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2014-11-17
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Report from the SMHI monitoring cruise with R/V Aranda

Survey period: 2014-11-08 - 2014-11-17
Survey area: Skagerrak, Kattegat, the Sound and the Baltic Proper
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 Skagerrak, Kattegat, the Sound and the Baltic Proper. Data presented in this report have been subject to preliminary quality control procedures only.

The water temperature in the surface layer was still above normal in all areas. Surface nutrients showed, for the season, almost normal values, except for silicate in the Baltic Proper. At the station BY1 in the Arkona Basin all nutrients showed increased values. In the Bornholm Basin and Hanö Bight acute hypoxia (< 2 ml/l) was present from depths exceeding 70 meters. In the Eastern Gotland Basin completely anoxic conditions were found from depths exceeding 125 meters (at BY20 already from 80 m) and acute hypoxia from 60 - 80 meters. In the Western Gotland Basin the oxygen situation was serious as acute hypoxia already occurred from depths exceeding 70 meters and hydrogen sulphide from 80-90 meters depth.

The next cruise is planned for December 6-14 and will cover Skagerrak, Kattegat, the Sound and the Baltic Proper.

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SMHI

PRELIMINARY RESULTS

The cruise, performed on board the Finnish research vessel Aranda, began in Helsinki on 8th of October and ended in Turku on the 15th. Winds during the expedition were mainly fresh, around 10m/s, varying in direction between east and south. Air temperature varied between 6 - 10°C.
Due to problems with a winch no CTD measurements were carried out in the northern Kattegat or Skagerrak, which means no CTD-profiles or data on salinity can be presented from these areas. Additionally, a problem with the nutrient auto analyzer entails that phosphate- and ammonium data are missing from stations in the Skagerrak.

The Skagerrak

Temperature, down to a depth of about 100 meters, was clearly higher than normal for the season. The surface water temperatures were between 10.5 and 13.5 ^{o}C.
Nutrient levels in the surface layer showed concentrations normal for the season. The concentrations of inorganic nitrogen (nitrite + nitrate) varied between 0.9 and 1.3 µmol/l, while silicate ranged from 2.1 to 2.7 µmol/l. Data on phosphate are missing from the area.
The lowest oxygen level in the bottom waters were measured at the station Släggö, in the mouth of the Gullmar Fjord, where oxygen levels had dropped from 3.1 ml/l at the previous occasion in October to 2.3 ml/l.

The Kattegat and the Sound

In the Kattegat, the temperature was above normal throughout the whole water column, with surface values varying in the range of 10.5 to 11.5 ° C. Thermocline and halocline coincided and were found at depths between 15 and 20 meters. The salinity of the surface water was normal, about 23 psu, in the Sound 9.5 psu.
The concentrations of phosphate and inorganic nitrogen (nitrite + nitrate) showed values typical for the season, while silicate levels were lower than normal. Phosphate varied between 0.16 and 0.19 µmol/l, inorganic nitrogen from below the detection limit (<0.10 µmol/l) to 0.6 µmol/l. In the Sound levels were generally higher, phosphate 0.38 µmol/l and nitrite + nitrate at 1.7 µmol/l. Silicate concentrations in Kattegat were lower than normal, 0.7 – 2.0 while they were normal in the Sound 8.8 µmol/l.
Fluorescence measurements showed some plankton activity in the surface layer.
The lowest oxygen levels in the bottom waters were measured at Anholt E in the southern Kattegat as well as in the Sound, 3.81 ml/l.

The Baltic Proper

Water temperatures, throughout the whole surface layer down to the thermocline at 30 to 40 meters, were well above normal in the whole area, ranging from 8.7 °C in the north to 12.7 in the south. The salinity of the surface water was normal in most of the area, between 6.5 and 8.2 psu. In the Eastern Gotland Basin surface salinity is still approximately 0.15 psu below normal, 7 psu. The halocline was found at about 60 to 70 meters depth in the Western and Eastern Gotland Basins, while in the southern parts at depths between 30 and 50 meters.
Nutrients showed almost normal levels for the season in the surface layer, phosphate concentrations ranged from 0.25 to 0.39 µmol/l, while the concentrations of inorganic nitrogen (nitrite + nitrate) varied from 0.16 to 1.26 µmol/l. Silicate showed slightly elevated levels in the northern and central parts, whereas the concentration in the southern regions were below normal. The concentrations ranged between 4.7 and 12.5 µmol/l. The station BY1 in Arkona differed completely from the pattern and had clearly elevated levels of all nutrients. Phosphate concentration was 0.68 µmol/l, silicate 12.9 µmol/l and the concentrations of nitrite + nitrates was 3.05 µmol/l.

Fluorescence measurements showed that plankton activity was low throughout the area.

The effects of an inflow through the Sound of about 25 km^3 that took place in October were seen at BY2 in the Arkona Basin where the salinity in the deep water was as high as 22 psu. Also in the Bornholm Basin effects were seen at BY4 where oxygen in the bottom waters was higher than in the water above, 1.45 ml/l versus 0.65 ml/l. Acute hypoxia occurred in the Bornholm Basin and Hanö Bight from a depth of 70 meters. In the central parts of the Eastern Gotland Basin acute hypoxia occurred from 60 - 80 meters depth and hydrogen sulphide at depths exceeding 125 - 135 meters. At the station BY20, in the north, hydrogen sulphide was present already at 80 meters depth. In the Western Gotland Basin the oxygen situation was serious as acute hypoxia occurred from depths exceeding 70 meters and hydrogen sulphide from 80-90 meters depth.

PARTICIPANTS

Name		**Institute**
Anna-Kerstin Thell	Cruise leader	SMHI
Lars Andersson		SMHI
Sara Johansson (Lysekil – Turku)		SMHI
Mikael Krysell (Helsingfors – Lysekil)		SMHI
Vivi Månsson		SMHI
Sari Sipilä		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

TRACKCHART
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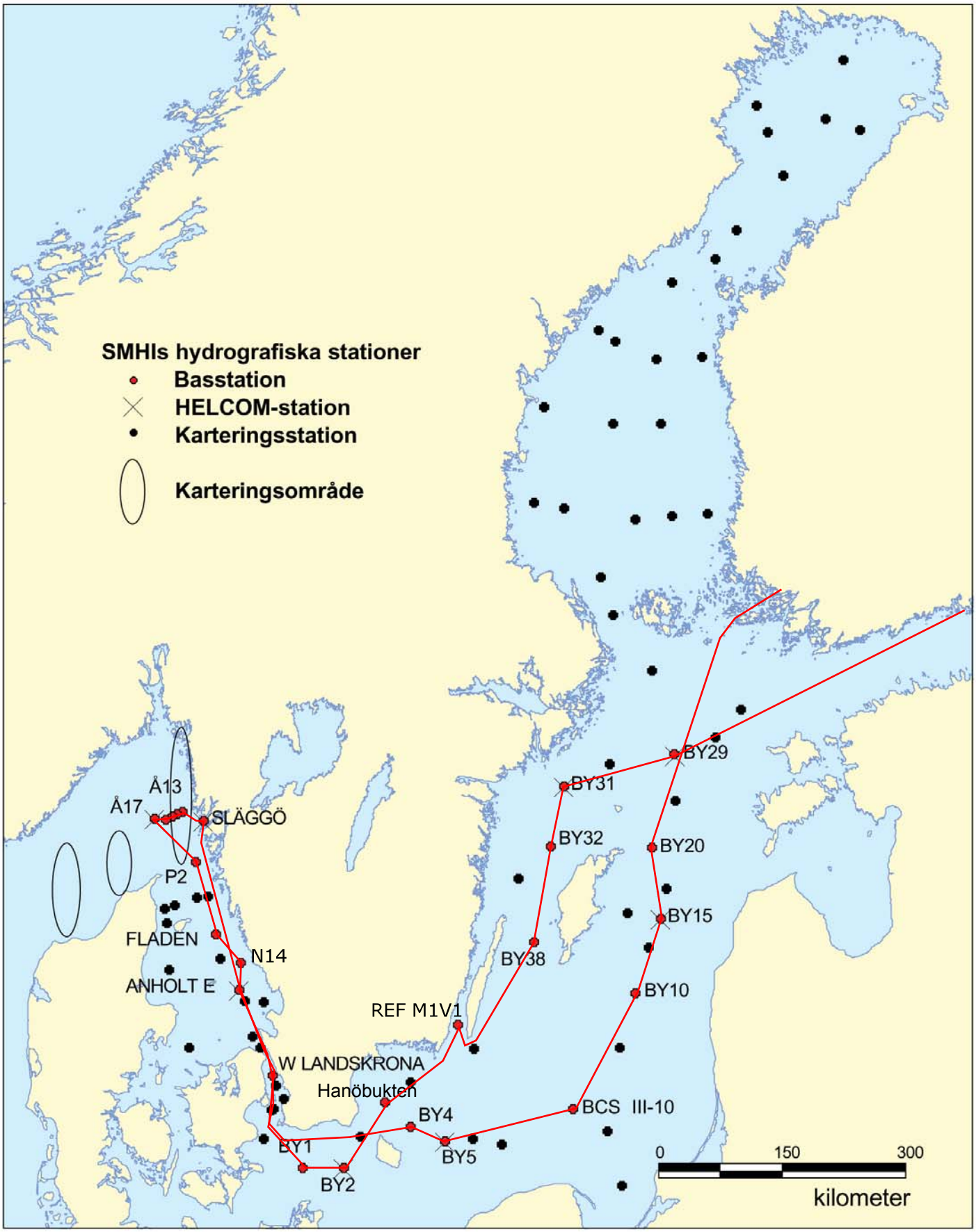
Ship: R/V ARANDA
Date: 20141108-20141115
Series: 0747-0771



