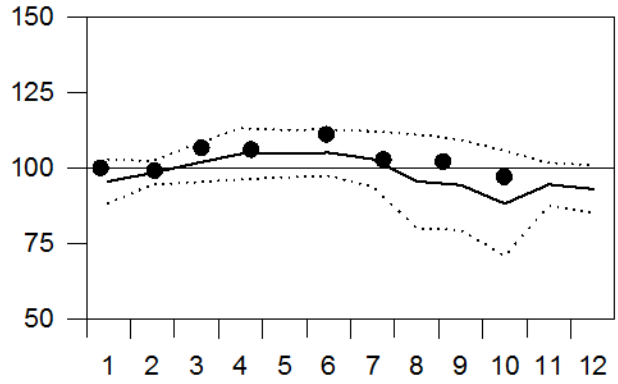
DIN µmol/l



SiO_3 µmol/l

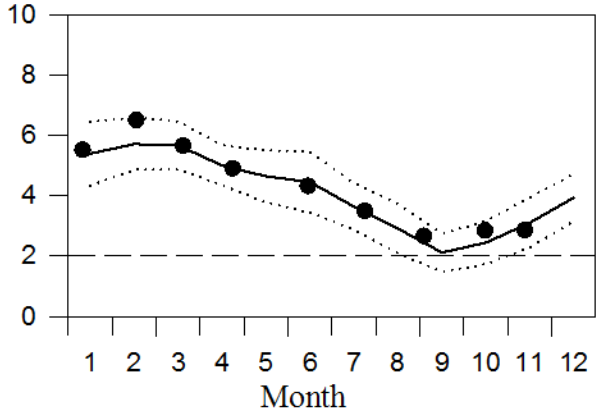


O_2 saturation %

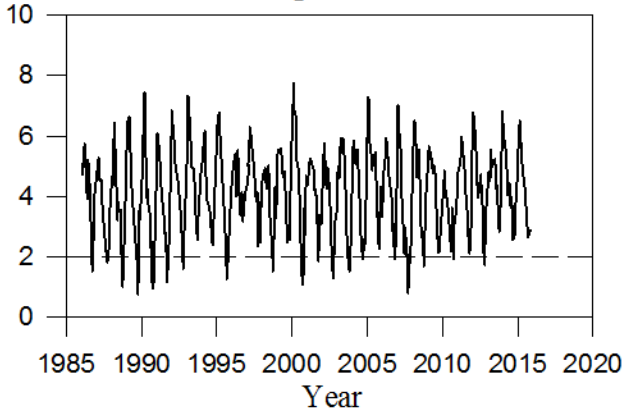


OXYGEN IN BOTTOM WATER (depth >40m)

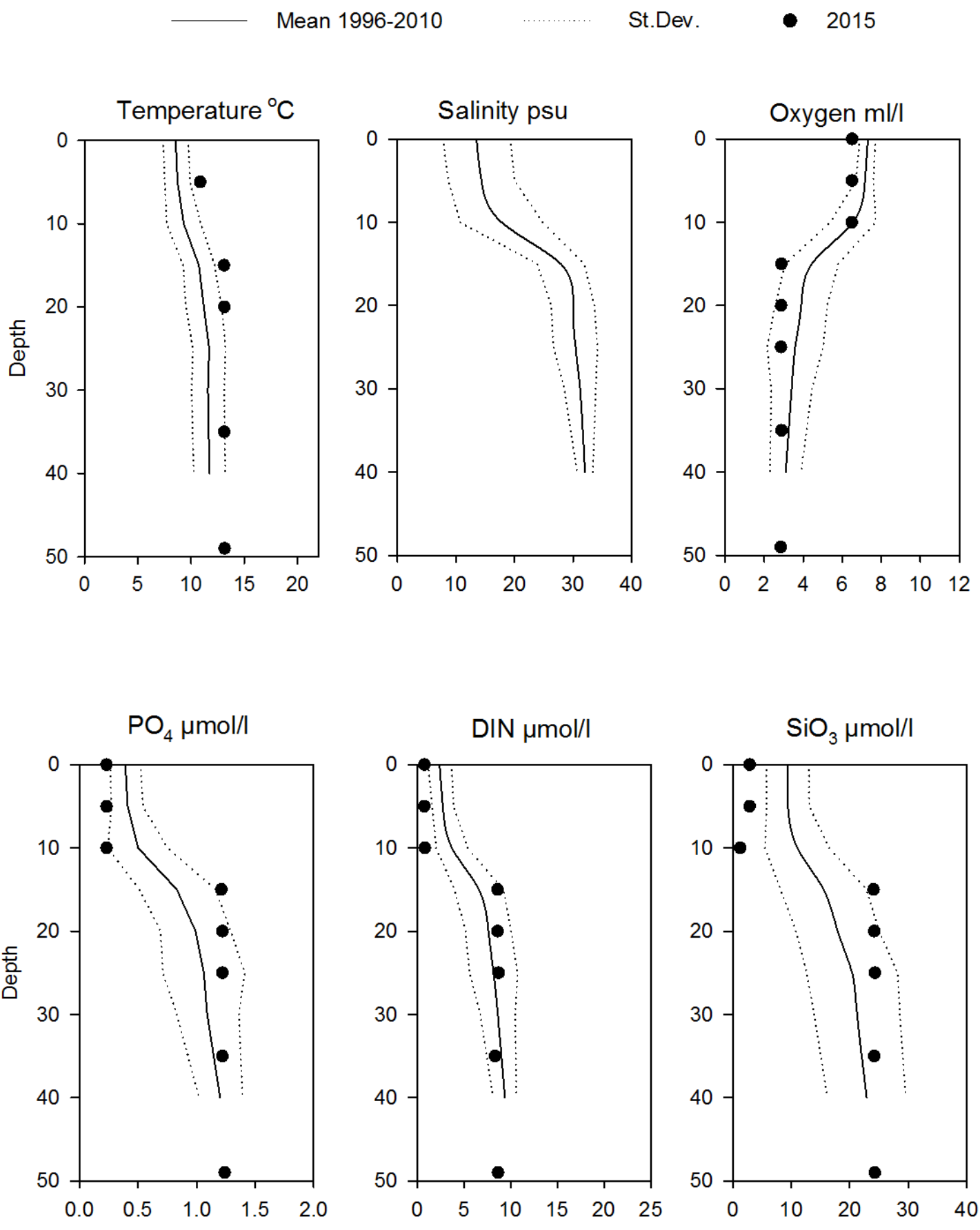
O_2 ml/l



O_2 ml/l

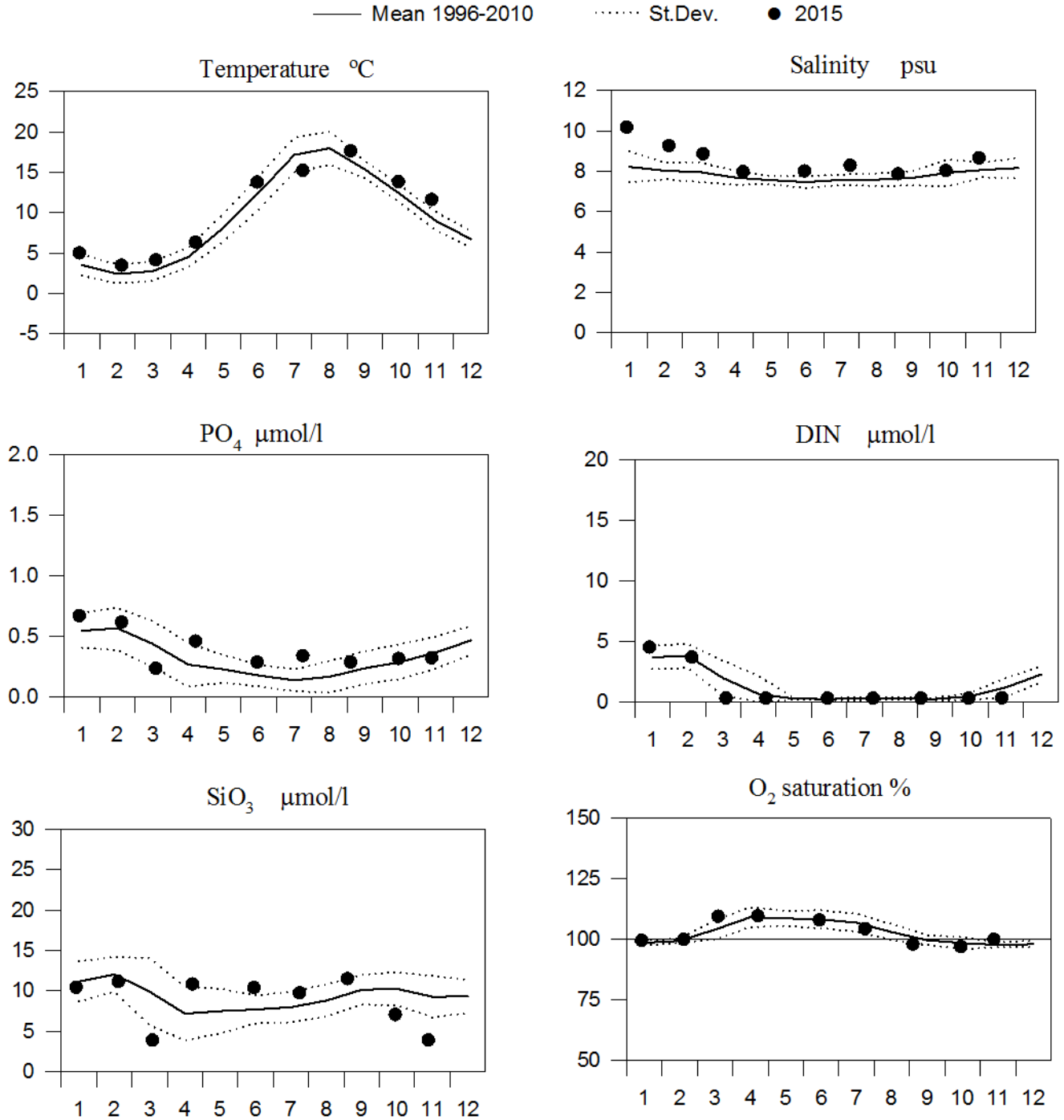


Vertical profiles W Landskrona November

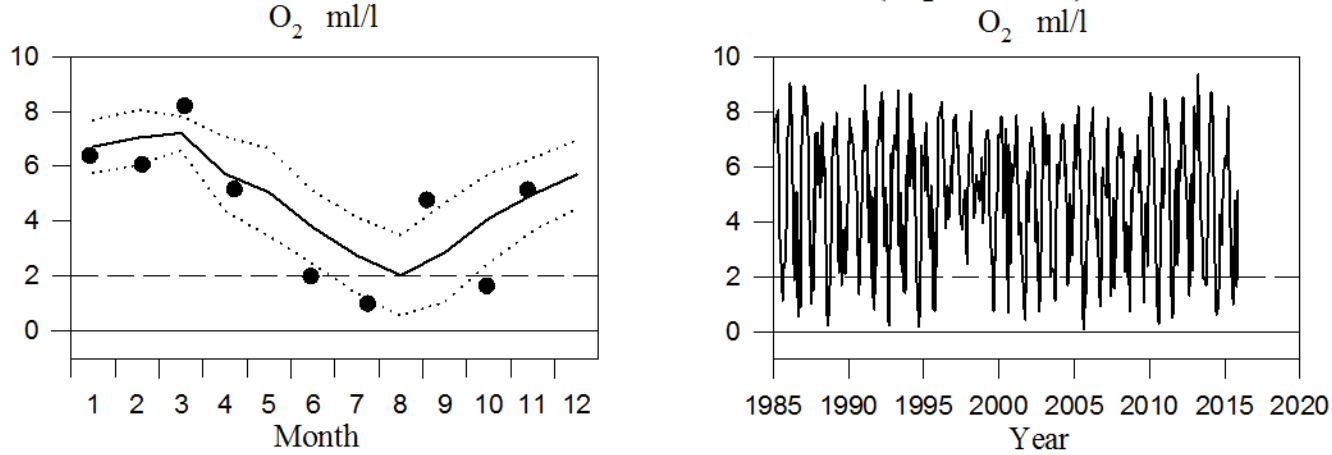


STATION BY1 SURFACE WATER

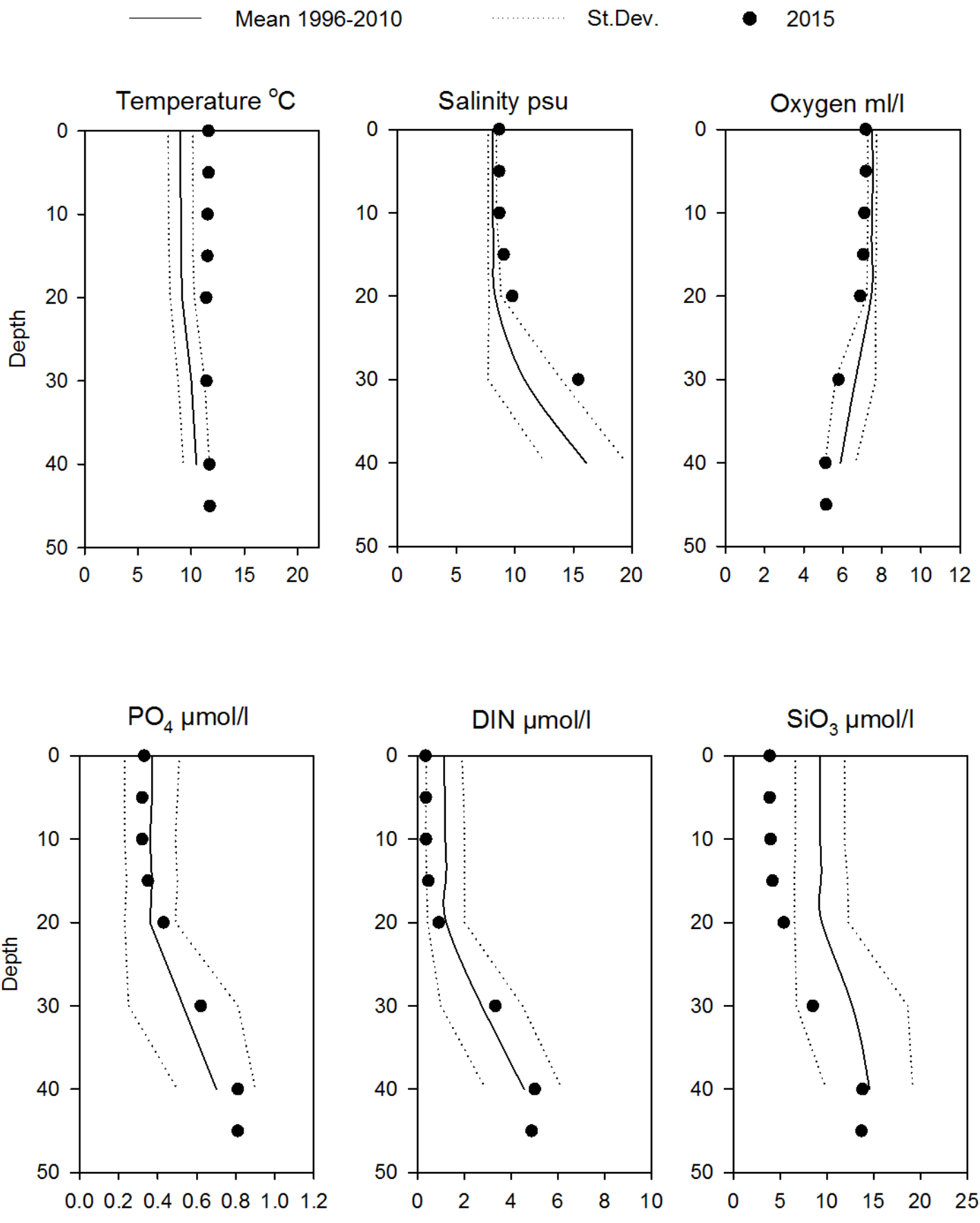
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >40m)



Vertical profiles BY1 November

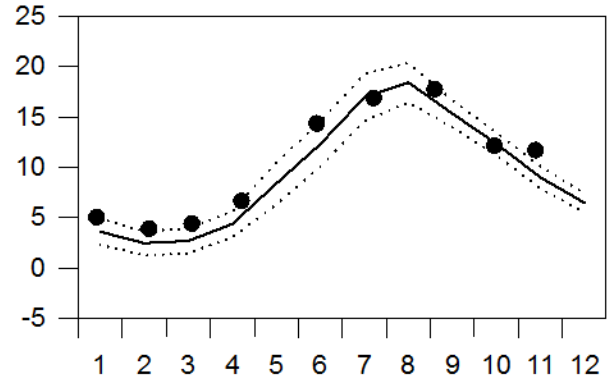


STATION BY2 SURFACE WATER

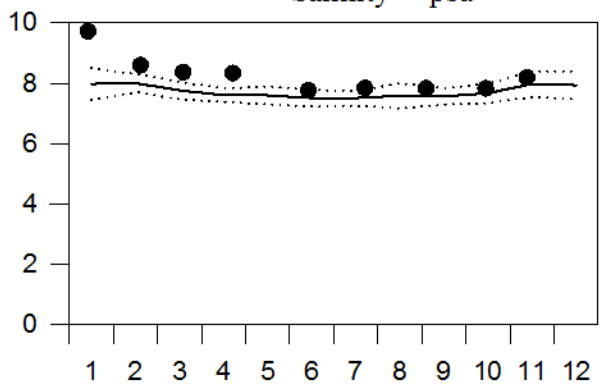
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

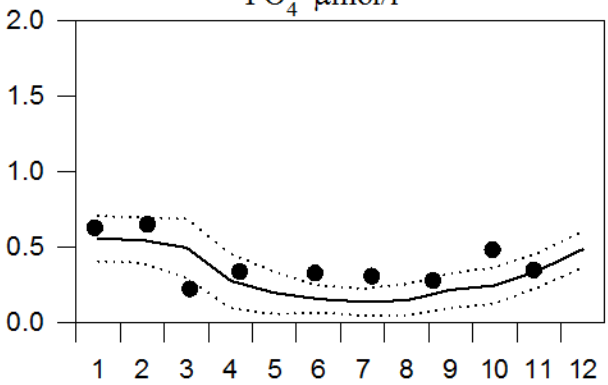
Temperature °C



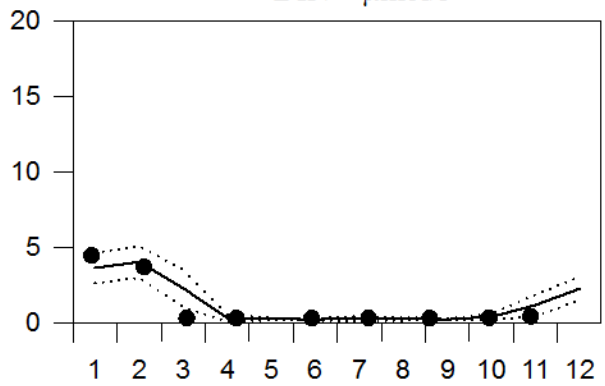
Salinity psu



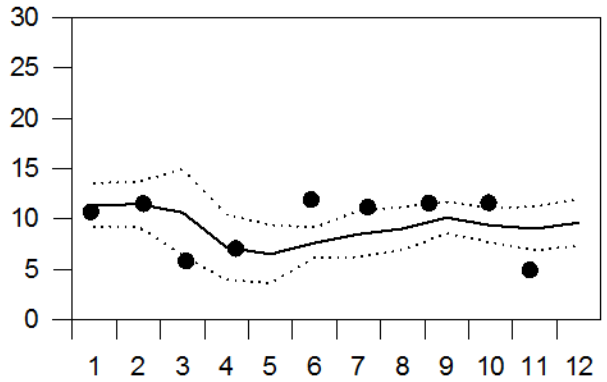
PO_4 µmol/l



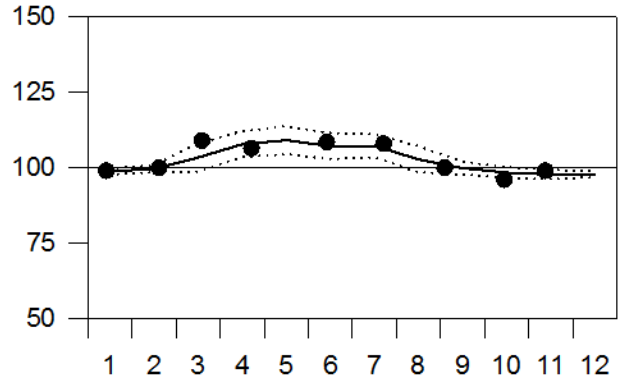
DIN µmol/l



SiO_3 µmol/l

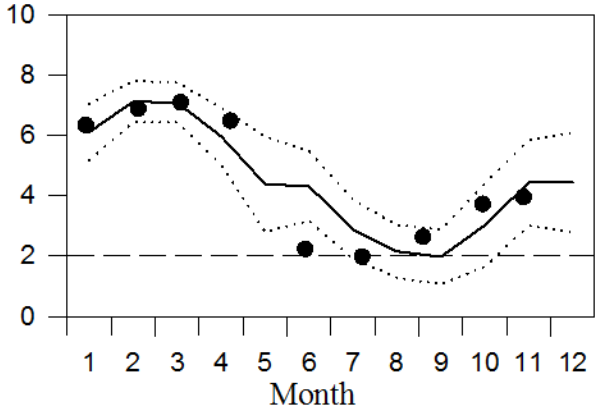


O_2 saturation %

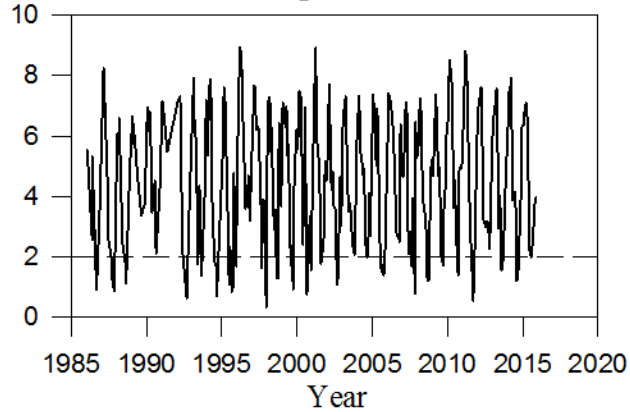


OXYGEN IN BOTTOM WATER (depth >40m)

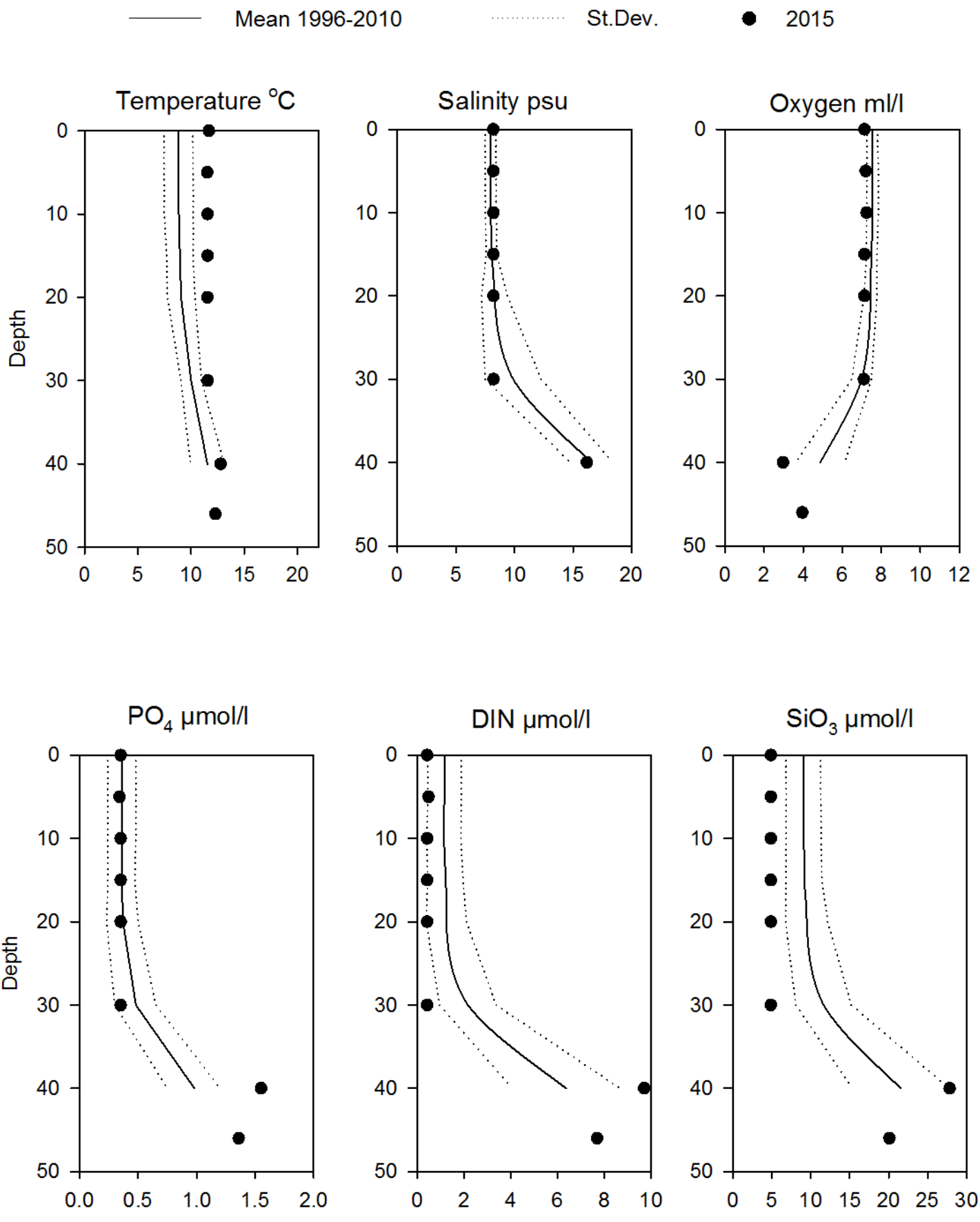
O_2 ml/l



O_2 ml/l



Vertical profiles BY2 November

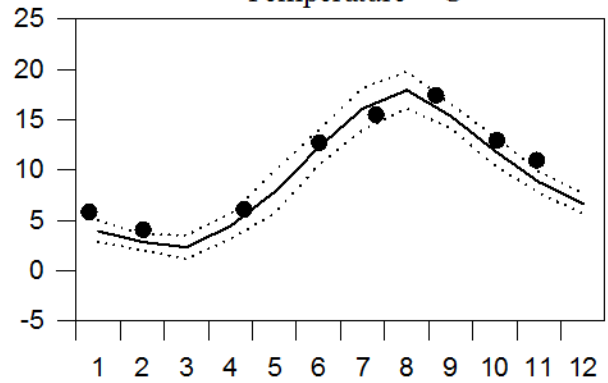


STATION HANÖBUKTEN SURFACE WATER

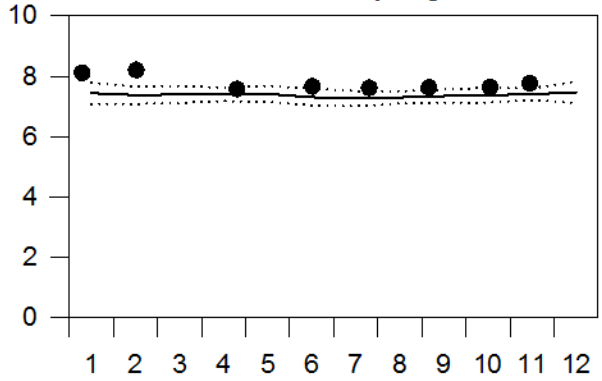
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

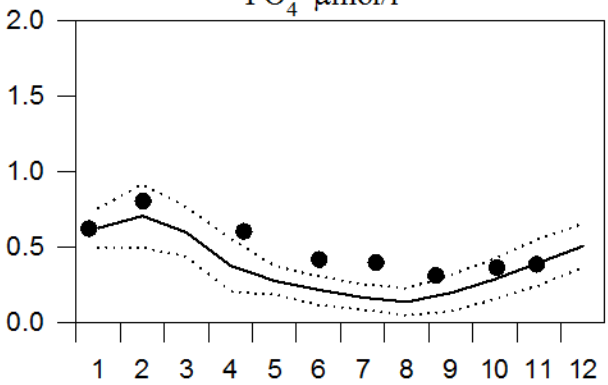
Temperature °C



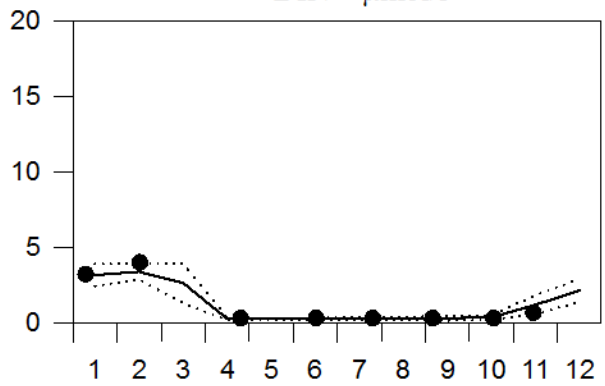
Salinity psu



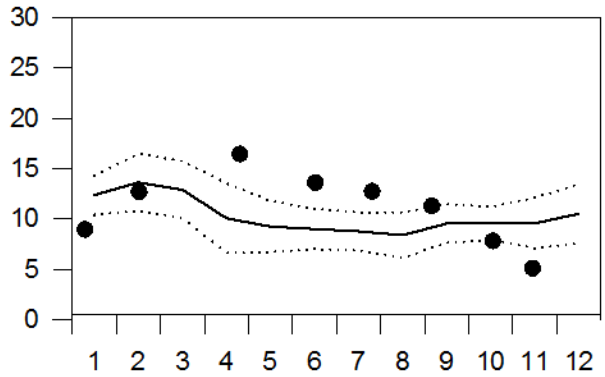
PO_4 µmol/l



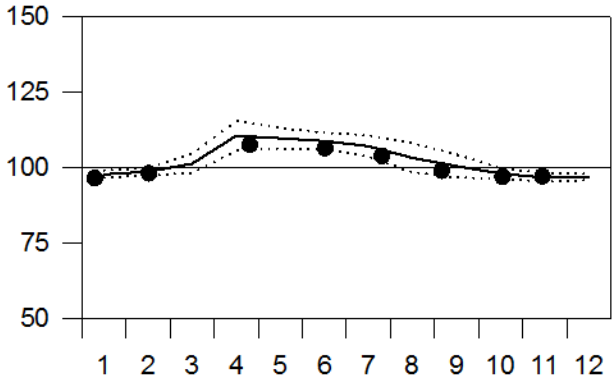
DIN µmol/l



SiO_3 µmol/l

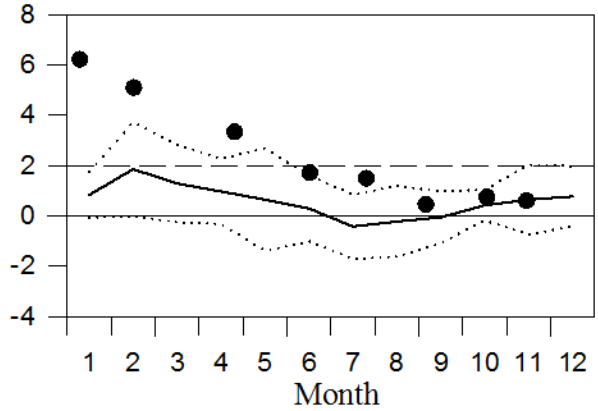


O_2 saturation %

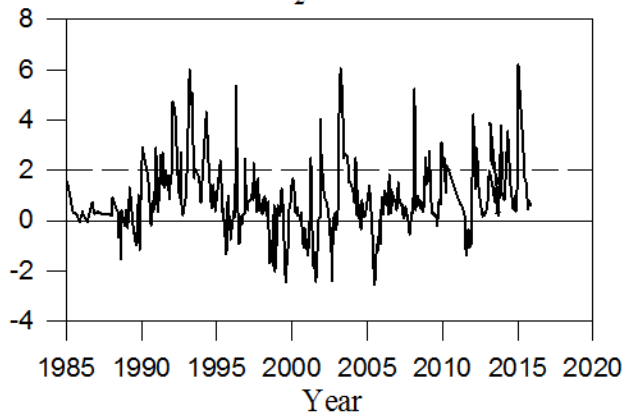


OXYGEN IN BOTTOM WATER (depth > 70m)