Ser no	Stat code	Proj	Station	Lat	Lon	Date yyyymmdd	Time hhmm utc	Bottom depth m	Secchi depth m	Wind di	Wind ve	Air temp C	Air pres hPa	WCSI	Ctd	PPCPZZT	No de	Temp	Salin	Ph	Oxyg	H2S	PO4P	TotP	NO2N	NO3N	NH4N	TotN	Alkal	SiO3	Humus	Ligni	PON	POC	TOC	Comm
0747	BPNX35	BAS	BY29	N5853	E2019	20141108	2300	175		19	6	8.8	1015	9990	x	--x----	16	x	x	-	x	x	x	x	x	x	x	x	-	x	-	-	-	-	-	x
0748	BPNX37	BAS	BY31 LANDSORTSDJ	N5835	E1814	20141109	0720	447	10	29	7	9.4	1017	4930	x	-xxxx--	23	x	x	x	x	x	x	x	x	x	x	x	x	x	-	-	-	-	-	x
0749	BPWX38	BAS	BY32 NORRKÖPINGSDJ	N5801	E1759	20141109	1310	200	10	19	6	9	1018	2730	x	--x----	17	x	x	-	x	x	x	x	x	x	x	x	-	x	-	-	-	-	-	x
0750	BPWX45	BAS	BY38 KARLSÖDJ	N5707	E1740	20141109	2010	109		15	13	9.2	1017	9990	x	--x----	14	x	x	-	x	x	x	x	x	x	x	x	-	x	-	-	-	-	-	-
0751	BPWK01	BAS	REF M1V1	N5622.25	E1612.1	20141110	0615	18		18	8	10.6	1012	2830	x	-xxxx--	5	x	x	x	x	-	x	x	x	x	x	x	x	x	-	-	-	-	-	-
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0753	BPSA03	BAS	BY2 ARKONA	N5500	E1405	20141110	1850	47		22	6	10.1	1010	9990	x	--xxx--	8	x	x	-	x	-	x	x	x	x	x	x	-	x	-	-	-	-	-	x
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0755	SOCX39	BAS	W LANDSKRONA	N5552.0	E1245.0	20141111	0420	50		21	5	9.5	1011	9990	x	--x----	9	x	x	-	x	-	x	x	x	x	x	x	-	x	-	-	-	-	-	-
0756	KAEX29	BAS	ANHOLT E	N5640.0	E1207.0	20141111	1000	63	9	20	9	9.6	1013	2730	x	-xxxx--	10	x	x	x	x	-	x	x	x	x	x	x	x	x	-	-	-	-	-	-
0757	KANX50	BAS	N14 FALKENBERG	N5656.40	E1212.70	20141111	1212	31	8.5	19	7	9.6	1014	2830	x	-xxxx--	7	x	x	x	x	-	x	x	x	x	x	x	x	x	-	-	-	-	-	x
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0760	SKEX18	BAS	Å17	N5816.5	E1030.8	20141112	0020	353		12	6	10.4	1015	9990	-	--xx---	14	x	x	x	x	-	-	x	x	x	-	x	x	x	-	-	-	-	-	x
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0763	FIBG27	BAS	SLÄGGÖ	N5815.5	E1126.0	20141112	0645	76	5	08	10	7.2	1015	2730	-	-xxx---	9	x	x	-	x	-	-	x	x	x	-	x	x	x	-	-	-	-	-	x
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0768	BPEX13	BAS	BY10	N5638	E1935	20141114	0705	143		11	9	7.5	1024	2840	x	-xxx---	15	x	x	-	x	x	x	x	x	x	x	x	x	x	-	-	-	-	-	x
0769	BPEX21	BAS	BY15 GOTLANDSDJ	N5720	E2003	20141114	1150	239	7	13	9	7.0	1024	2840	x	-xxx---	19	-	x	x	x	x	x	x	x	x	x	x	x	x	-	-	-	-	-	x
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0771	BPEX26	BAS	BY20 FÅRÖDJ	N5800	E1953	20141114	1700	193		11	9	6.7	1025	9990	x	--x----	17	x	x	-	x	x	x	x	x	x	x	x	-	x	-	-	-	-	-	-

Bottom water oxygen concentration (ml/l)

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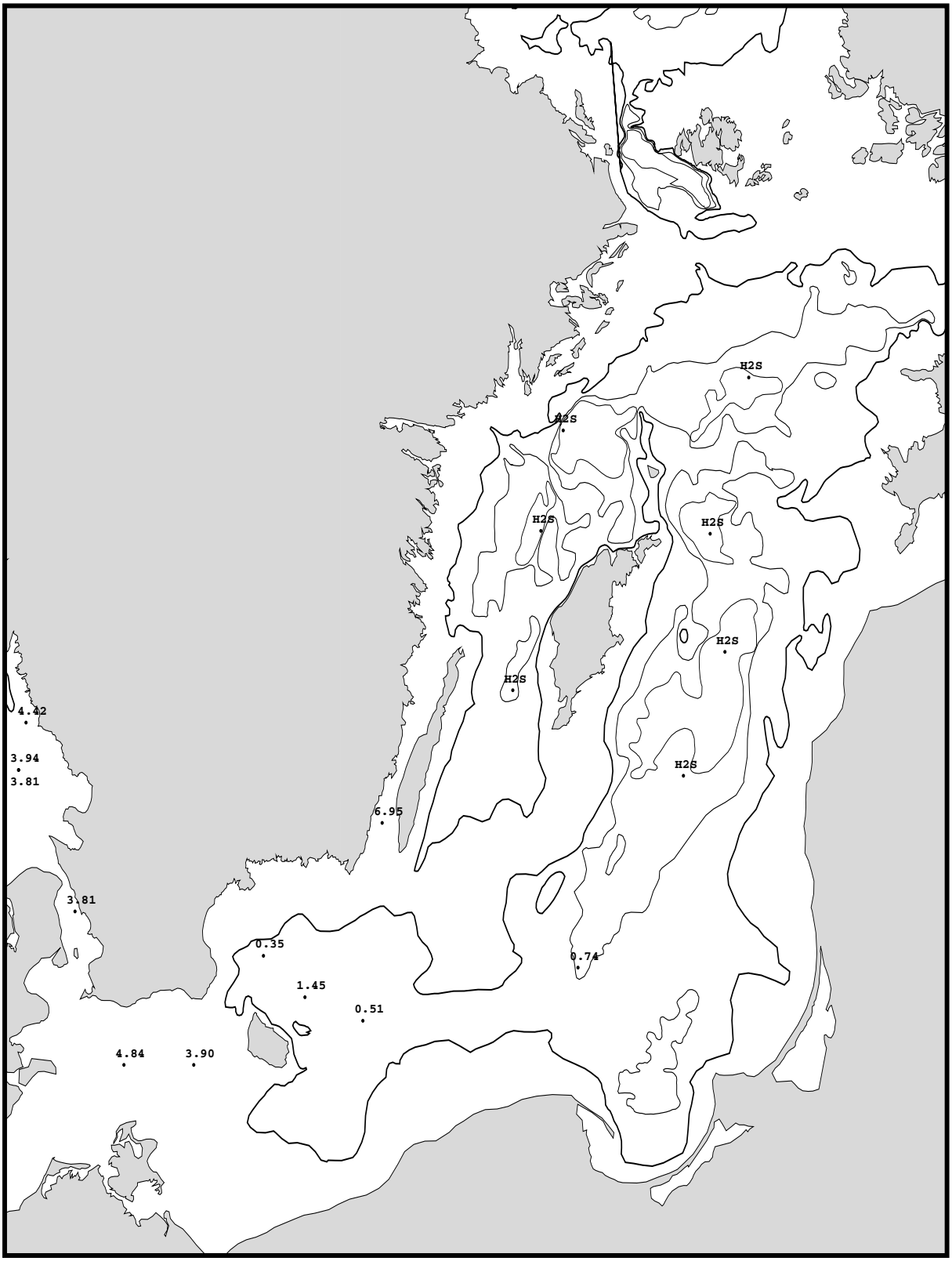
Ship : Aranda
Date : 20141108-20141114
Series : 0747-0771