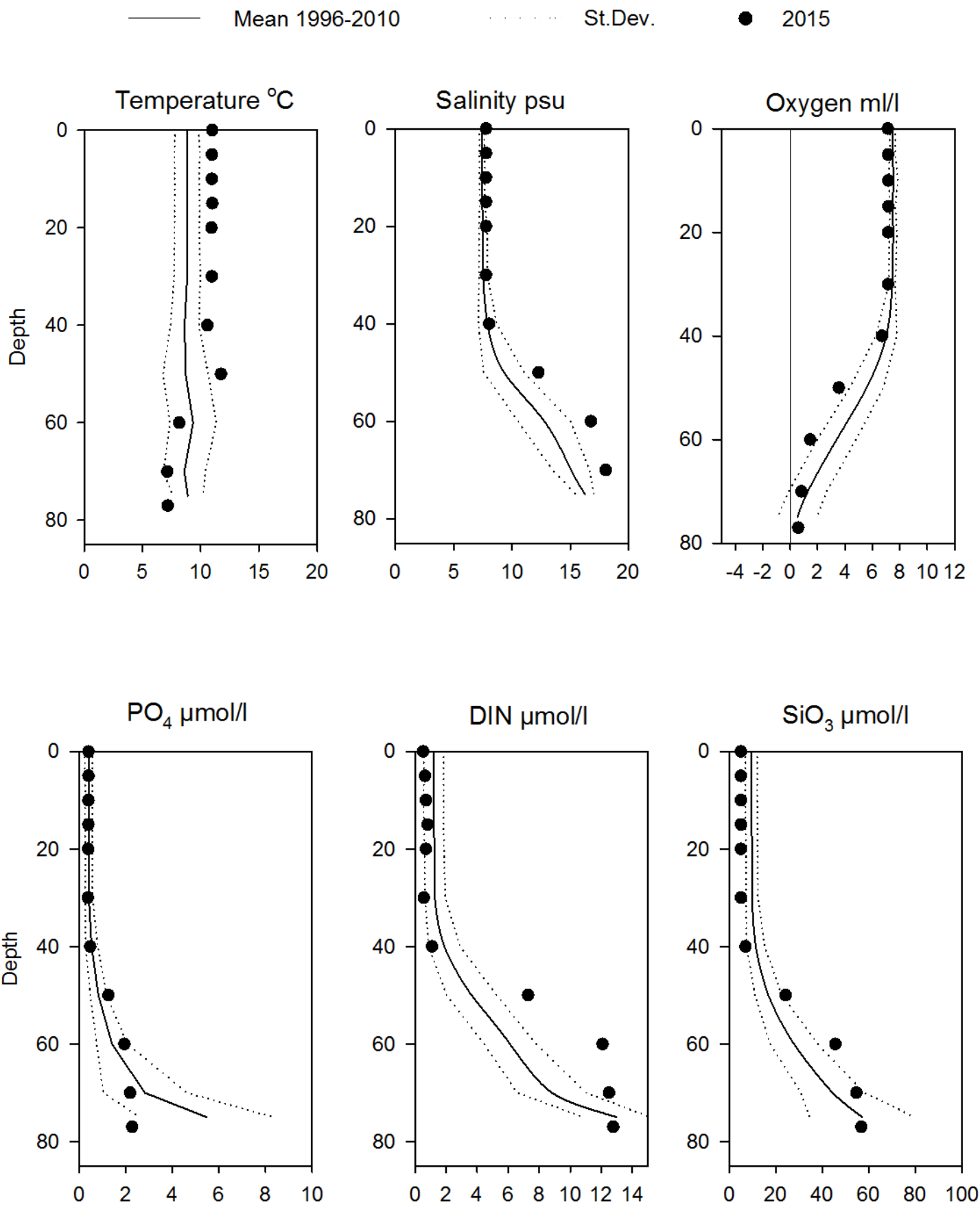
O_2 ml/l



O_2 ml/l



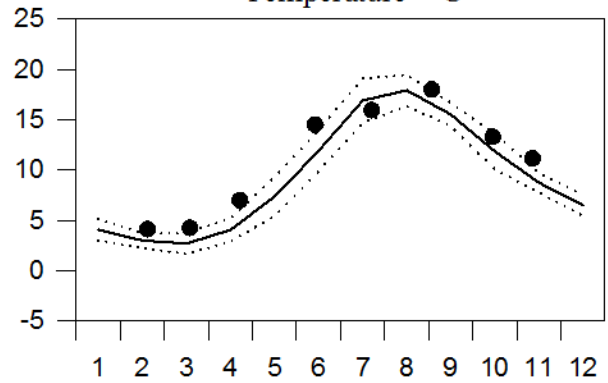
Vertical profiles Hanöbukten November



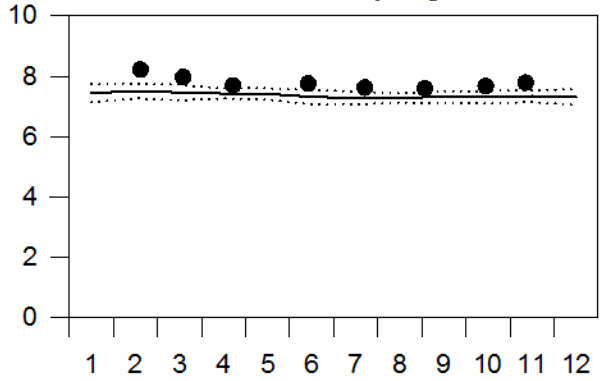
STATION BY4 SURFACE WATER

Annual Cycles

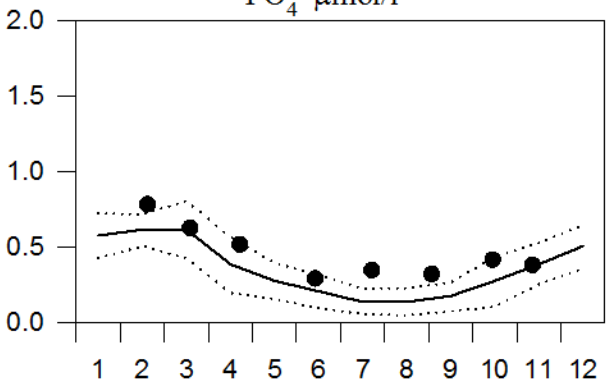
Temperature °C



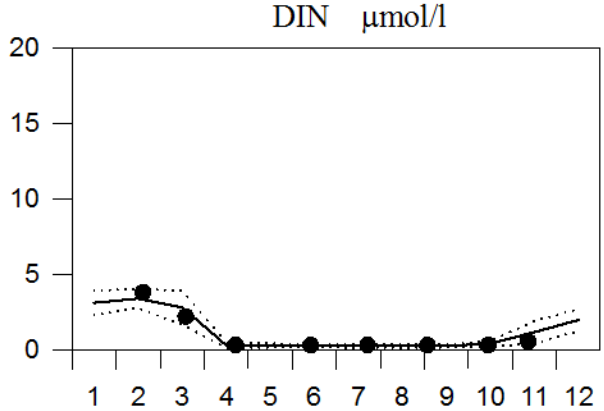
Salinity psu



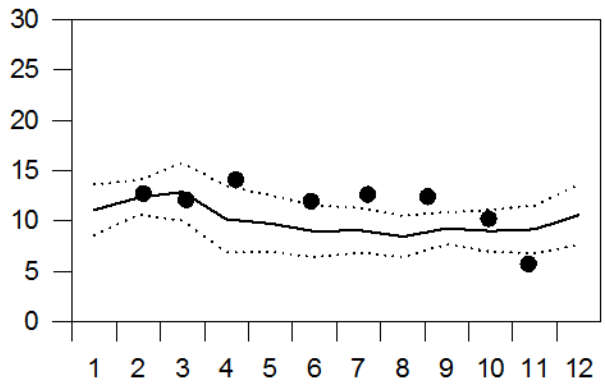
PO_4 µmol/l



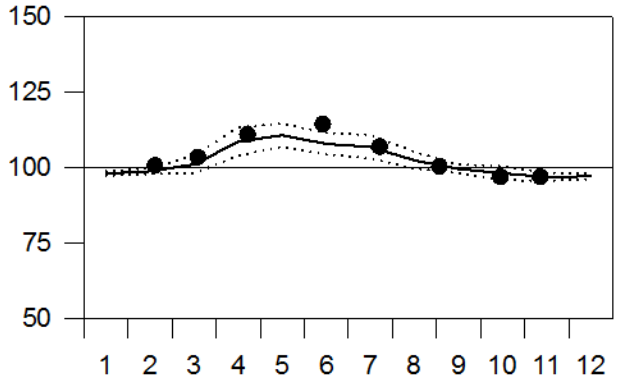
DIN µmol/l



SiO_3 µmol/l

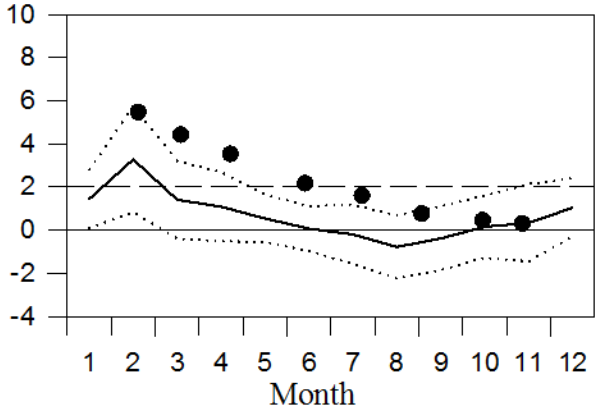


O_2 saturation %

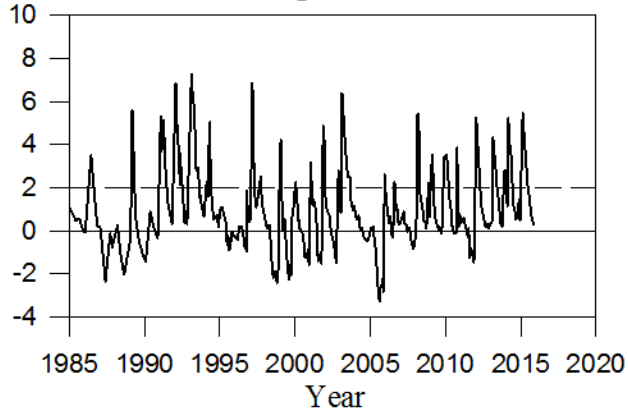


OXYGEN IN BOTTOM WATER (depth >80m)

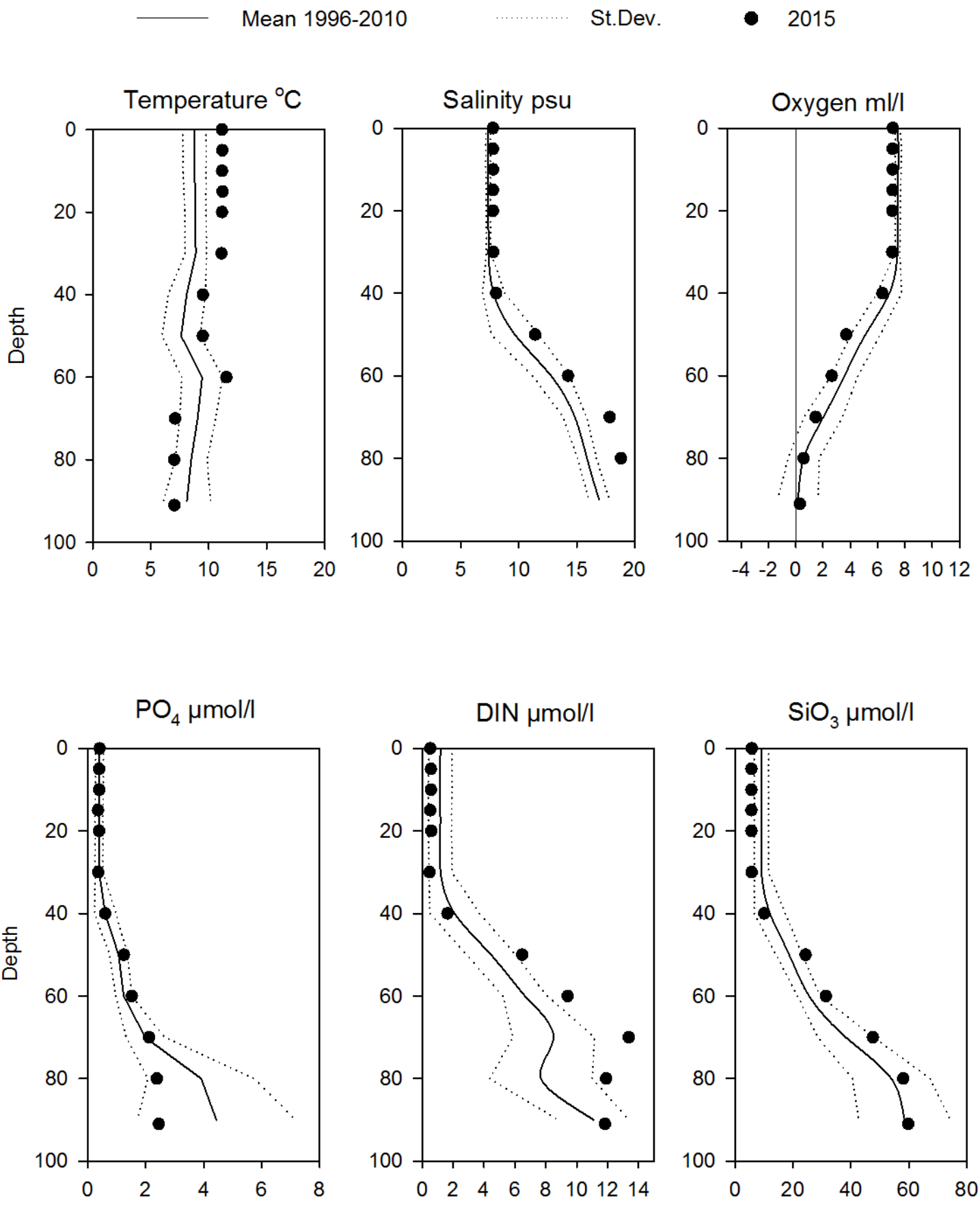
O_2 ml/l



O_2 ml/l



Vertical profiles BY4 November

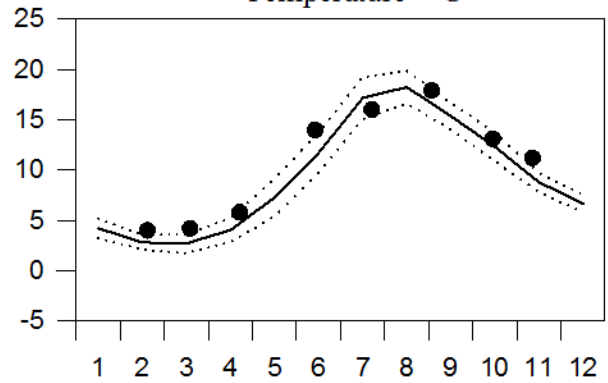


STATION BY5 SURFACE WATER

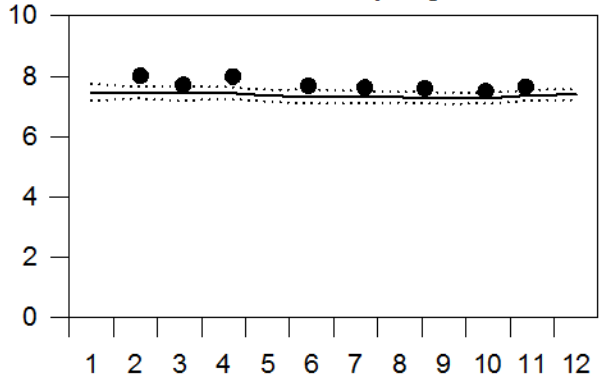
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

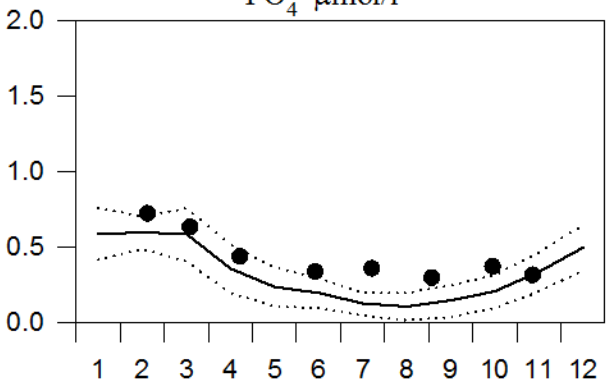
Temperature °C



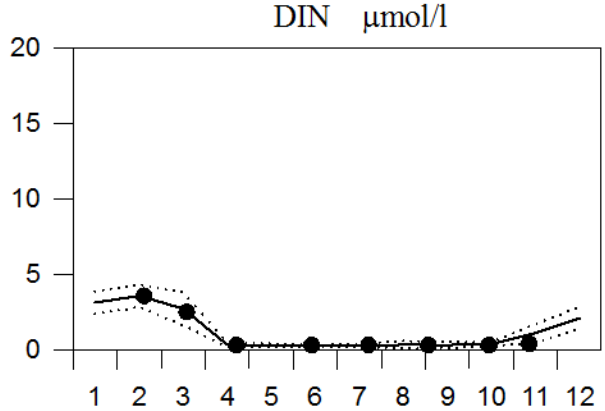
Salinity psu



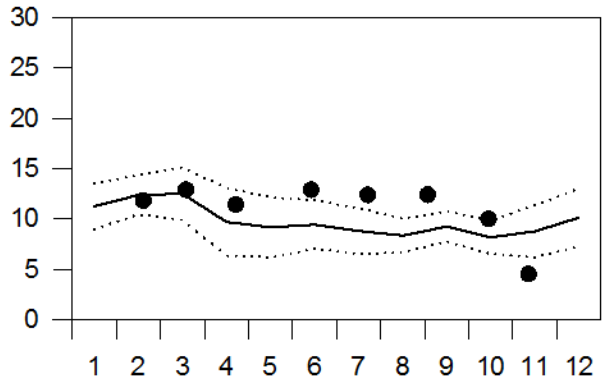
PO_4 µmol/l



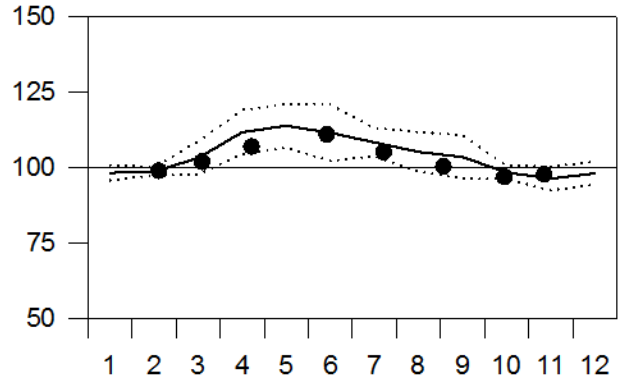
DIN µmol/l



SiO_3 µmol/l

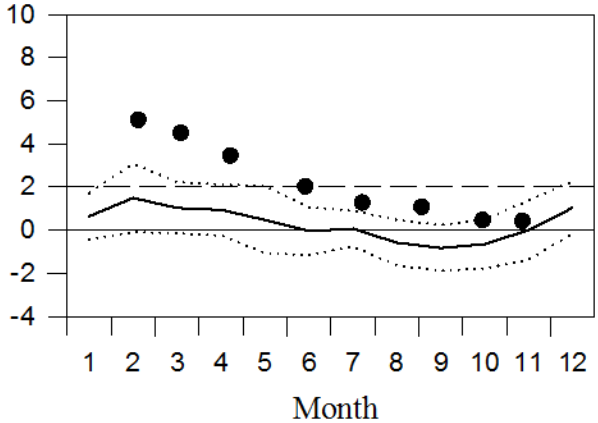


O_2 saturation %

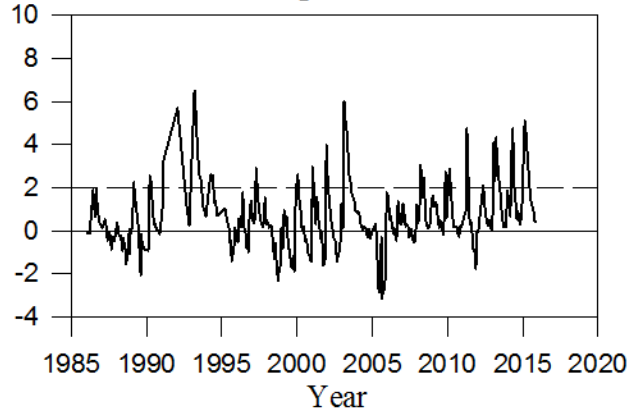


OXYGEN IN BOTTOM WATER (depth >80m)

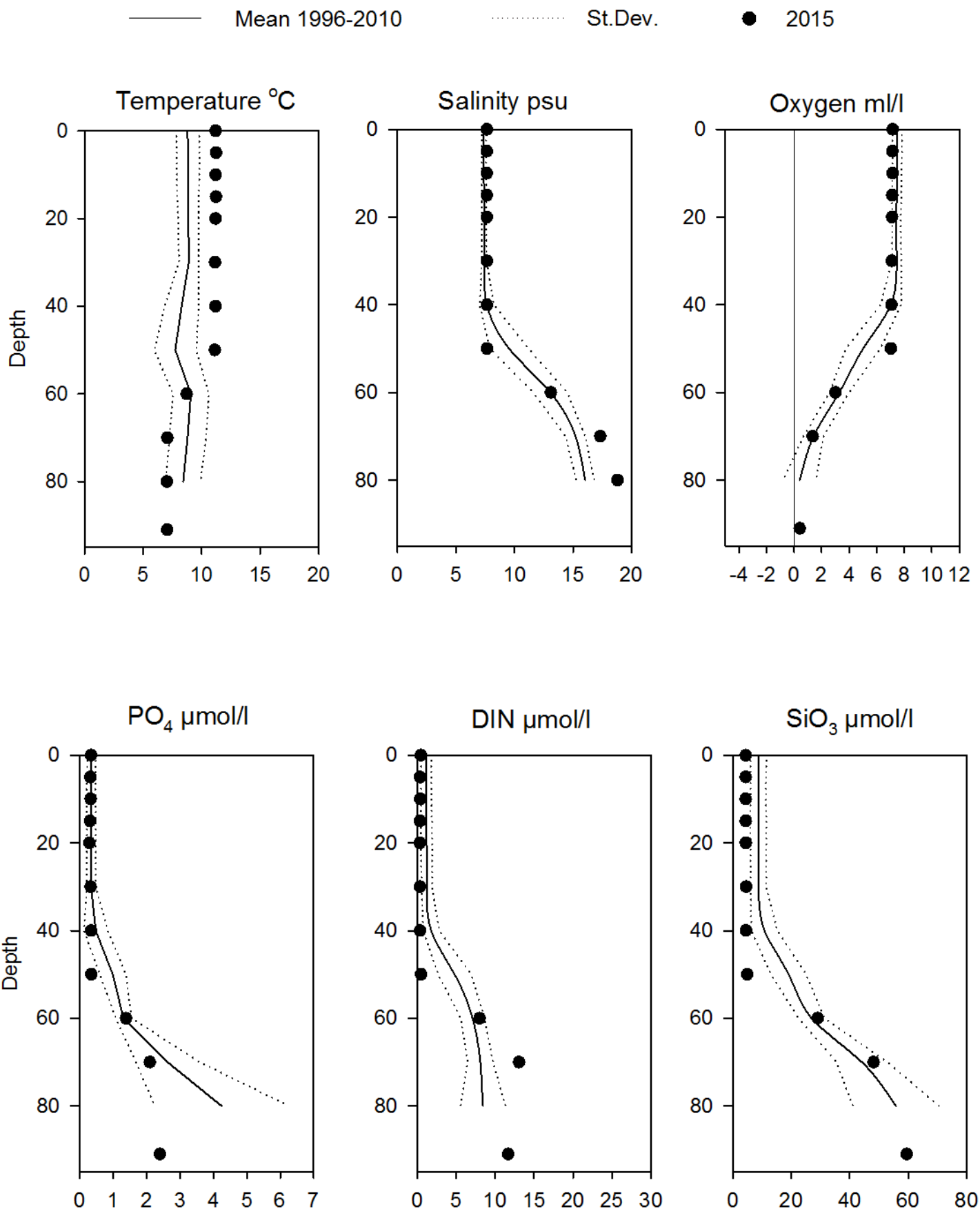
O_2 ml/l



O_2 ml/l



Vertical profiles BY5 November

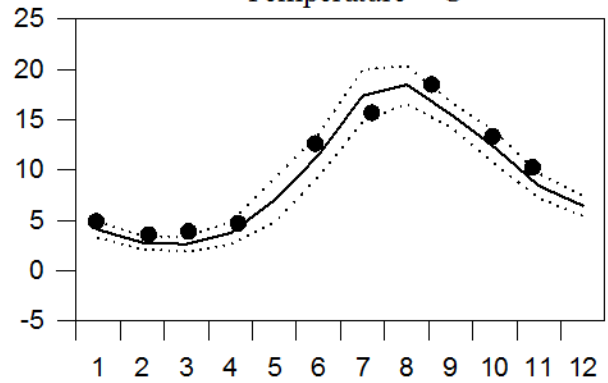


STATION BCS III-10 SURFACE WATER

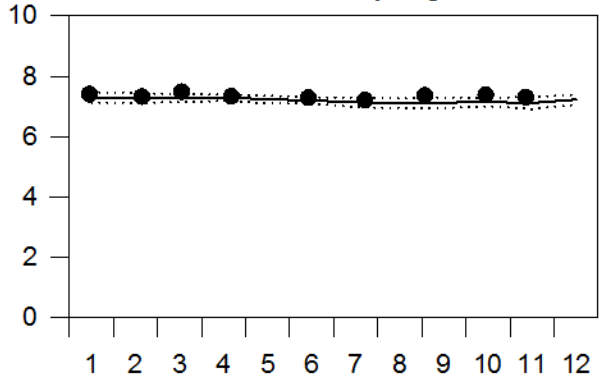
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