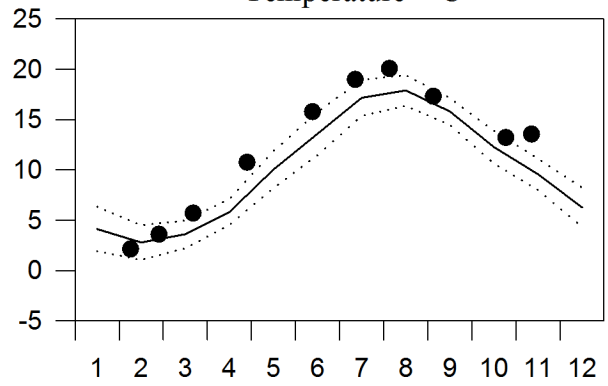


STATION P2 SURFACE WATER

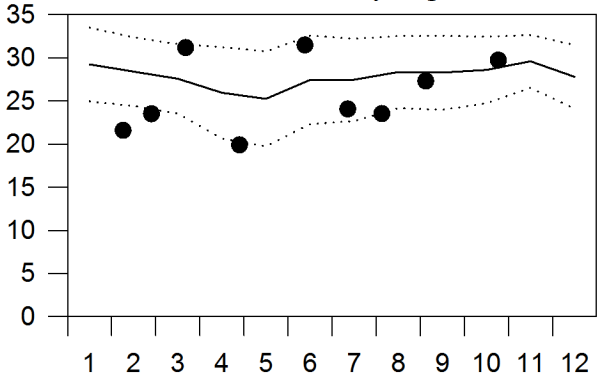
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2014

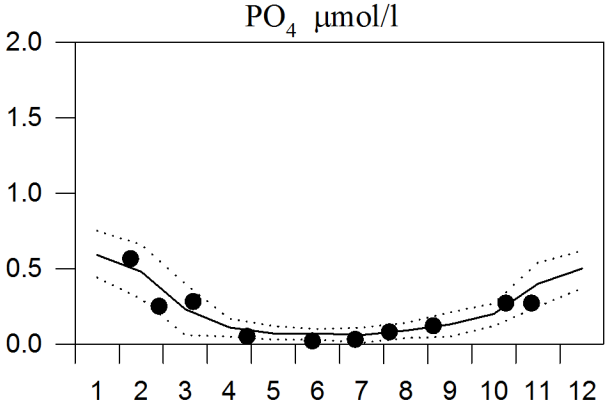
Temperature °C



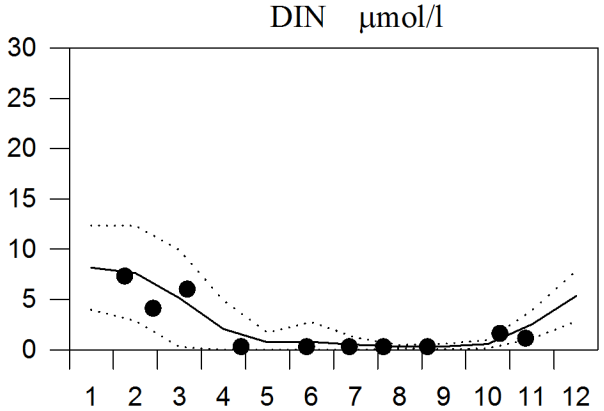
Salinity psu



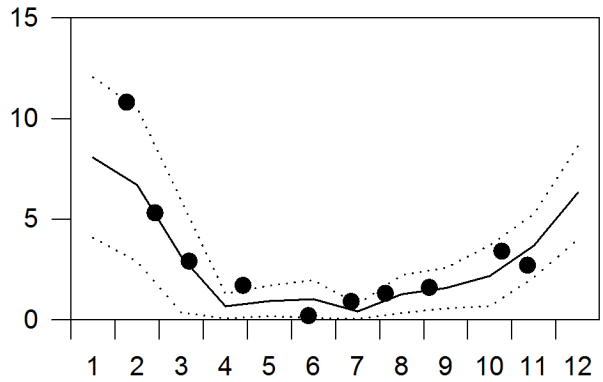
PO_4 µmol/l



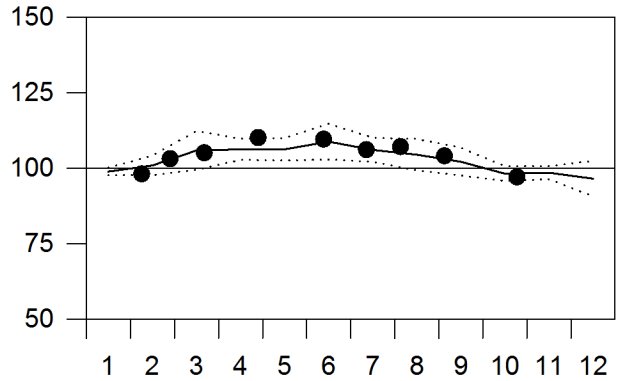
DIN µmol/l



SiO_3 µmol/l

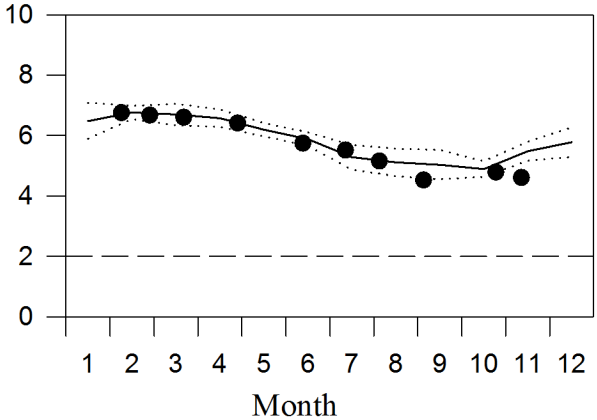


O_2 saturation %



OXYGEN IN BOTTOM WATER (depth >75m)

O_2 ml/l



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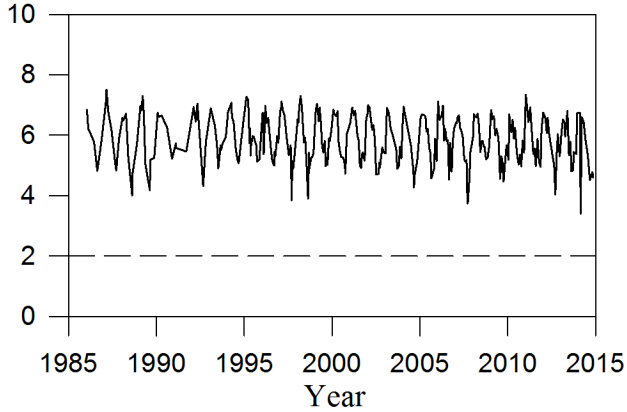
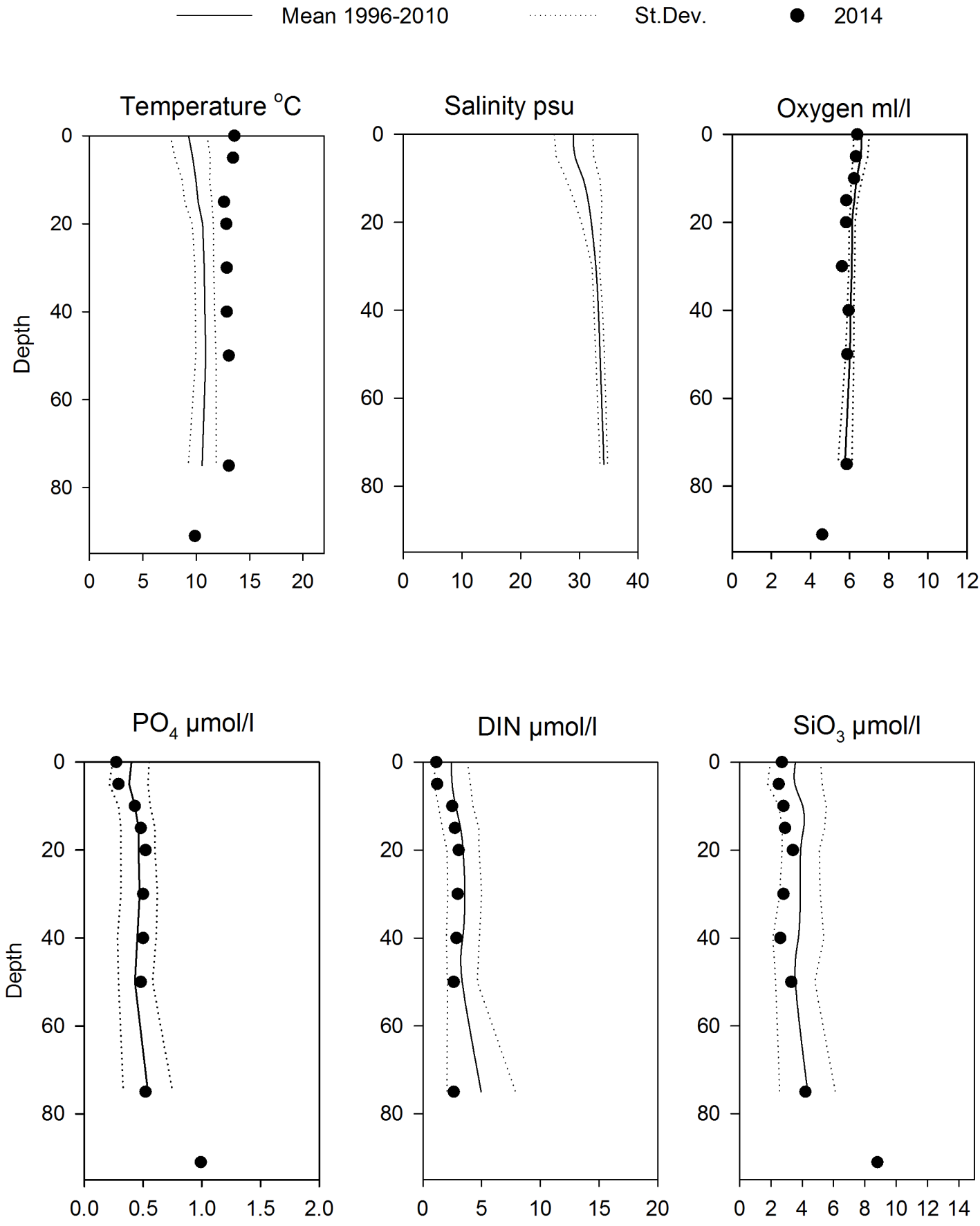