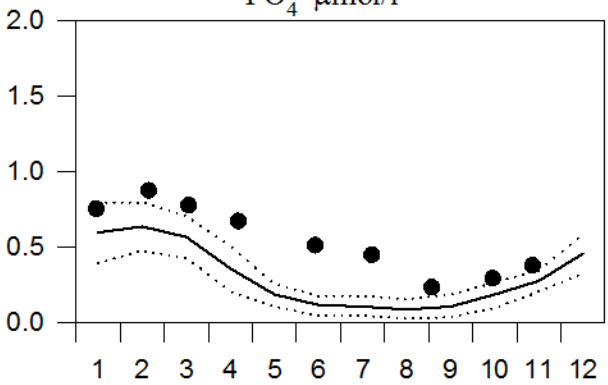
Temperature °C



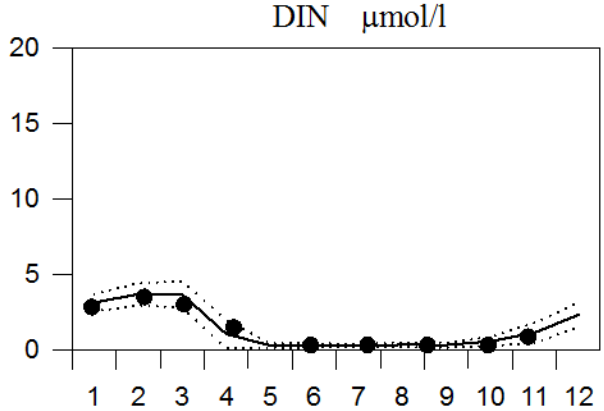
Salinity psu



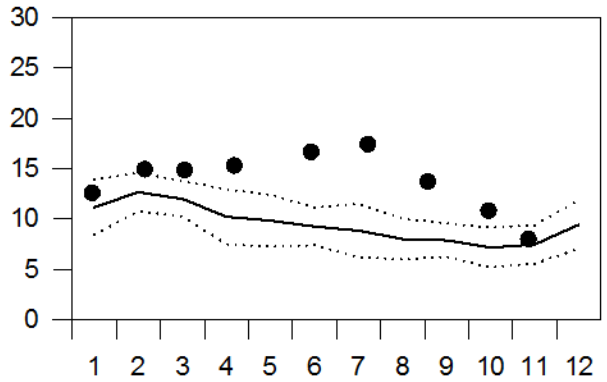
PO_4 µmol/l



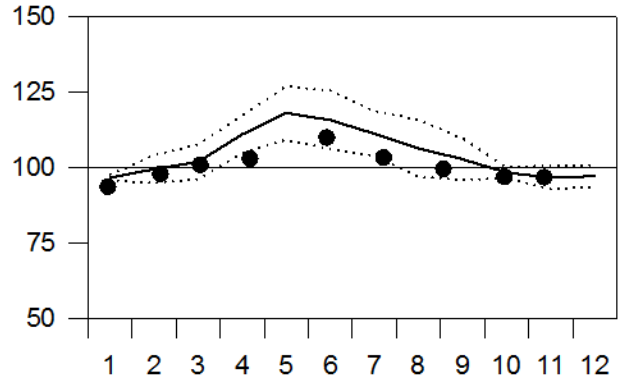
DIN µmol/l



SiO_3 µmol/l

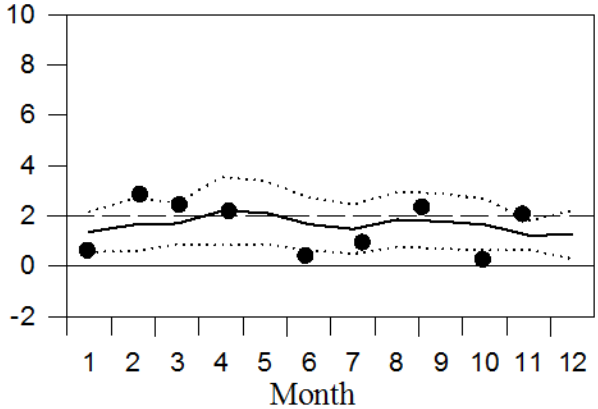


O_2 saturation %

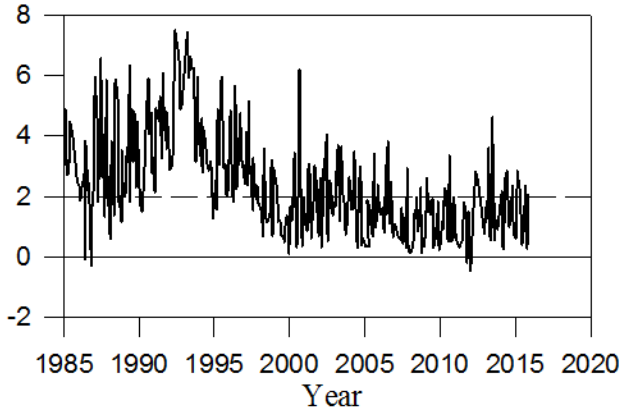


OXYGEN IN BOTTOM WATER (depth > 80m)

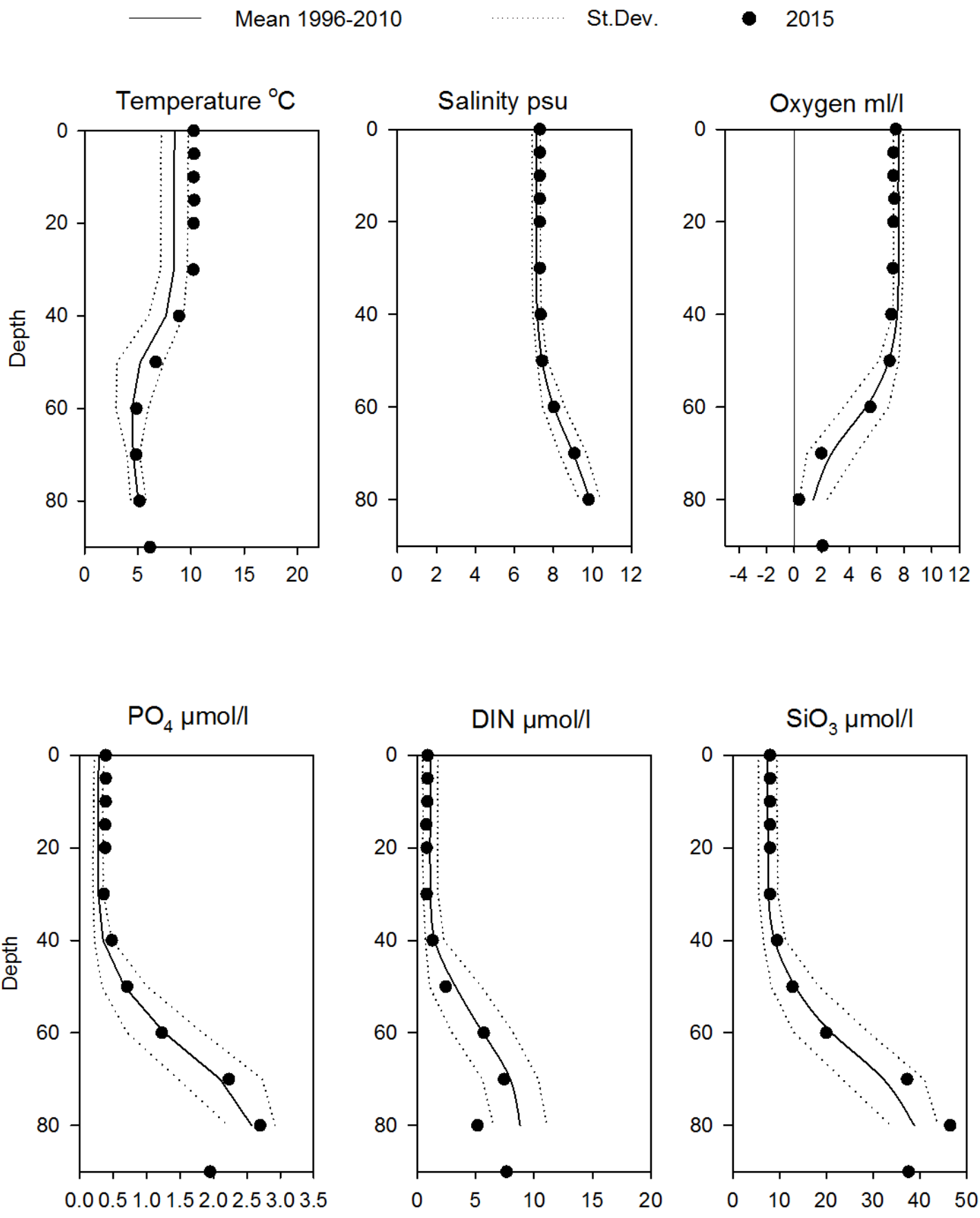
O_2 ml/l



O_2 ml/l



Vertical profiles BCS III-10 November

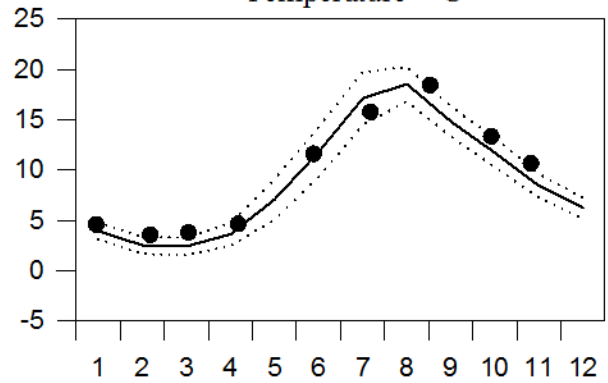


STATION BY10 SURFACE WATER

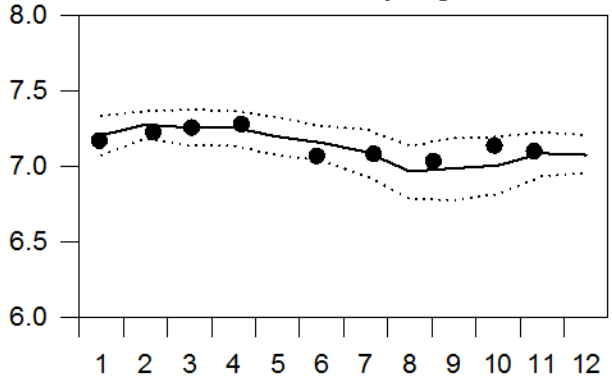
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

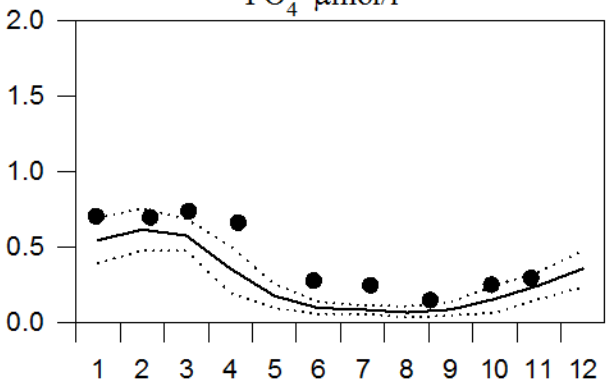
Temperature °C



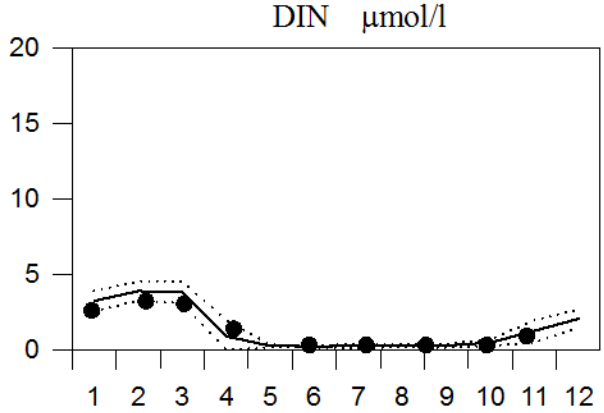
Salinity psu



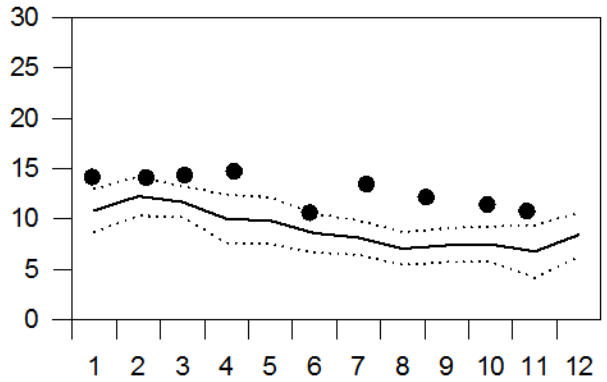
PO_4 µmol/l



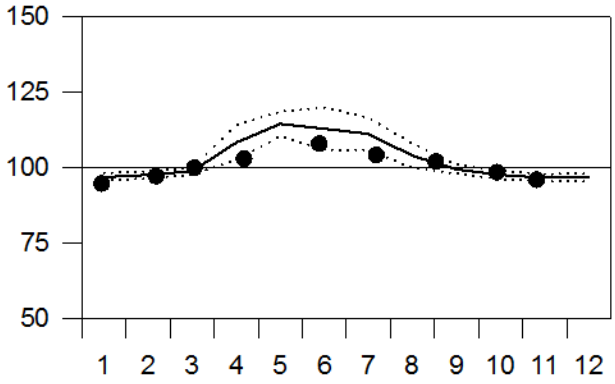
DIN µmol/l



SiO_3 µmol/l

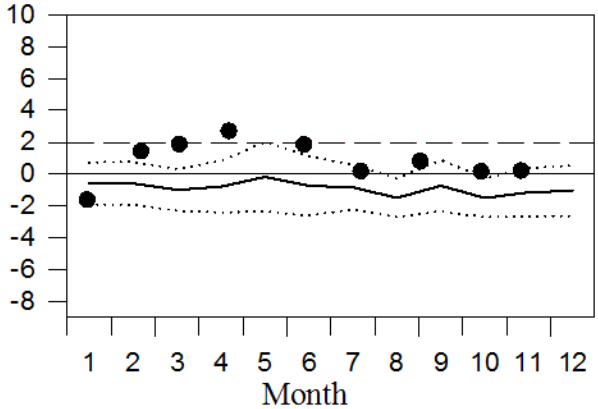


O_2 saturation %

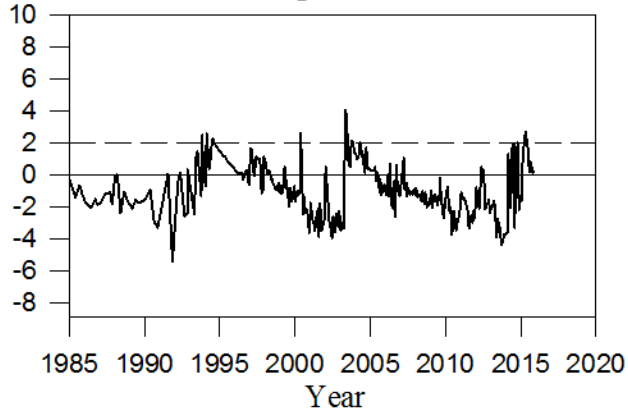


OXYGEN IN BOTTOM WATER (depth >125m)

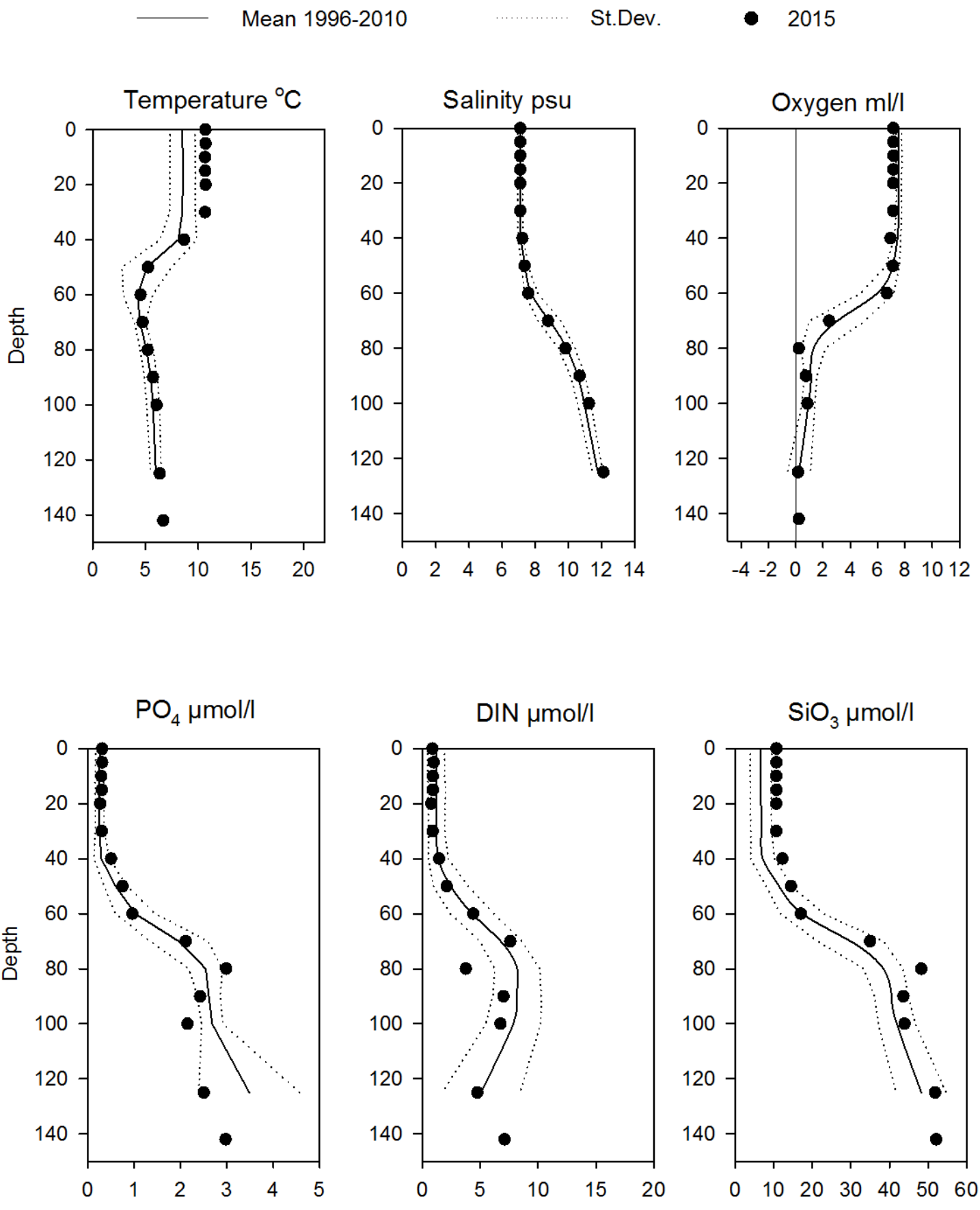
O_2 ml/l



O_2 ml/l



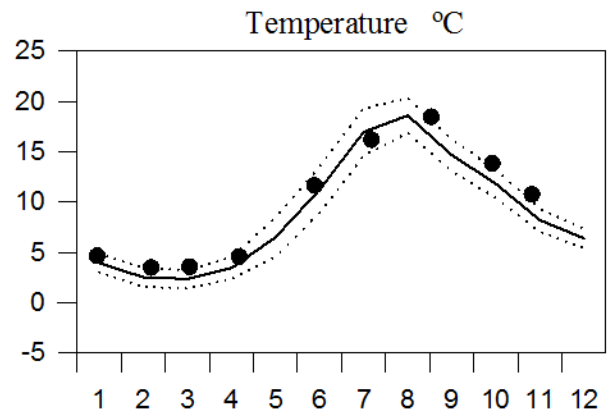
Vertical profiles BY10 November

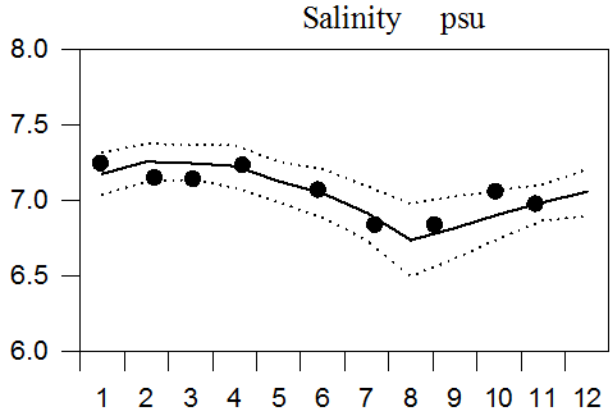


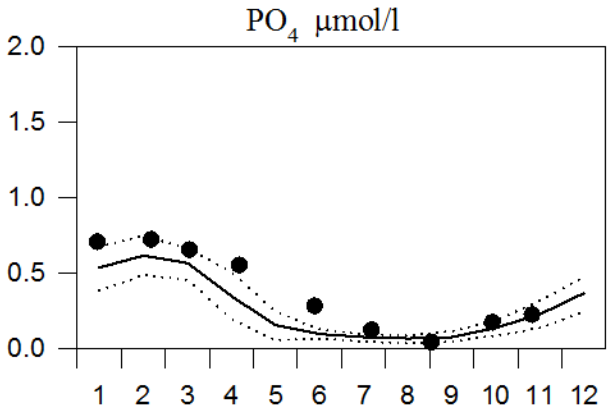
STATION BY15 SURFACE WATER

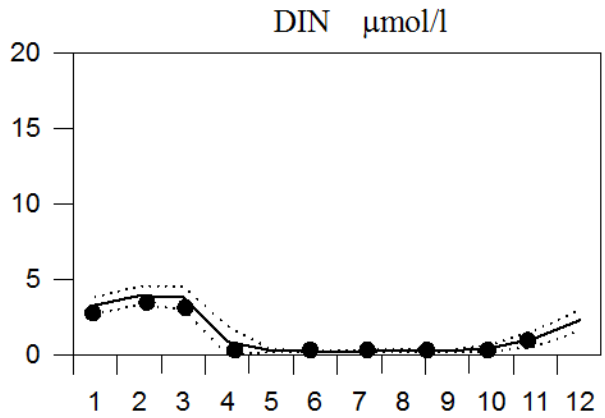
Annual Cycles

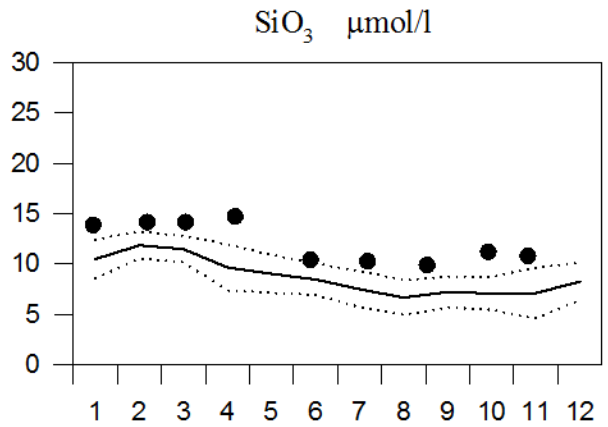
Mean 1996-2010 ····· St.Dev. ● 2015

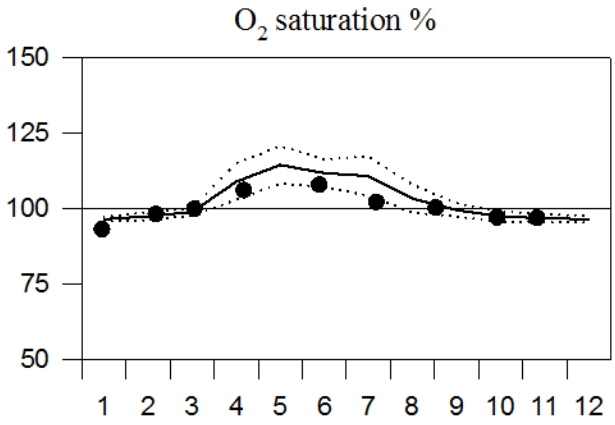




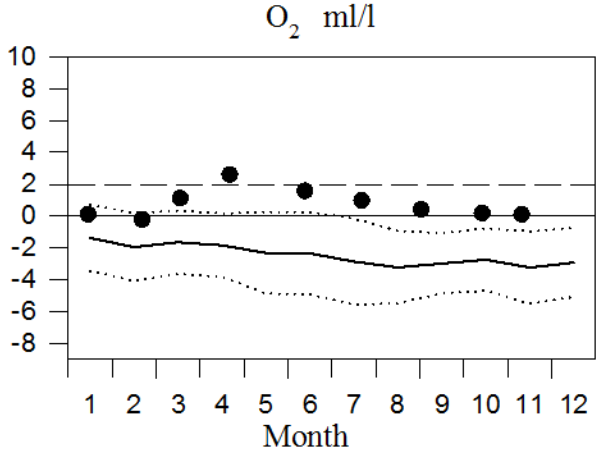


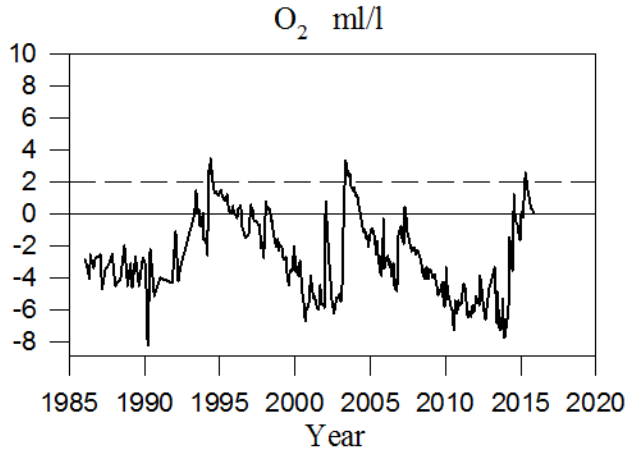




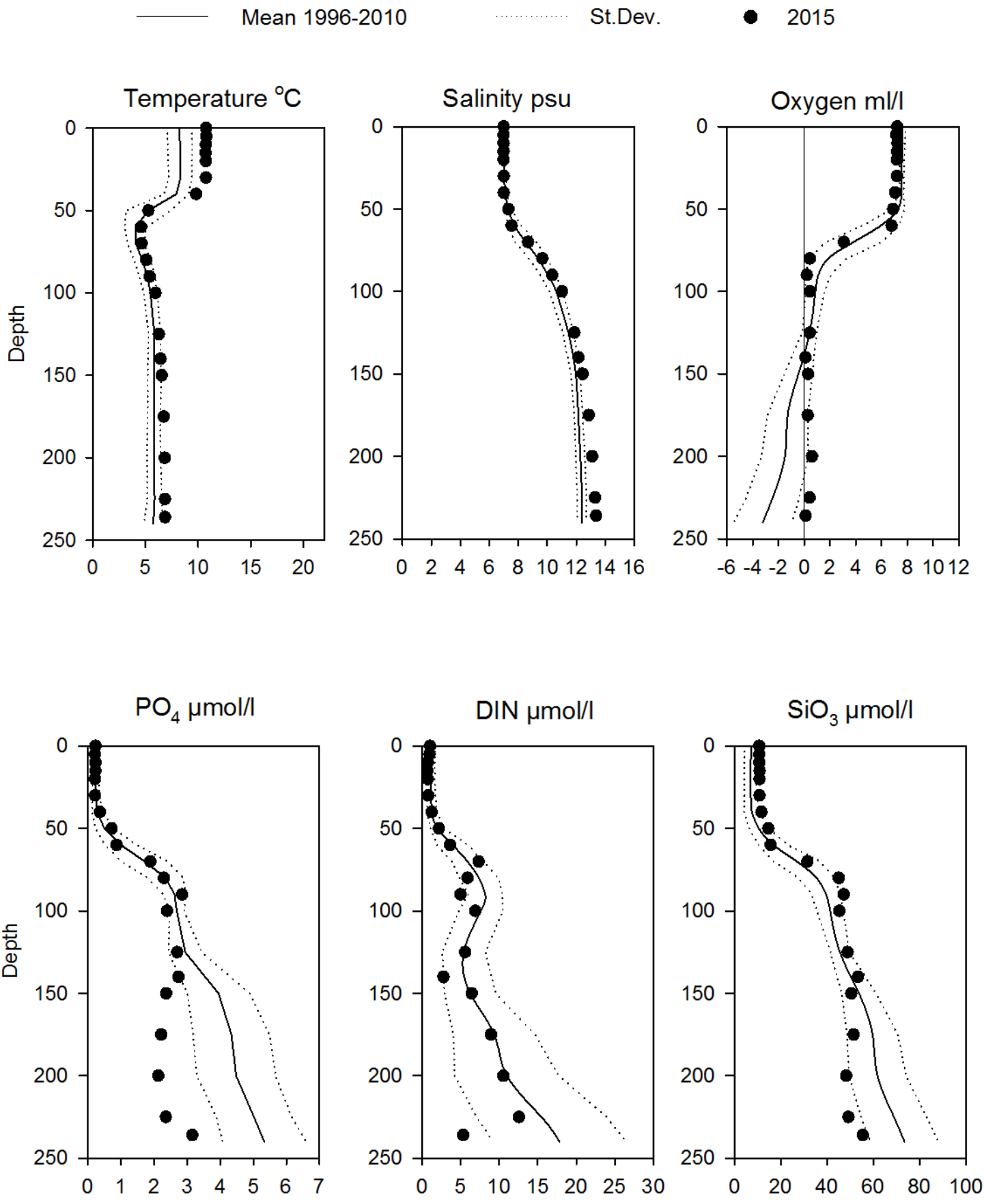


OXYGEN IN BOTTOM WATER (depth >225m)





Vertical profiles BY15 November

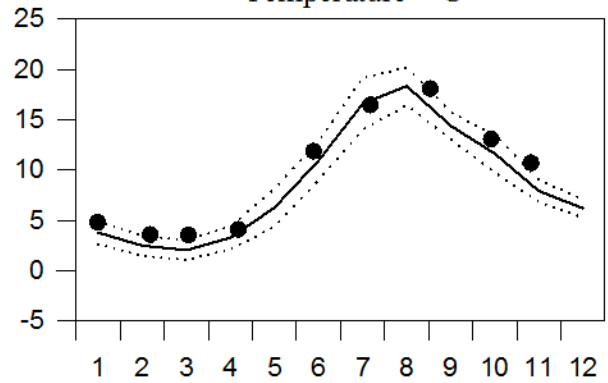


STATION BY20 SURFACE WATER

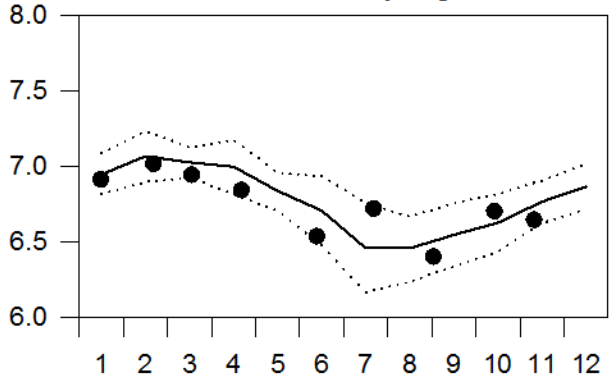
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

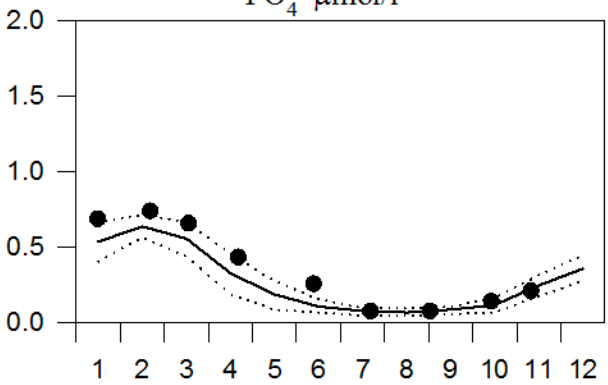
Temperature °C



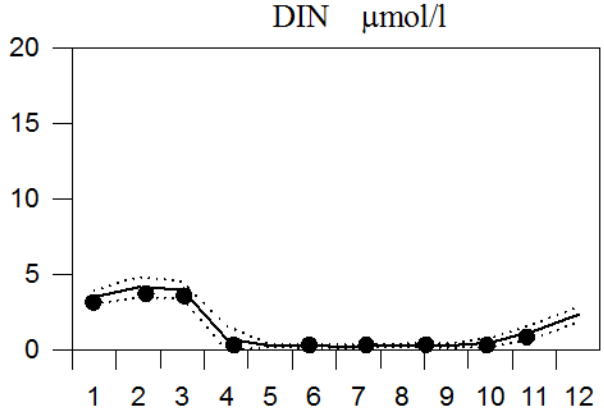
Salinity psu



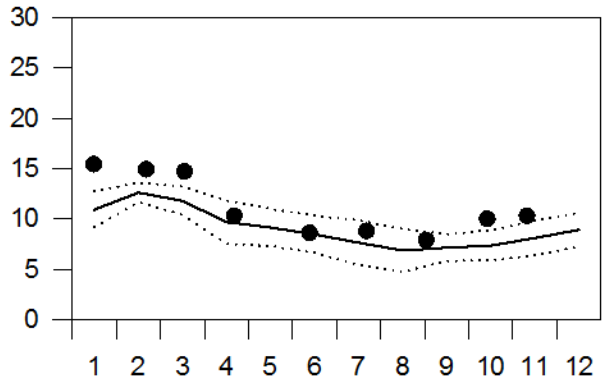
PO_4 µmol/l



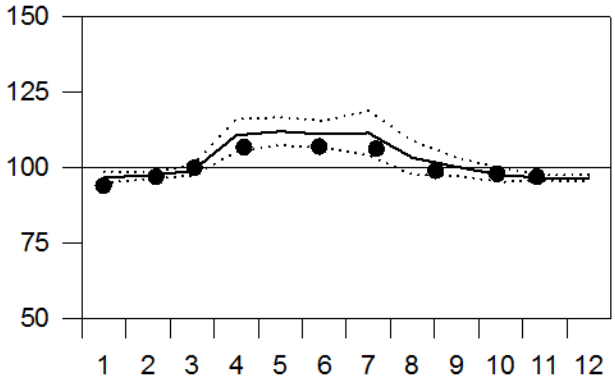
DIN µmol/l



SiO_3 µmol/l

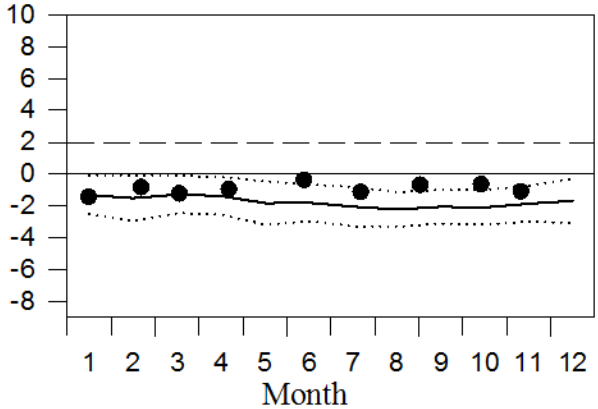


O_2 saturation %

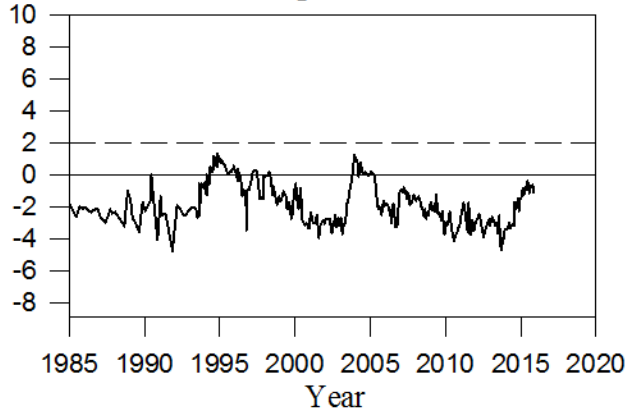


OXYGEN IN BOTTOM WATER (depth >175m)