Vertical profiles P2 November

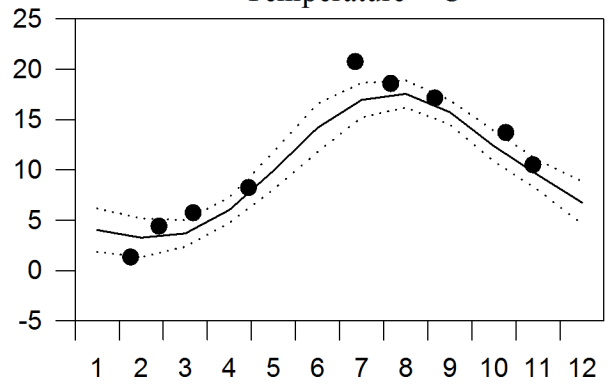


STATION Å13 SURFACE WATER

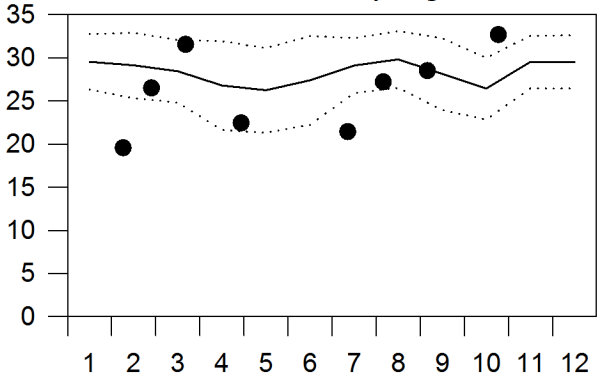
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2014

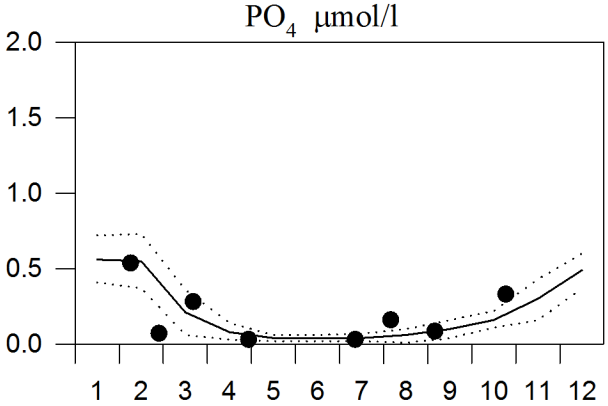
Temperature °C



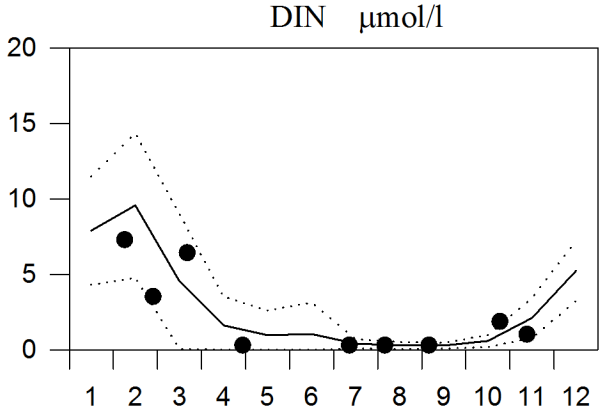
Salinity psu



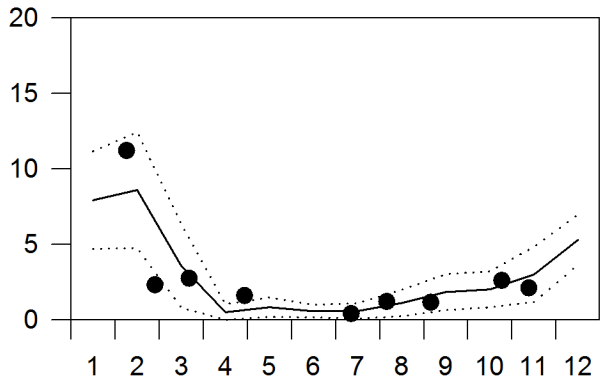
PO_4 µmol/l



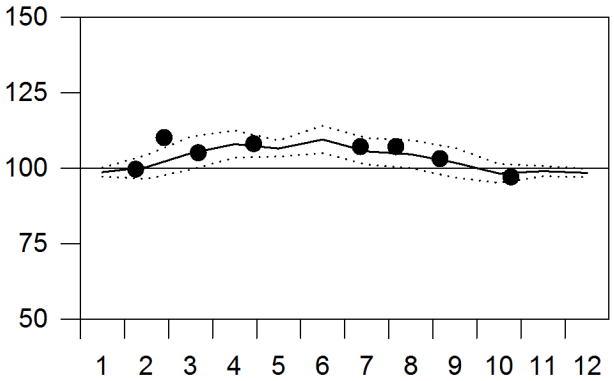
DIN µmol/l



SiO_3 µmol/l

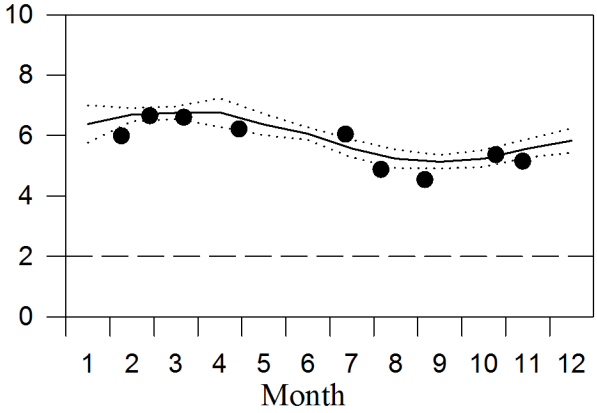


O_2 saturation %

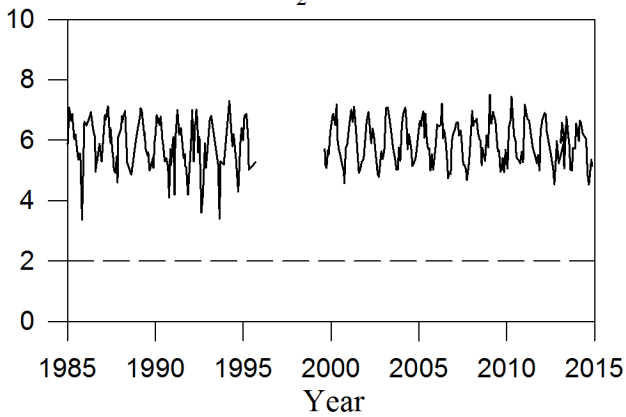


OXYGEN IN BOTTOM WATER (depth >=75m)