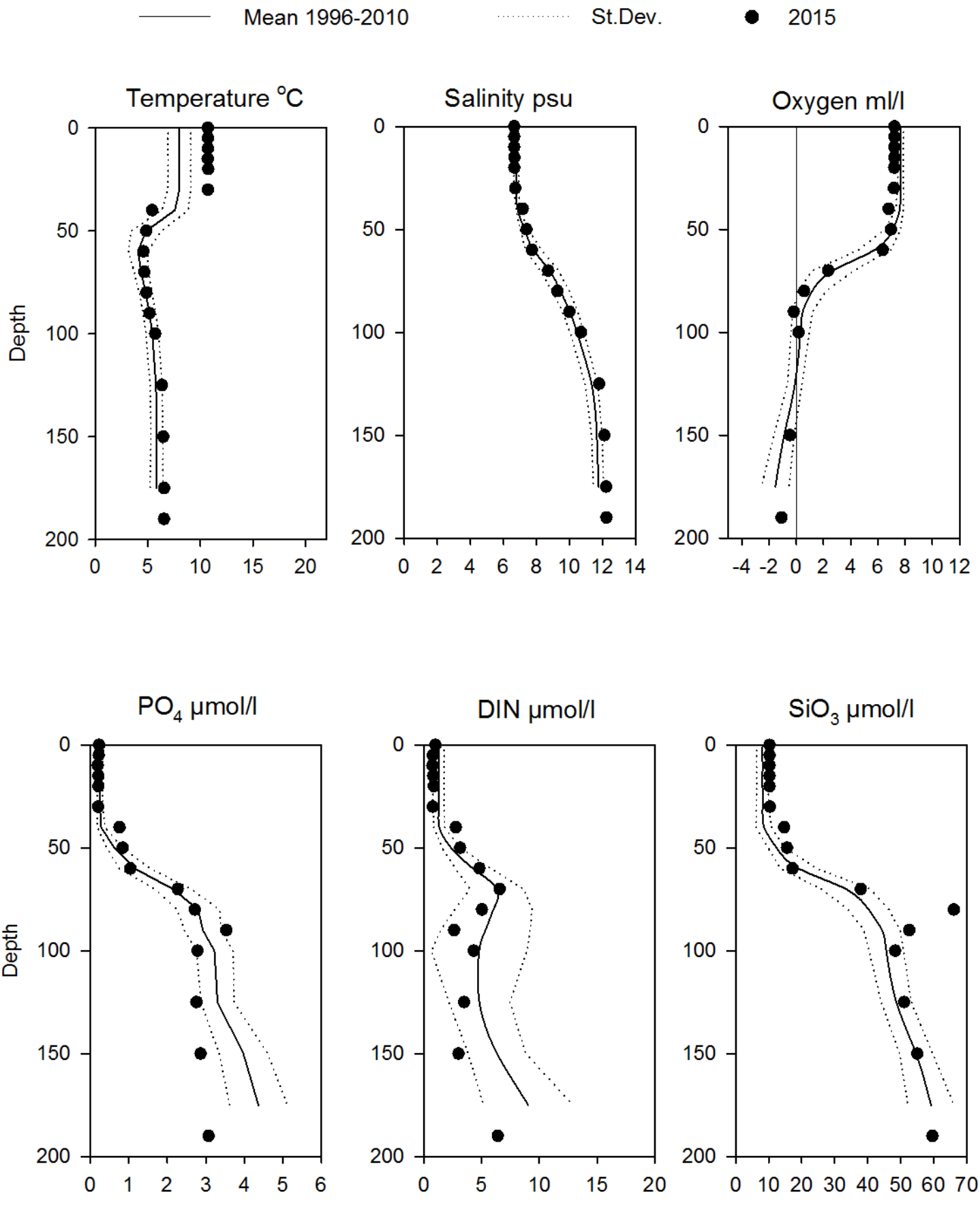
O_2 ml/l



O_2 ml/l



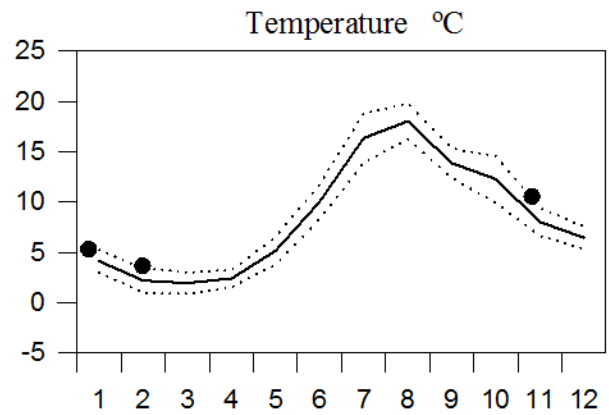
Vertical profiles BY20 November

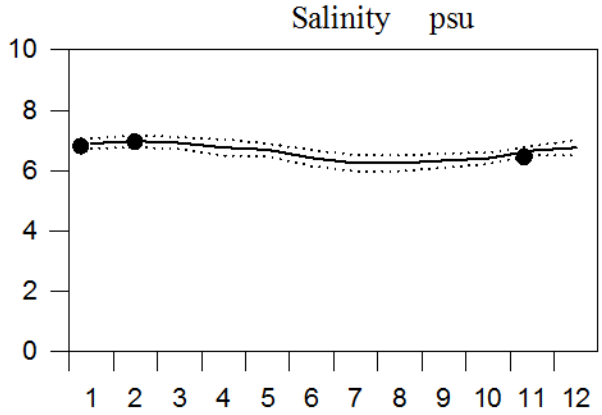


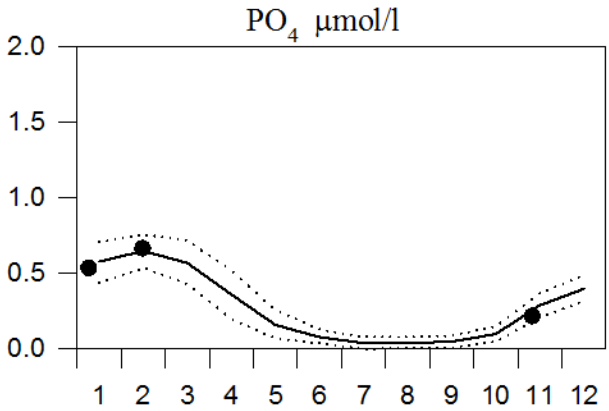
STATION BY29 SURFACE WATER

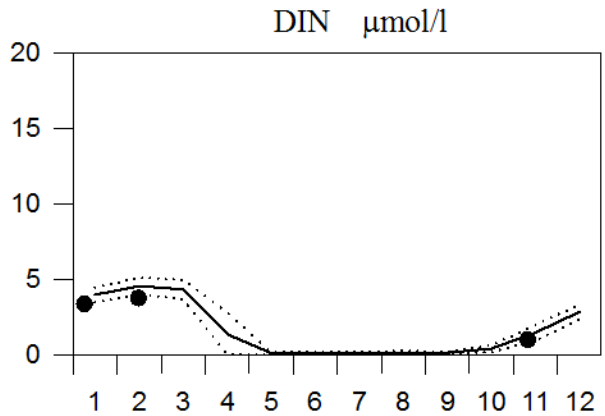
Annual Cycles

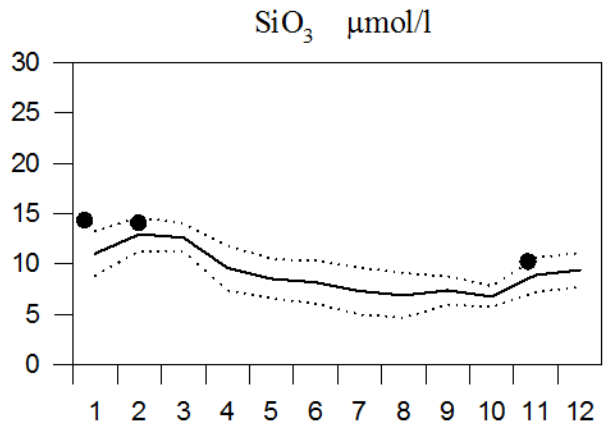
Mean 1996-2010 ····· St.Dev. ● 2015

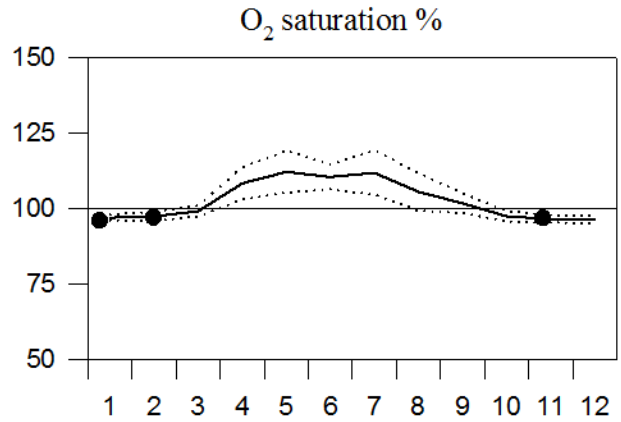




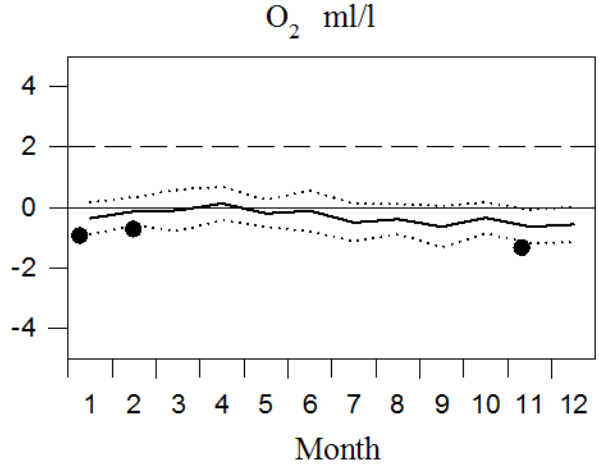


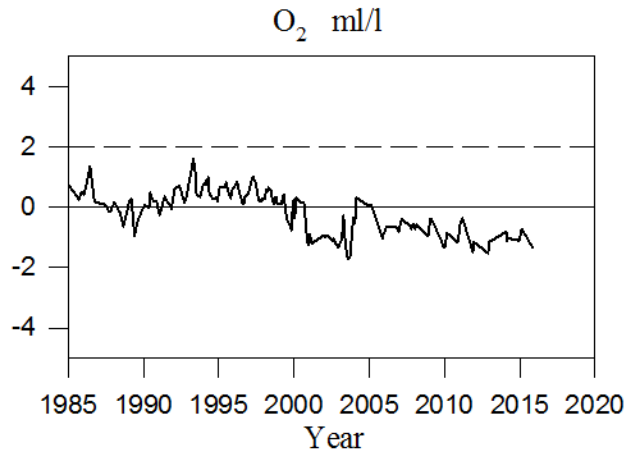




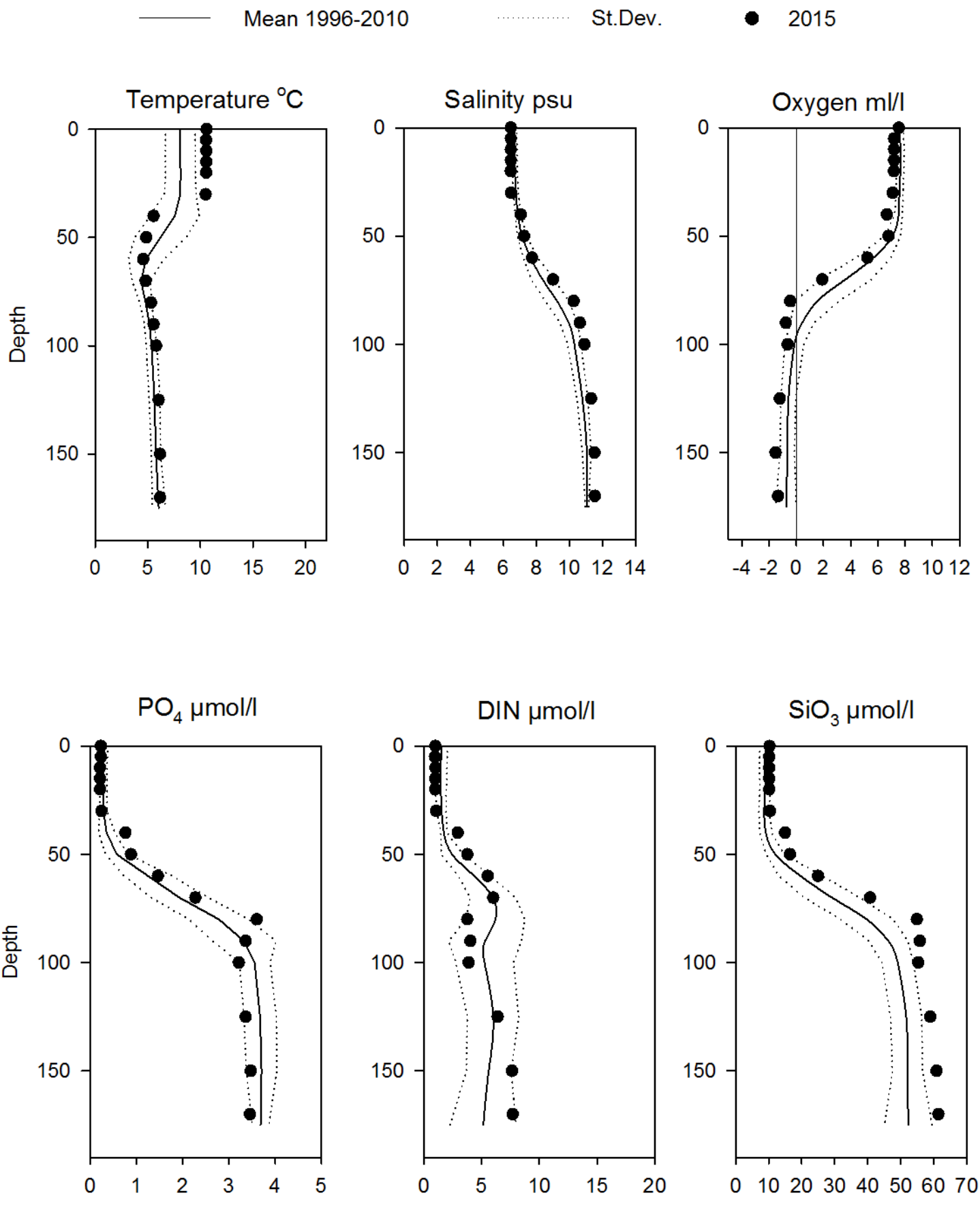


OXYGEN IN BOTTOM WATER (>=150m)





Vertical profiles BY29 November

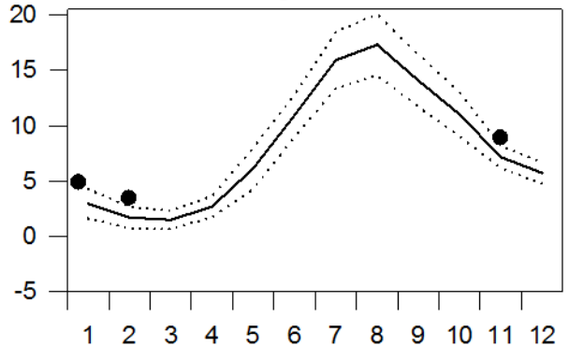


STATION BY31 SURFACE WATER

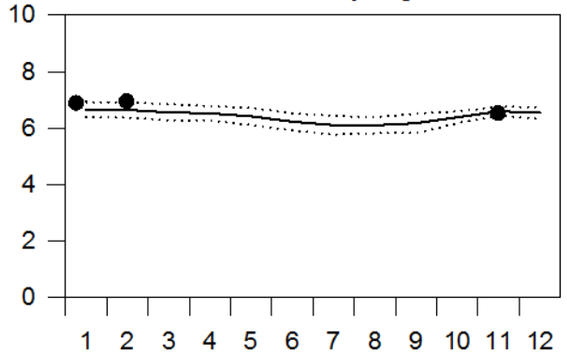
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

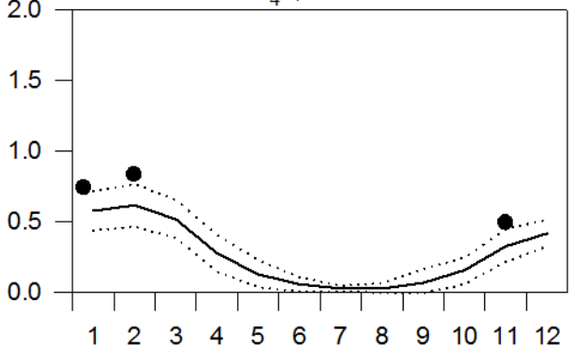
Temperature °C



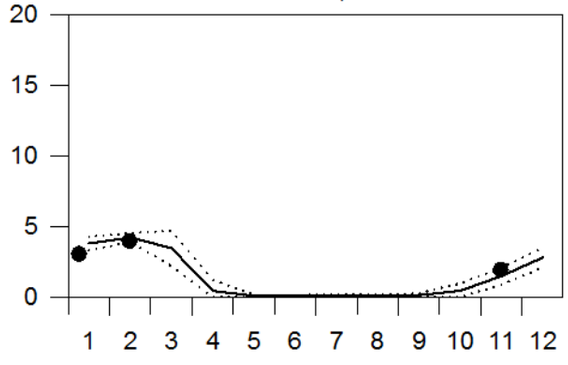
Salinity psu



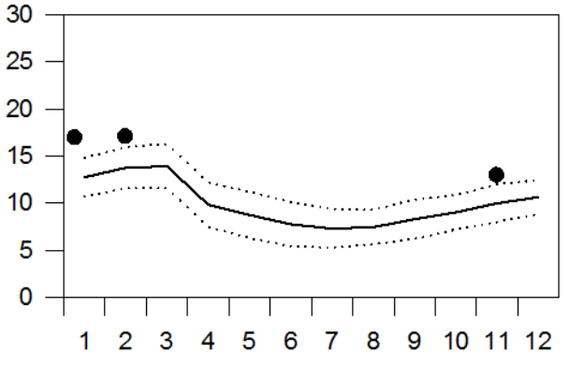
PO_4 µmol/l



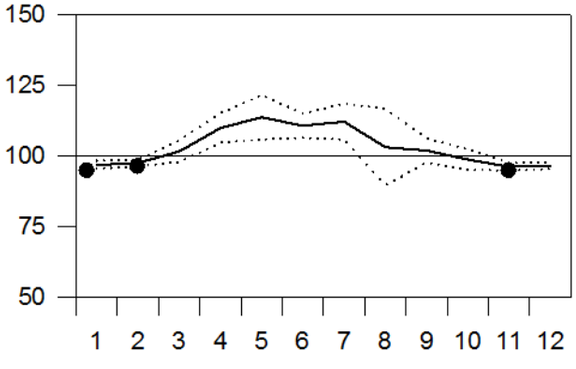
DIN µmol/l



SiO_3 µmol/l

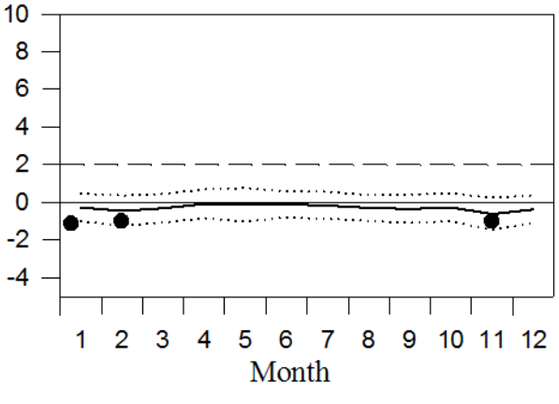


O_2 saturation %

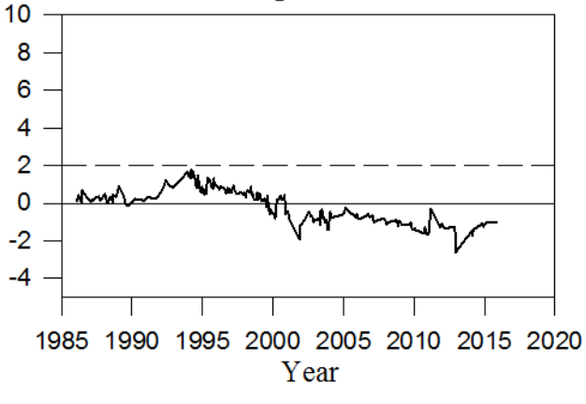


OXYGEN IN BOTTOM WATER (depth = 440m)