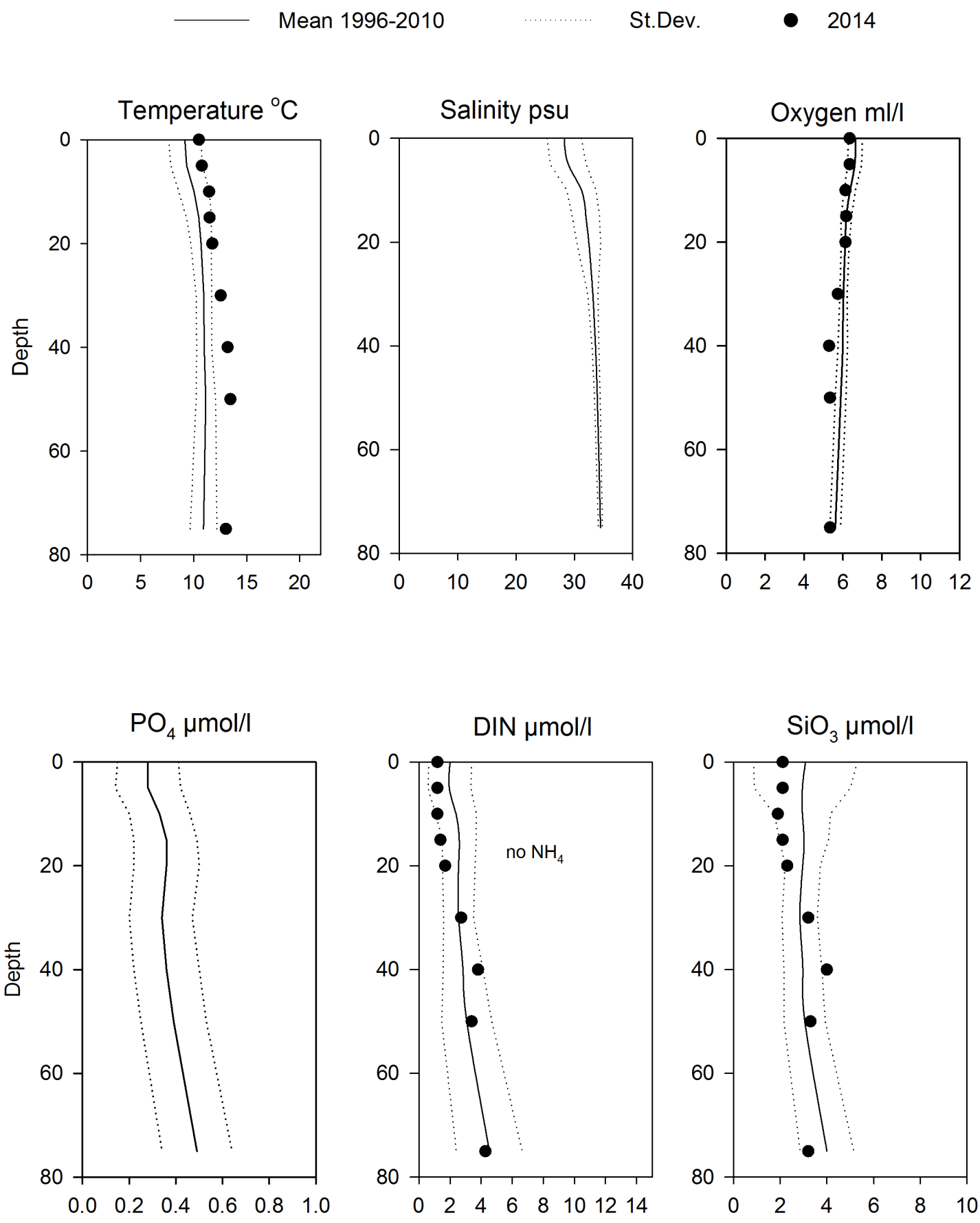
O_2 ml/l



O_2 ml/l



Vertical profiles Å13 November

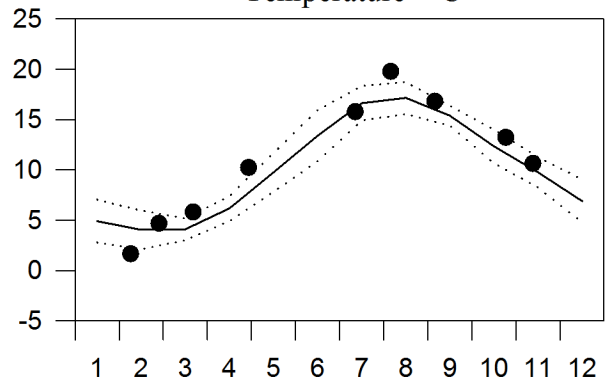


STATION Å15 SURFACE WATER

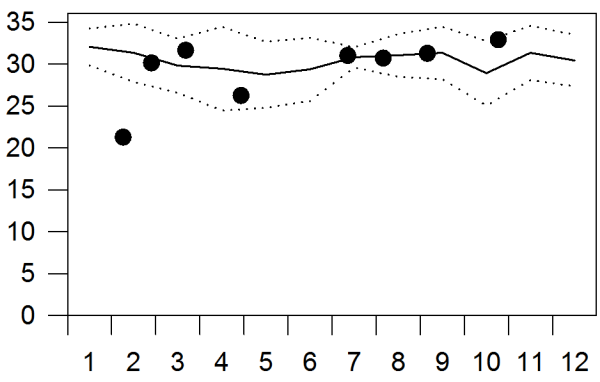
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2014

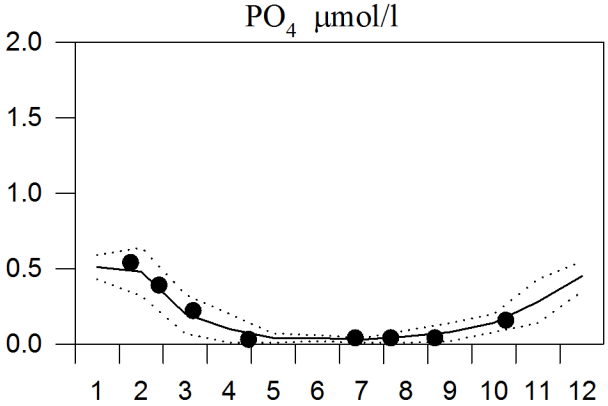
Temperature °C



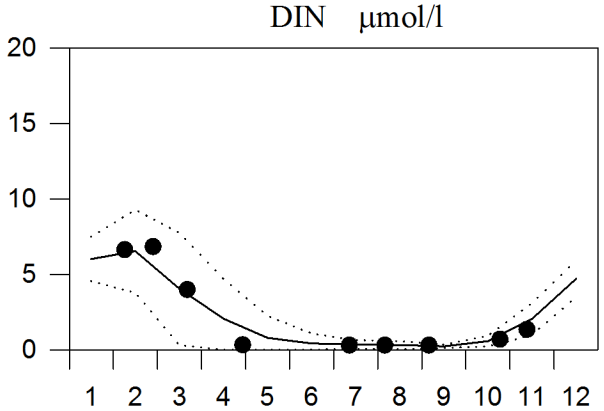
Salinity psu



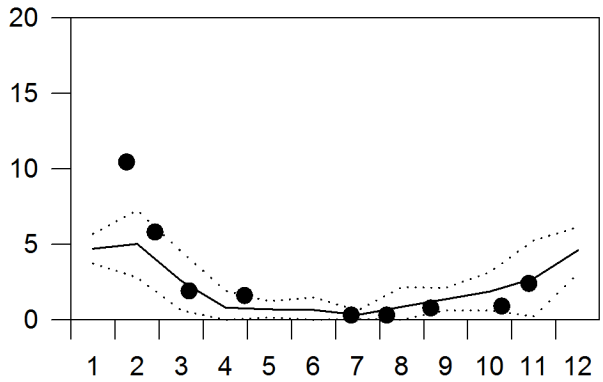
PO_4 µmol/l



DIN µmol/l



SiO_3 µmol/l



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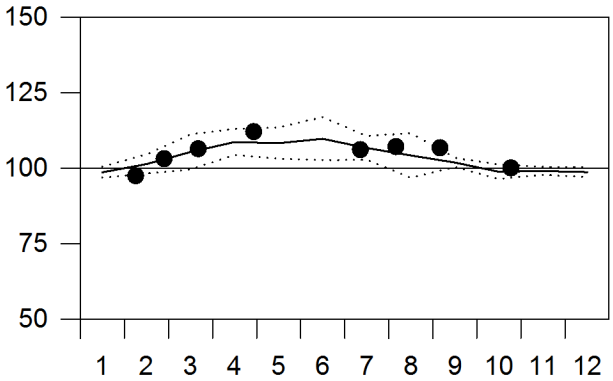
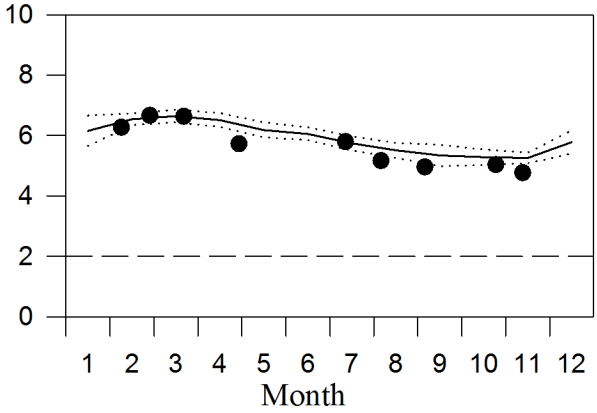
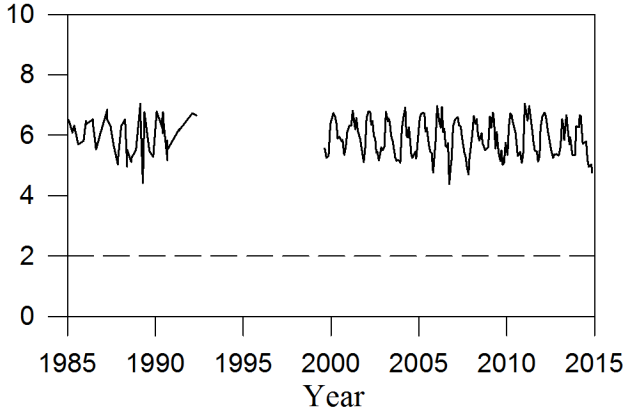


OXYGEN IN BOTTOM WATER (depth >=125m)

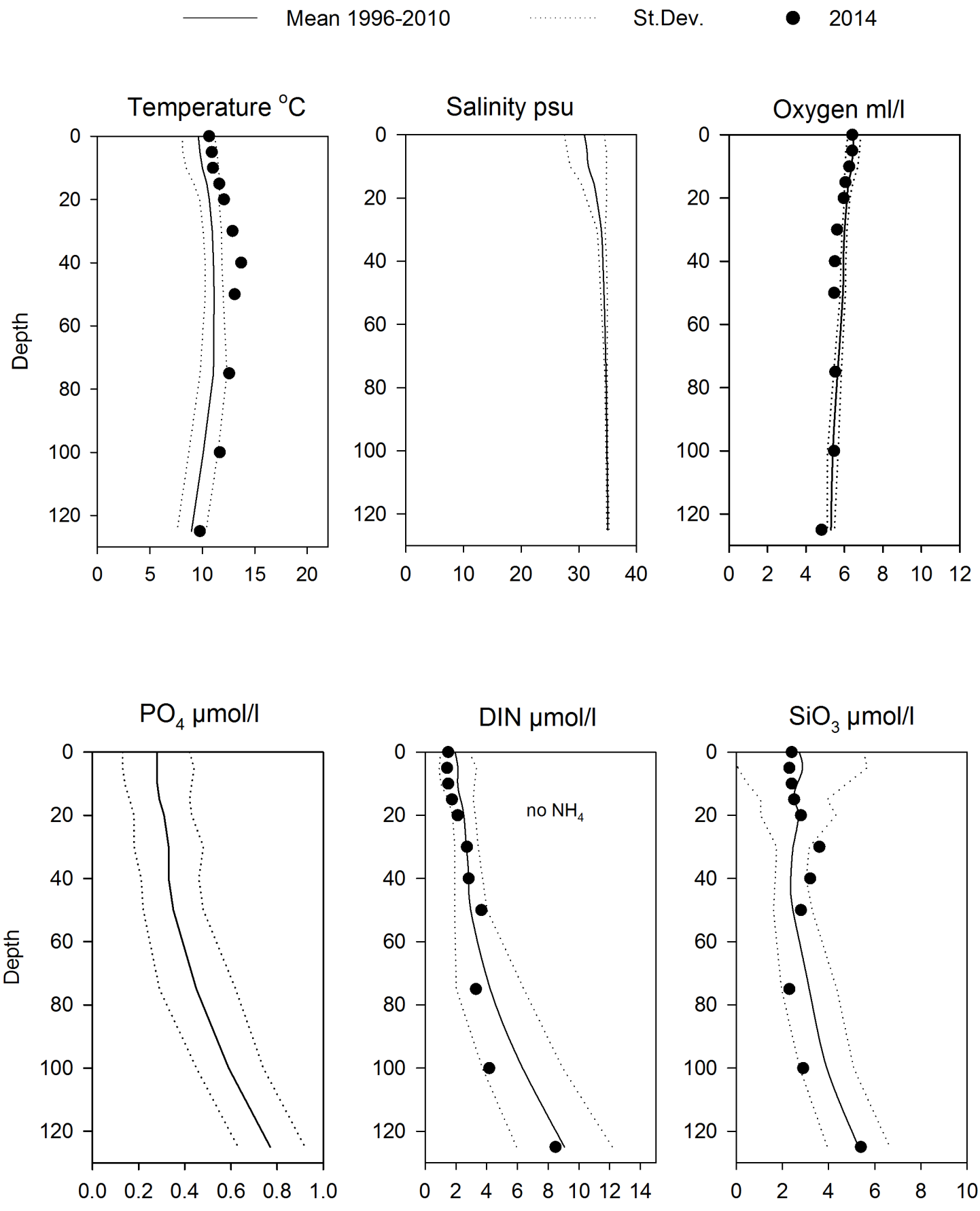
O_2 ml/l



O_2 ml/l



Vertical profiles Å15 November

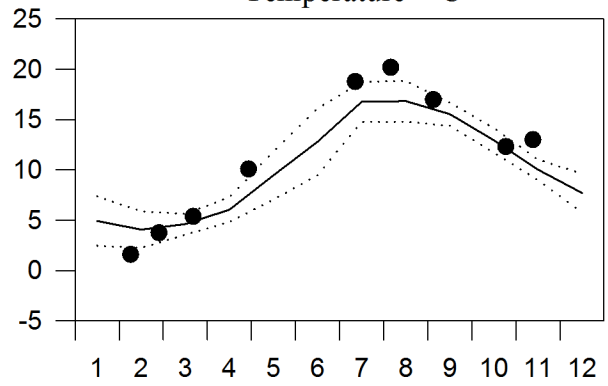


STATION Å17 SURFACE WATER

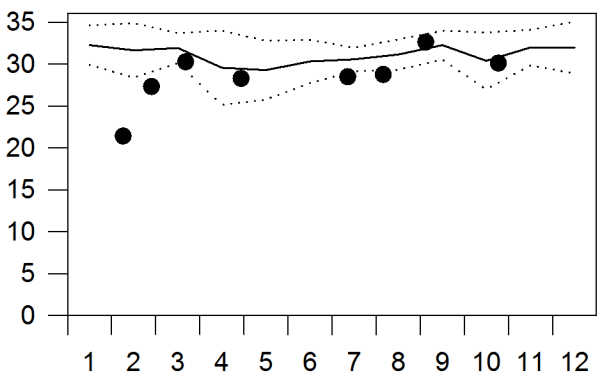
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2014