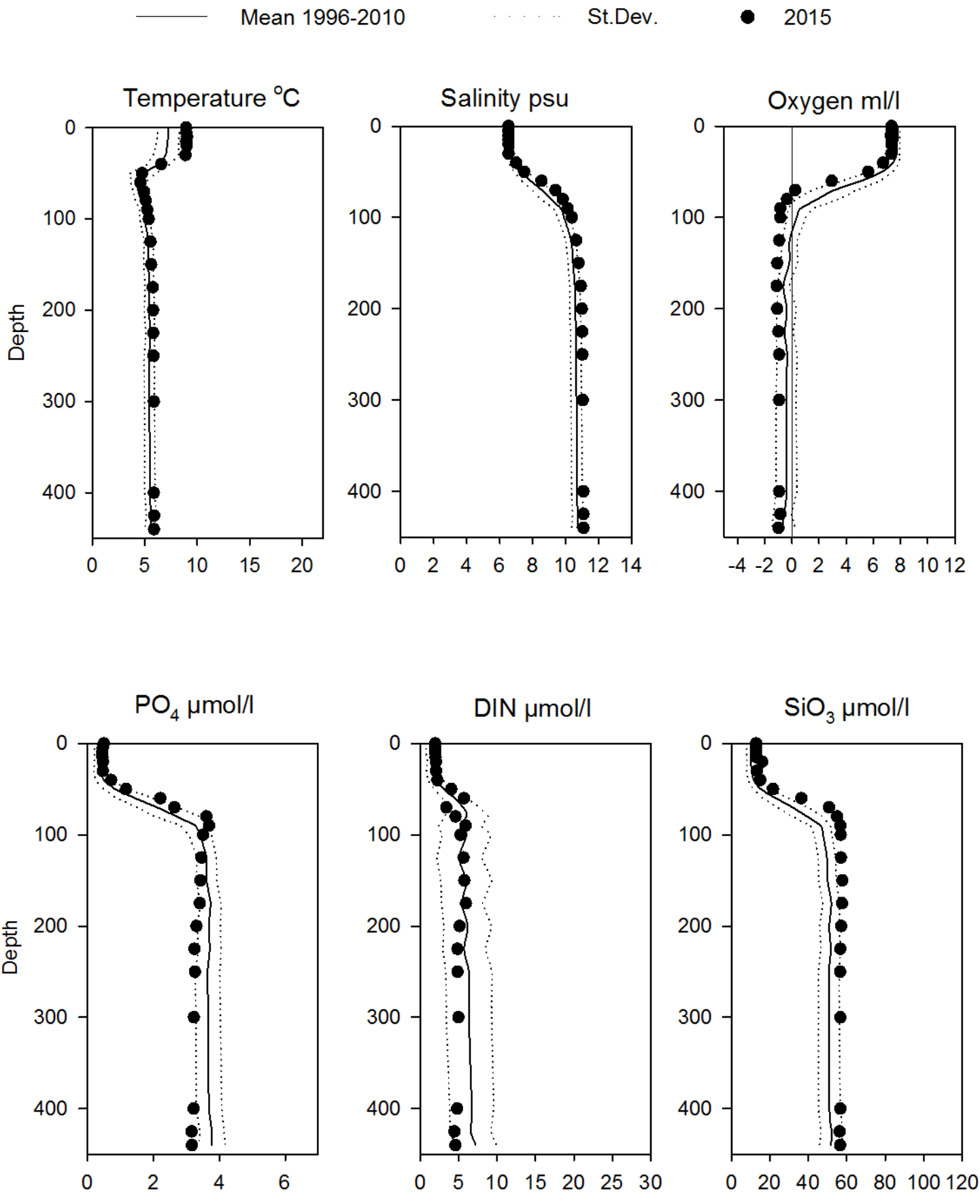
O_2 ml/l



O_2 ml/l



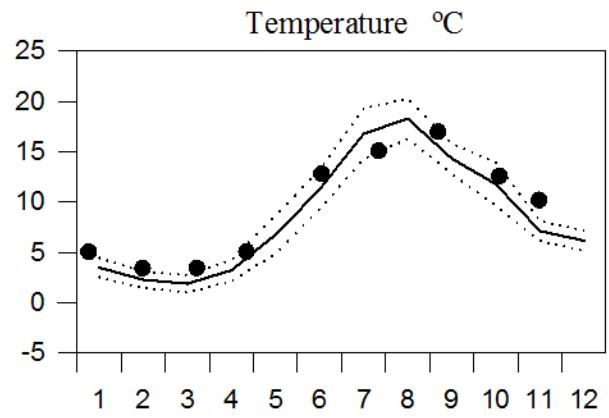
Vertical profiles BY31 November

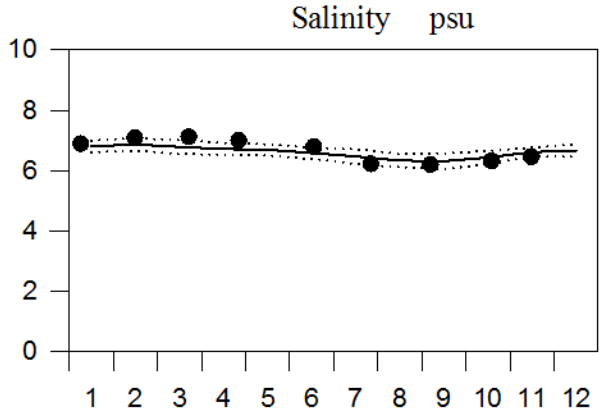


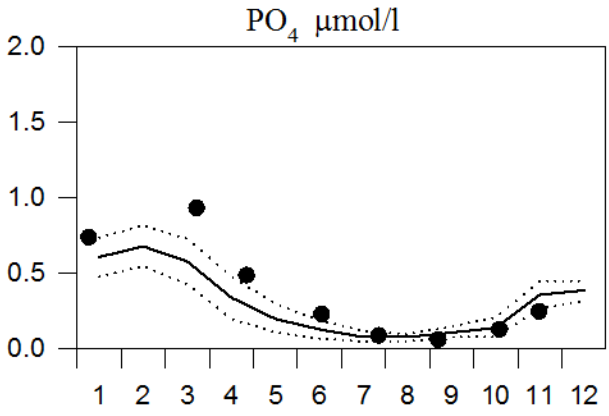
STATION BY32 SURFACE WATER

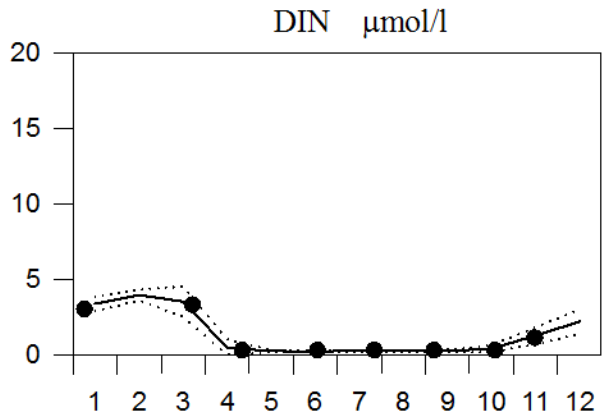
Annual Cycles

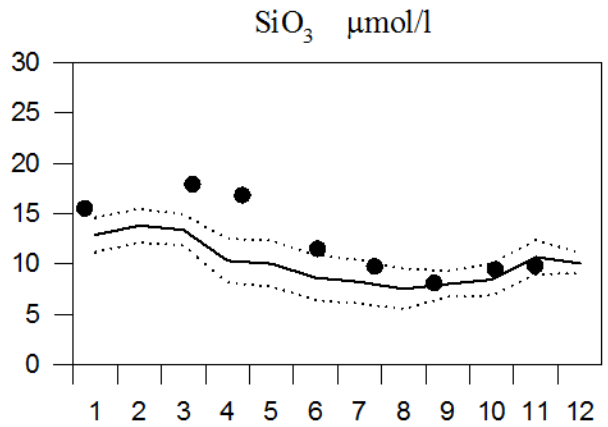
Mean 1996-2010 ····· St.Dev. ● 2015

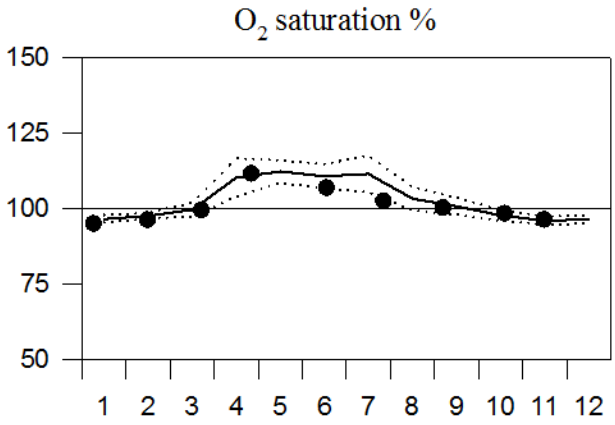




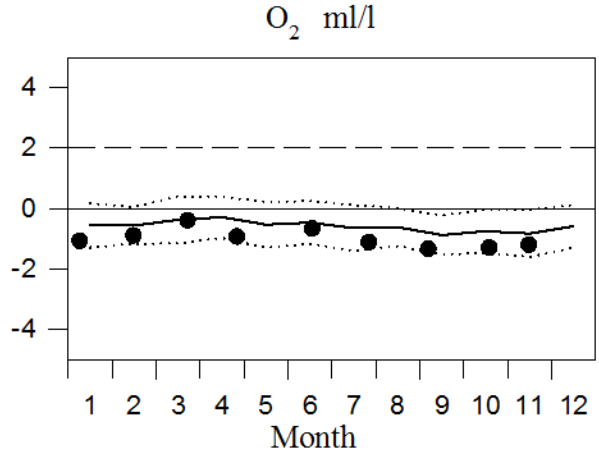


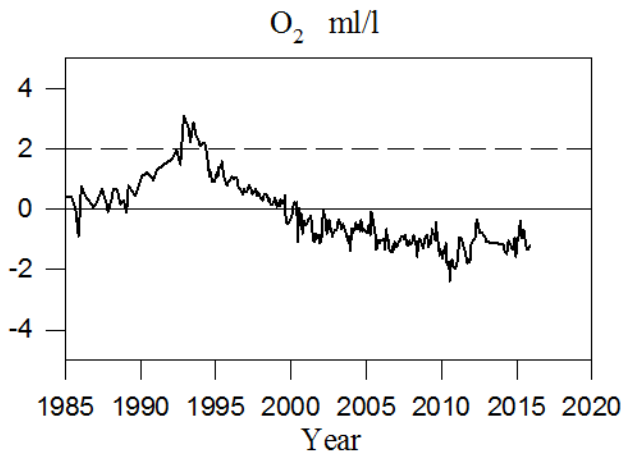




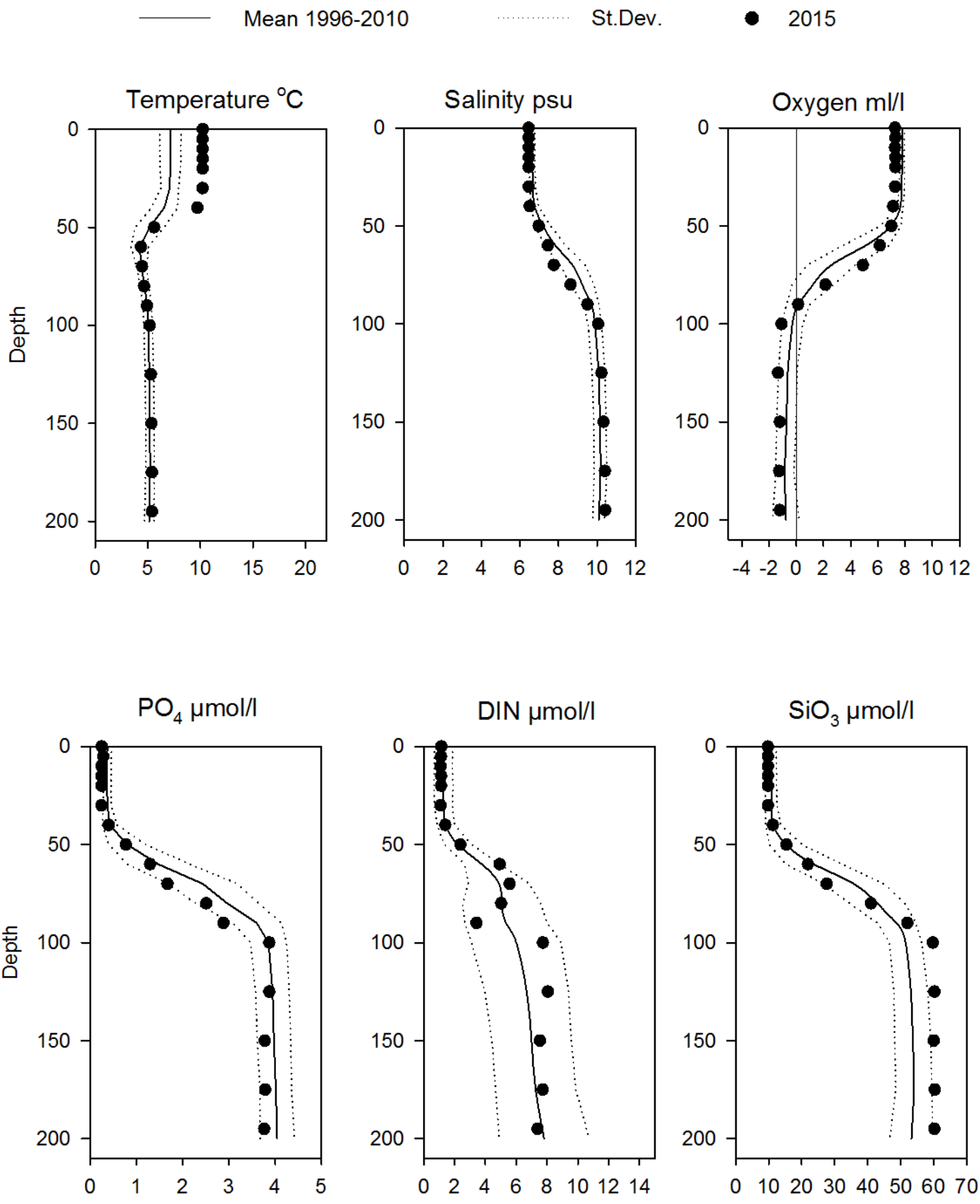


OXYGEN IN BOTTOM WATER (depth > 175m)





Vertical profiles BY32 November

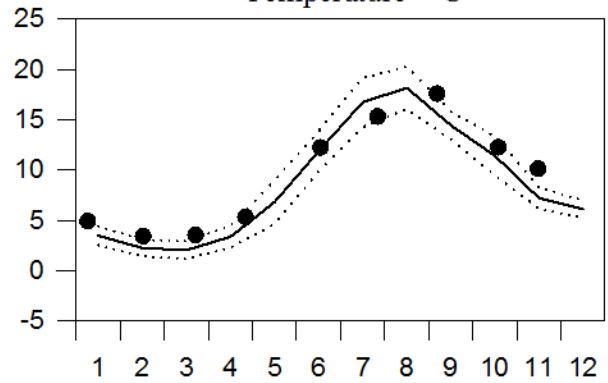


STATION BY38 SURFACE WATER

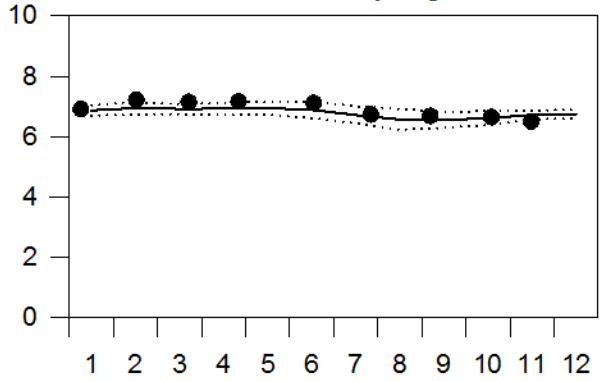
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

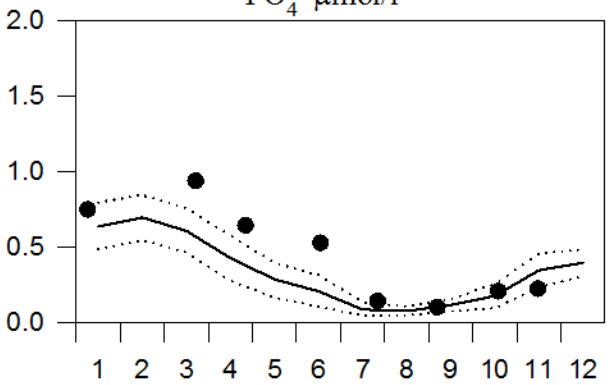
Temperature °C



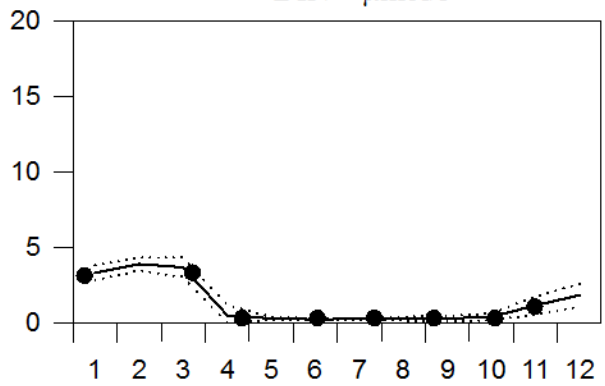
Salinity psu



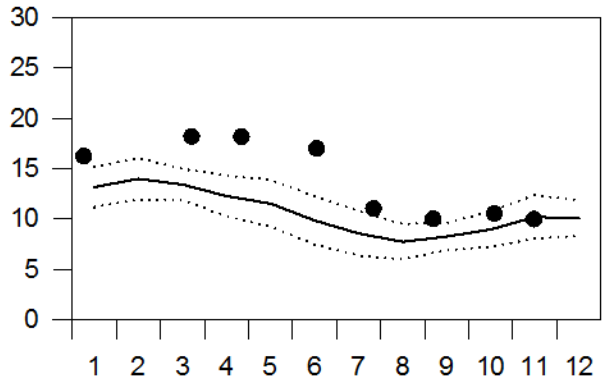
PO_4 µmol/l



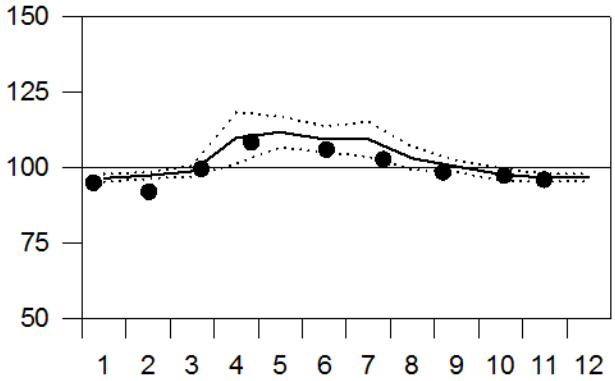
DIN µmol/l



SiO_3 µmol/l

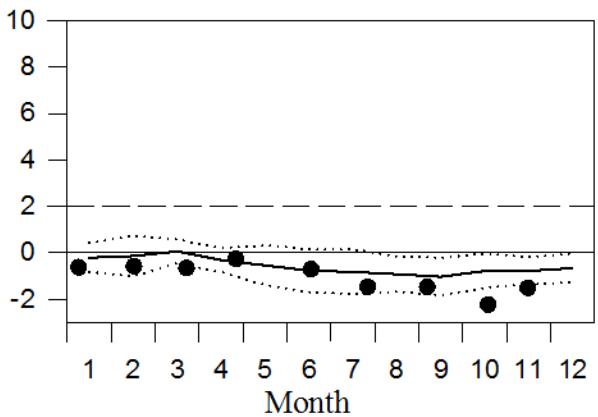


O_2 saturation %

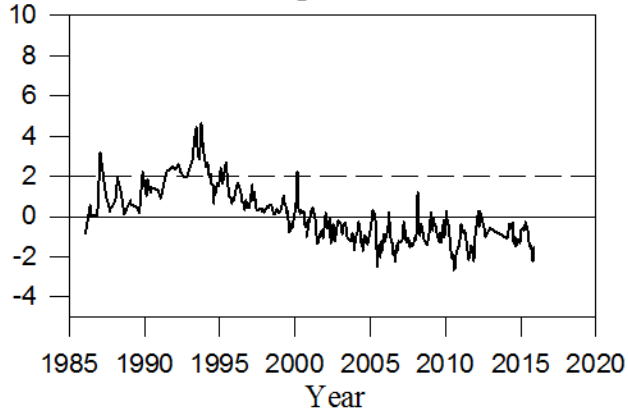


OXYGEN IN BOTTOM WATER (> 100m)