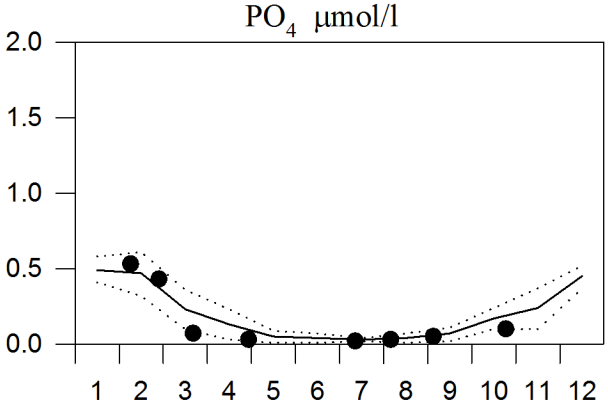
Temperature °C



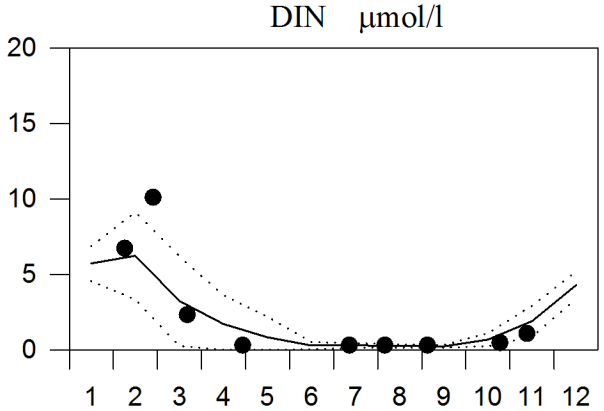
Salinity psu



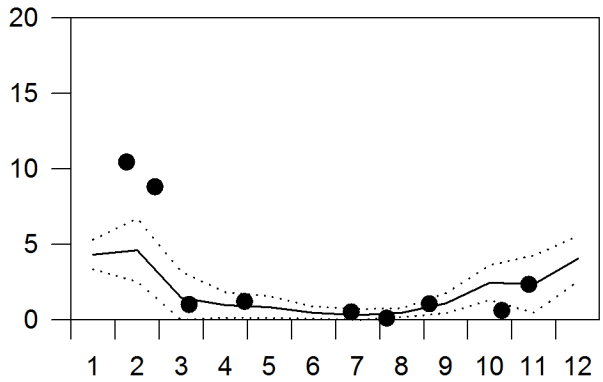
PO_4 µmol/l



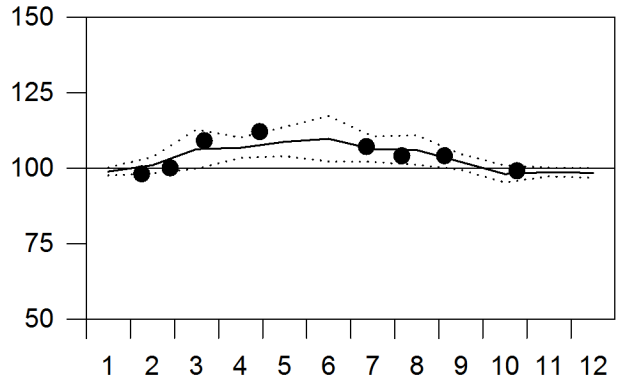
DIN µmol/l



SiO_3 µmol/l

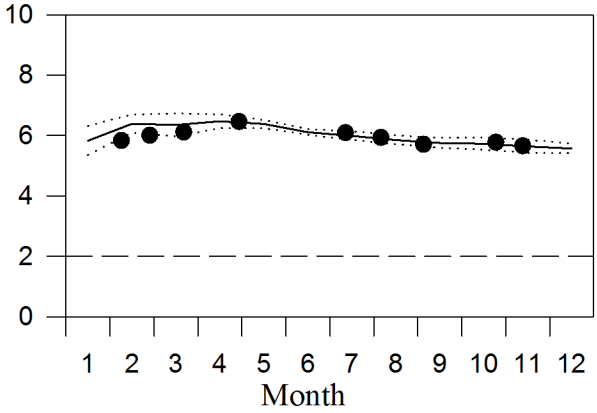


O_2 saturation %

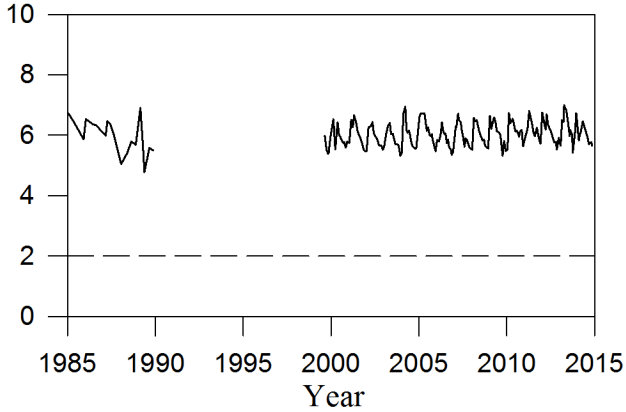


OXYGEN IN BOTTOM WATER (depth = 300m)

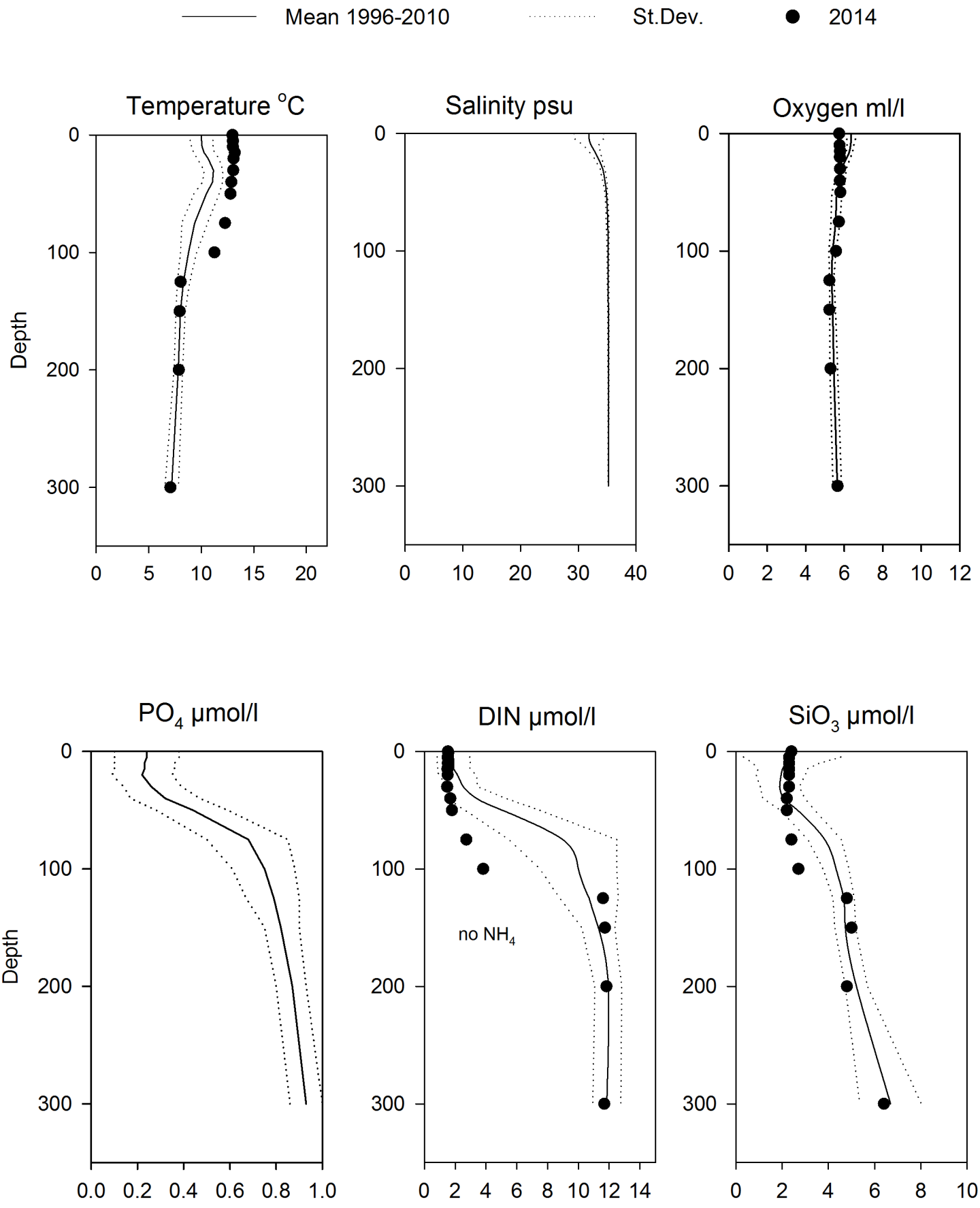
O_2 ml/l



O_2 ml/l



Vertical profiles Å17 November

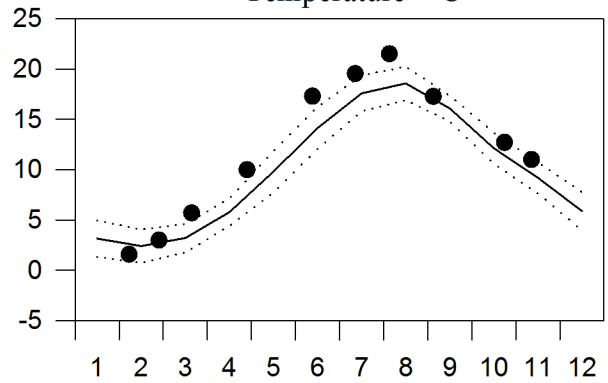


STATION FLADEN SURFACE WATER

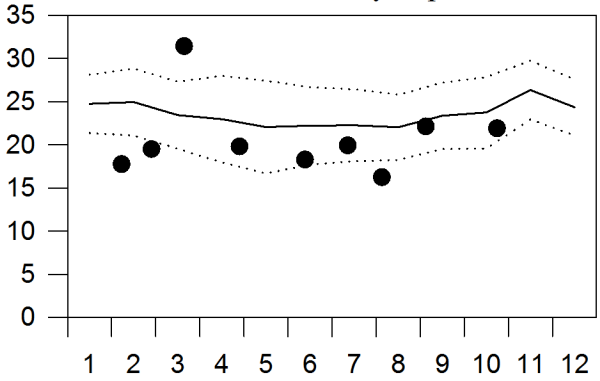
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2014