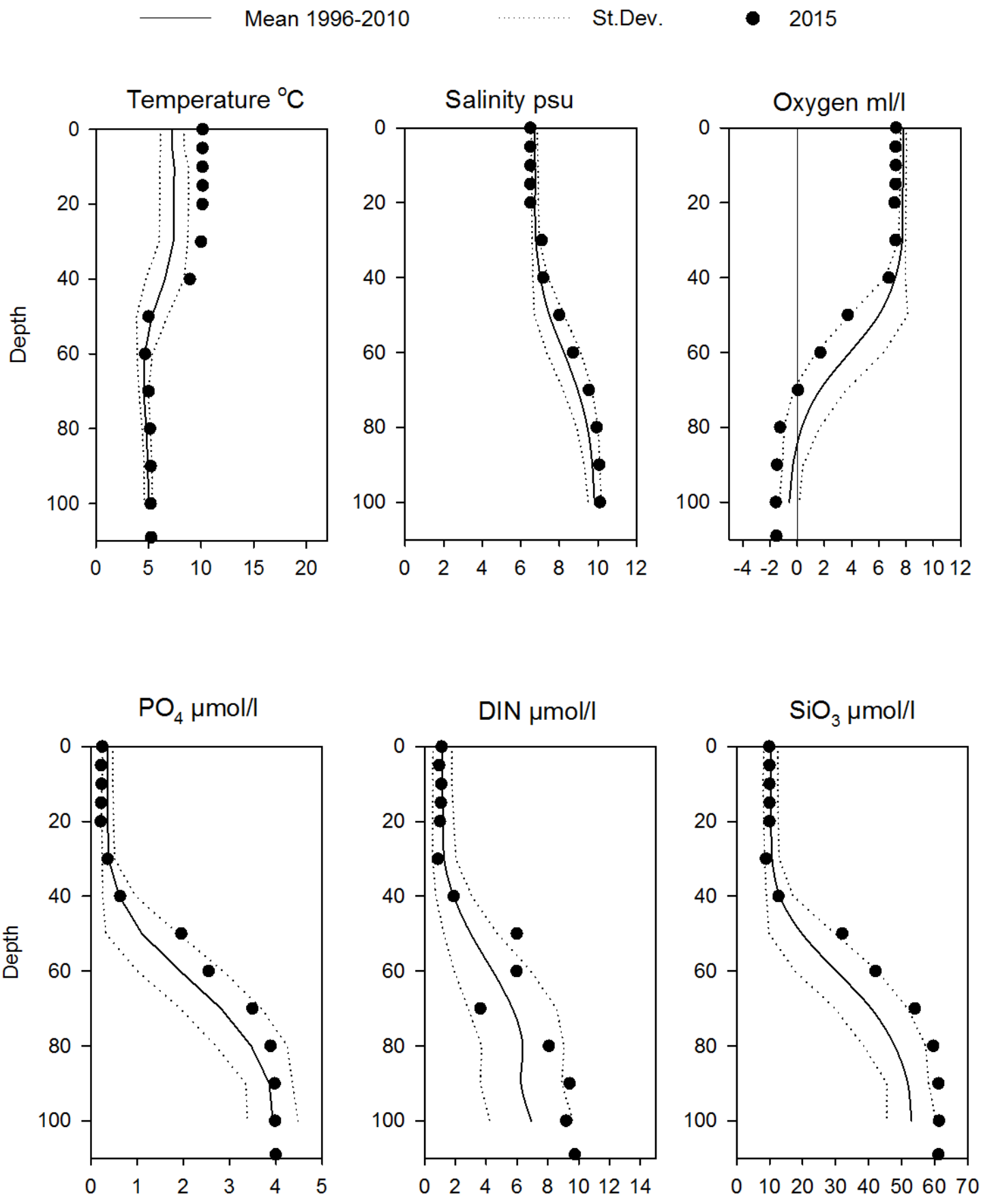
O_2 ml/l



O_2 ml/l



Vertical profiles BY38 November

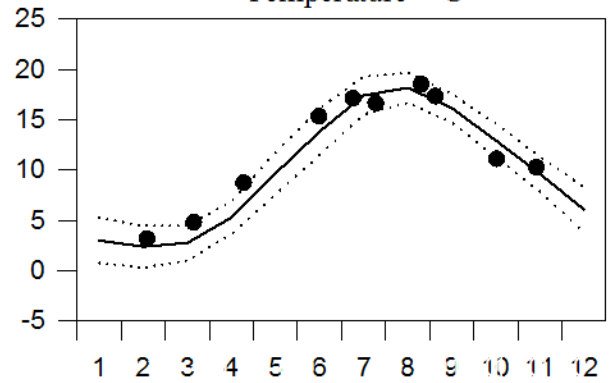


STATION SLÄGGÖ SURFACE WATER

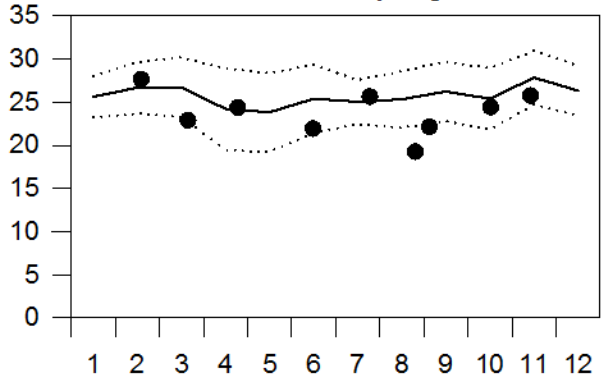
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

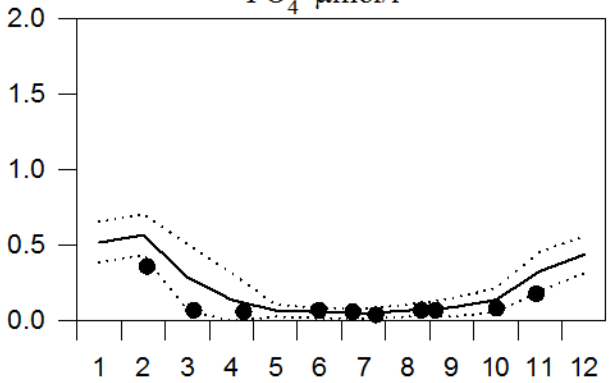
Temperature °C



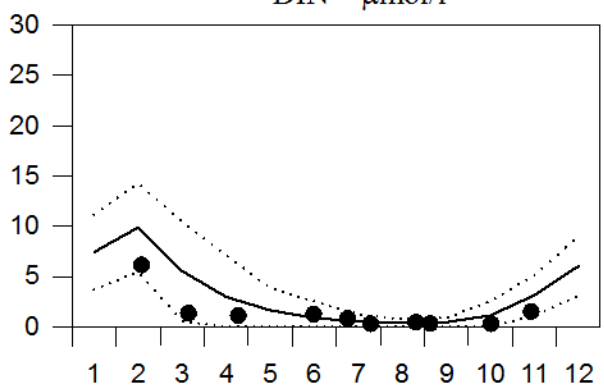
Salinity psu



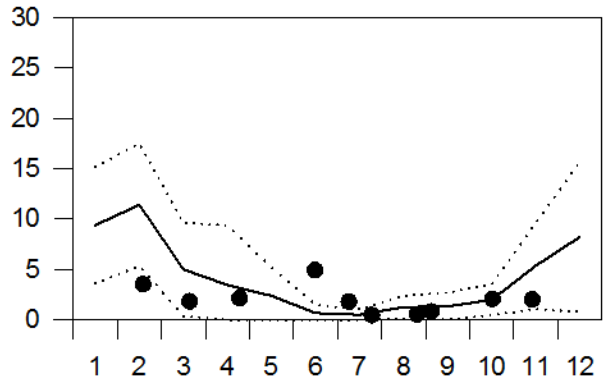
PO_4 µmol/l



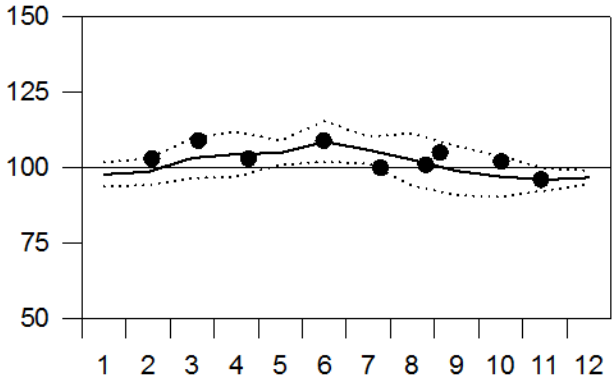
DIN µmol/l



SiO_3 µmol/l

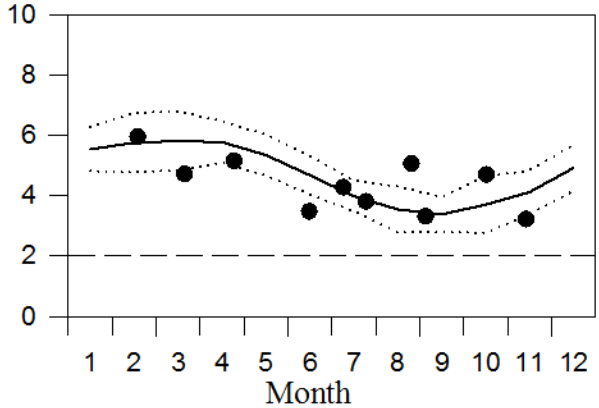


O_2 saturation %

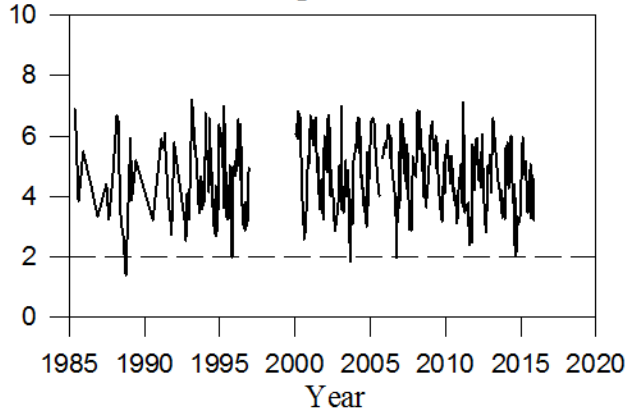


OXYGEN IN BOTTOM WATER (depth >50m)

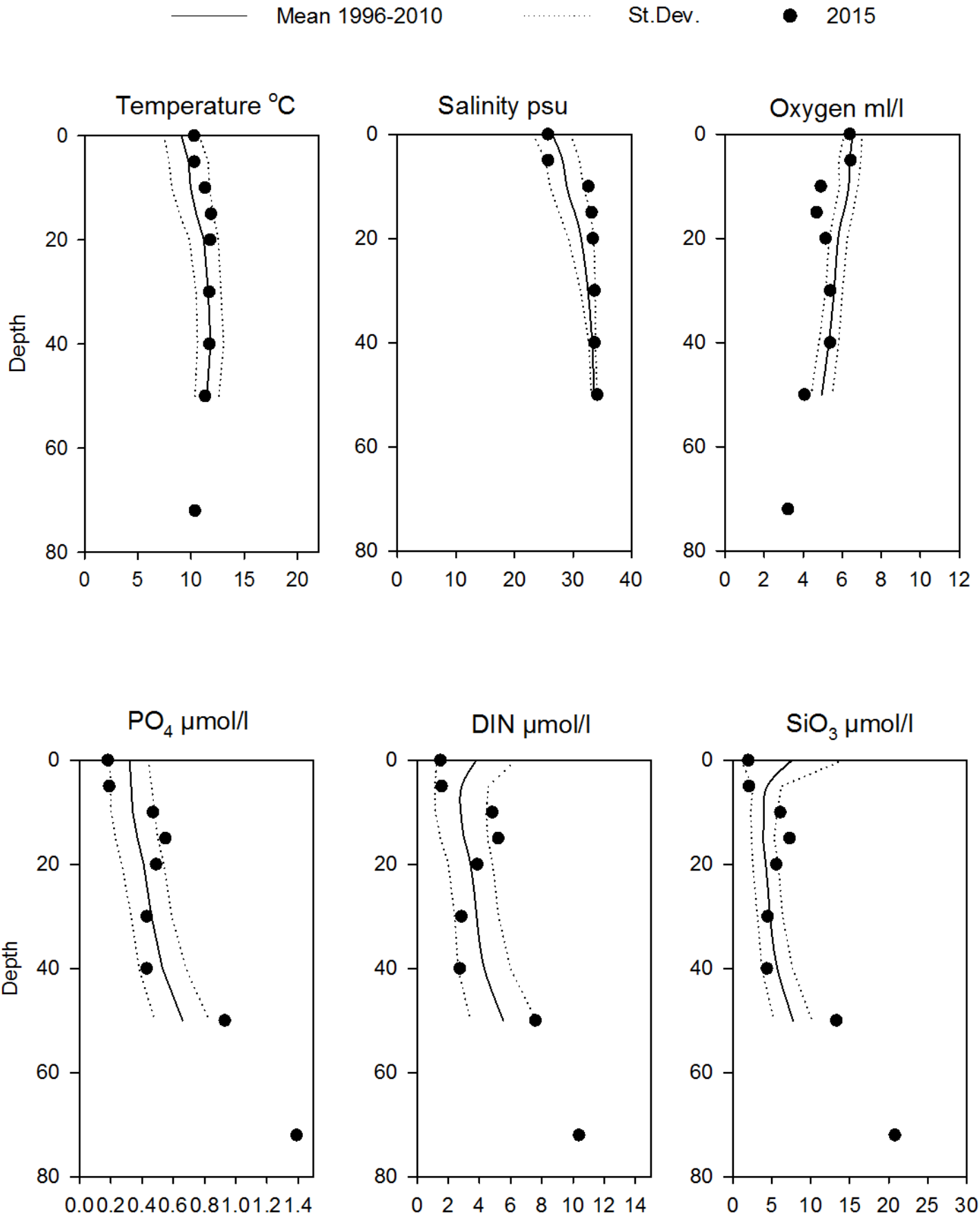
O_2 ml/l



O_2 ml/l



Vertical profiles Släggö November

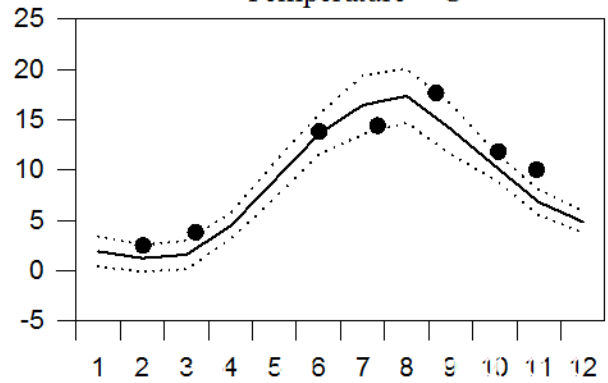


STATION REF M1V1 SURFACE WATER

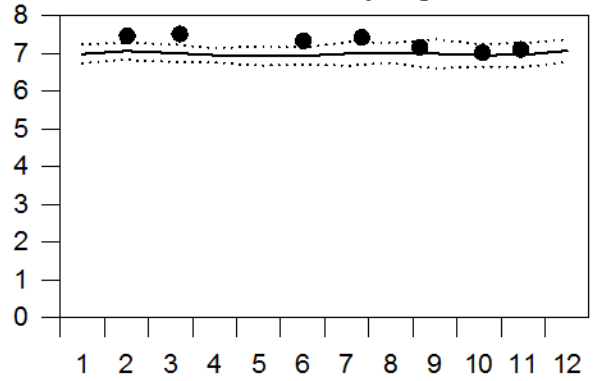
Annual Cycles

Mean 1996-2010 St.Dev. 2015

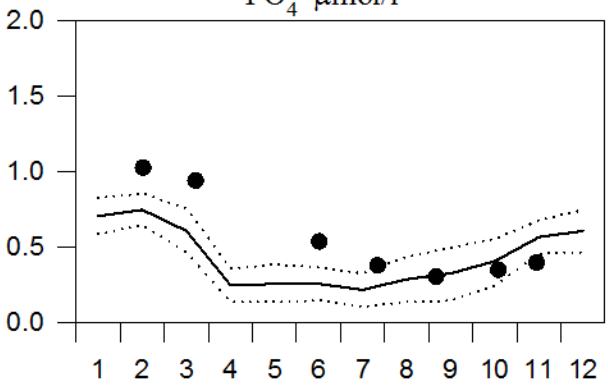
Temperature °C



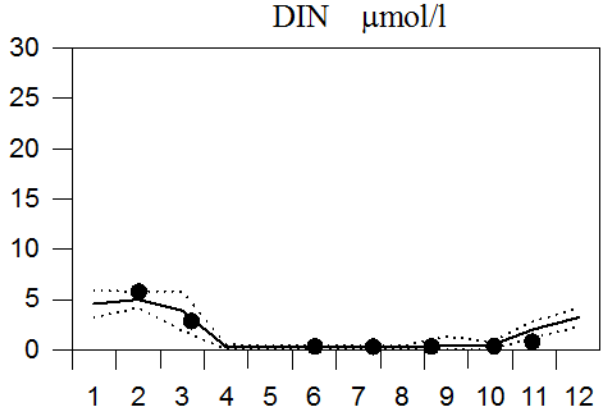
Salinity psu



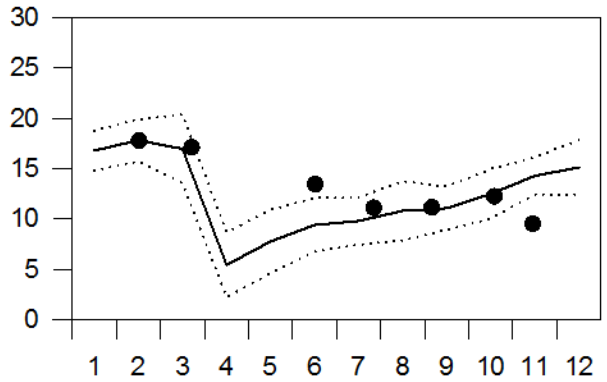
PO_4 µmol/l



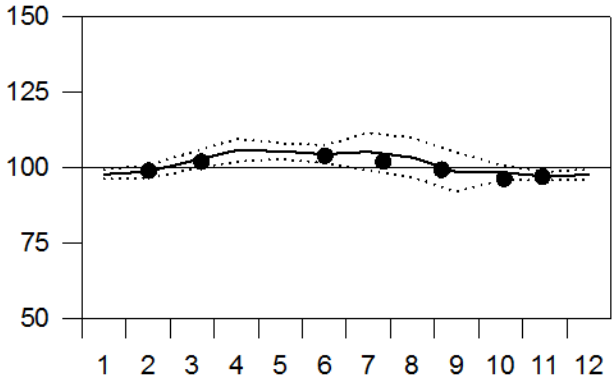
DIN µmol/l



SiO_3 µmol/l

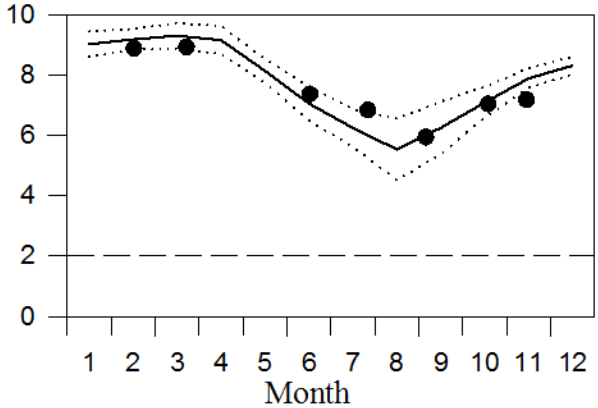


O_2 saturation %

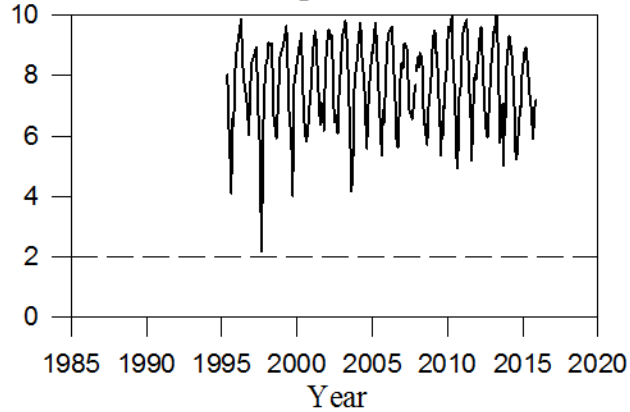


OXYGEN IN BOTTOM WATER (depth >15m)

O_2 ml/l



O_2 ml/l



Vertical profiles Ref M1V1 November