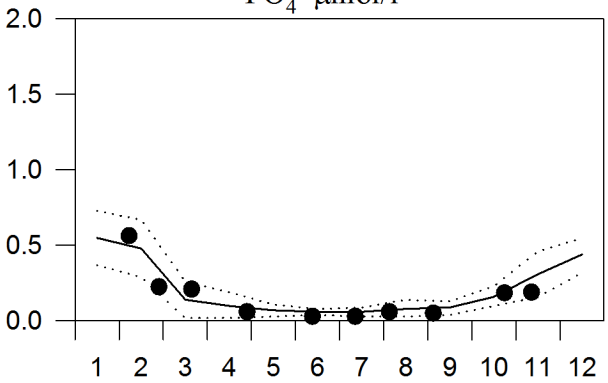
Temperature °C



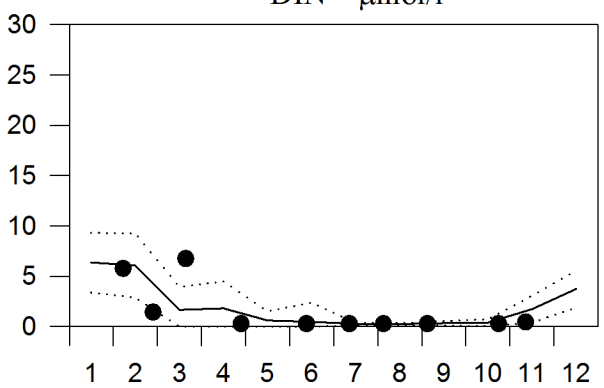
Salinity psu



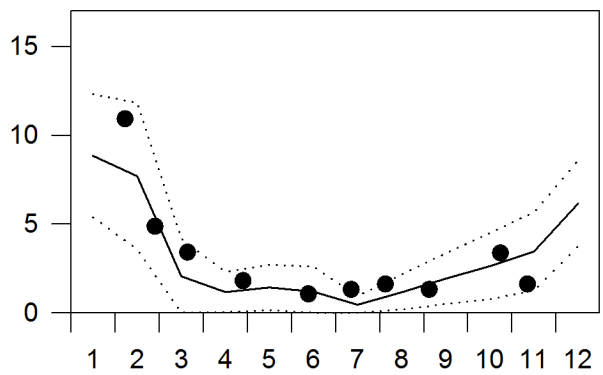
PO_4 µmol/l



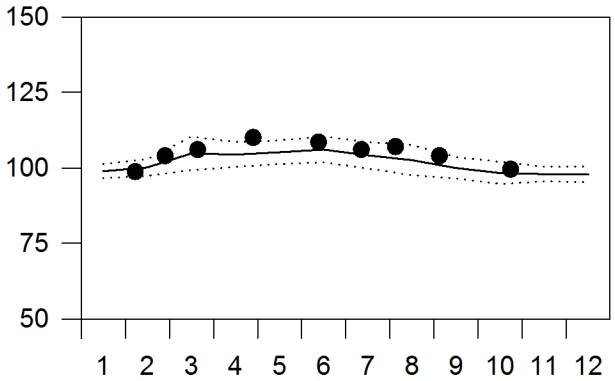
DIN µmol/l



SiO_3 µmol/l

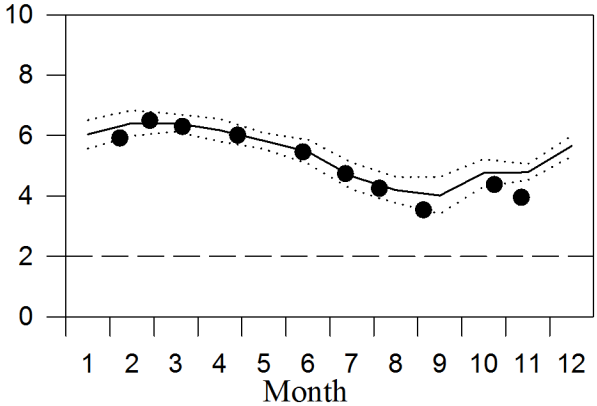


O_2 saturation %

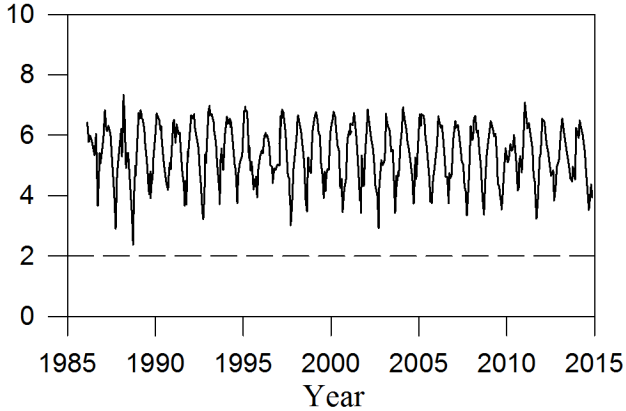


OXYGEN IN BOTTOM WATER (depth > 70m)

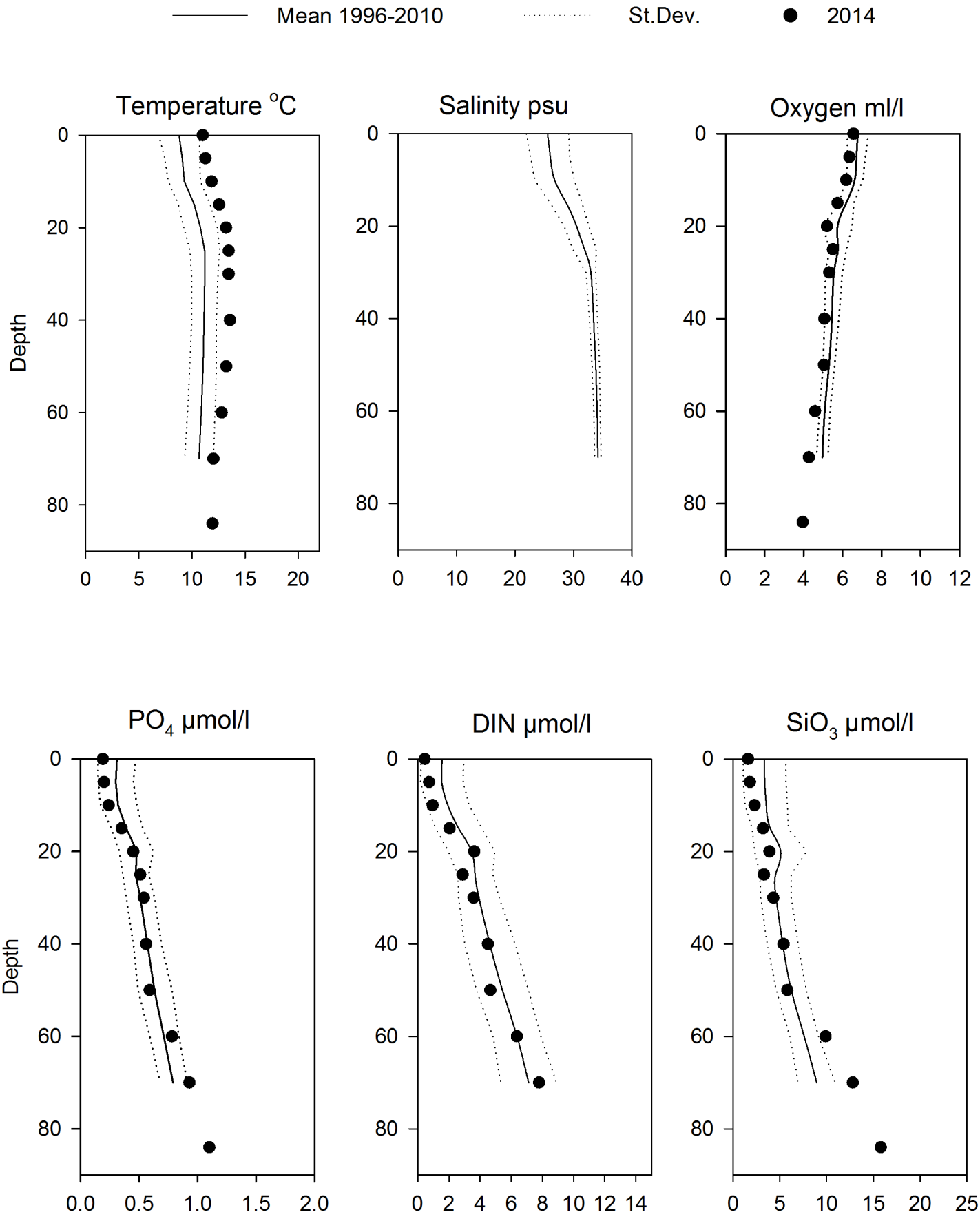
O_2 ml/l



O_2 ml/l



Vertical profiles Fladen November

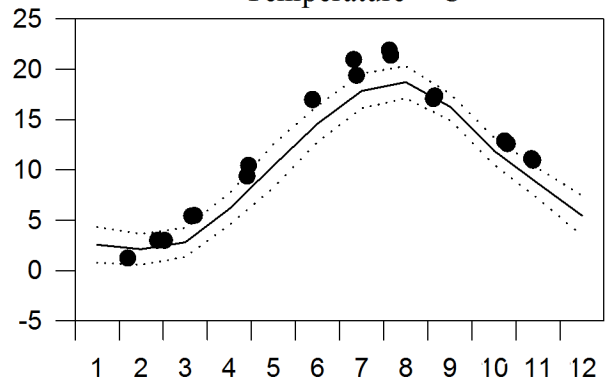


STATION ANHOLT E SURFACE WATER

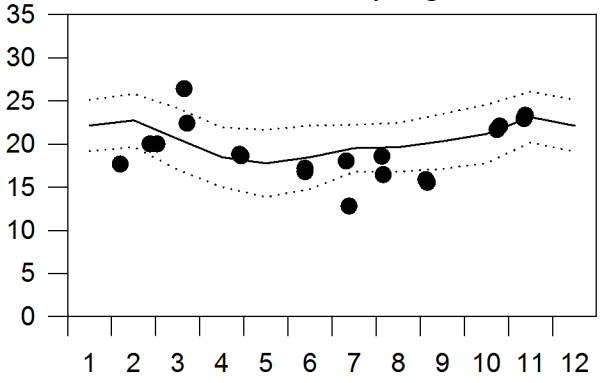
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2014

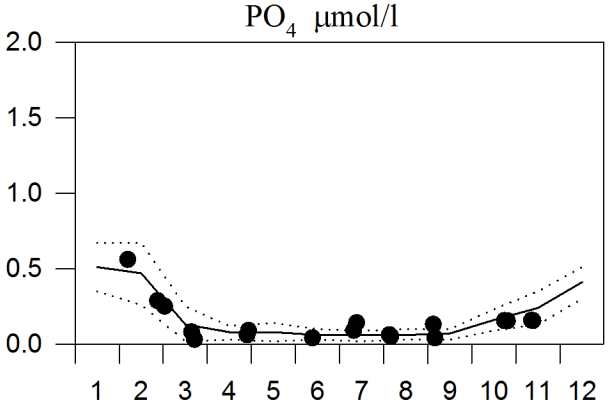
Temperature °C



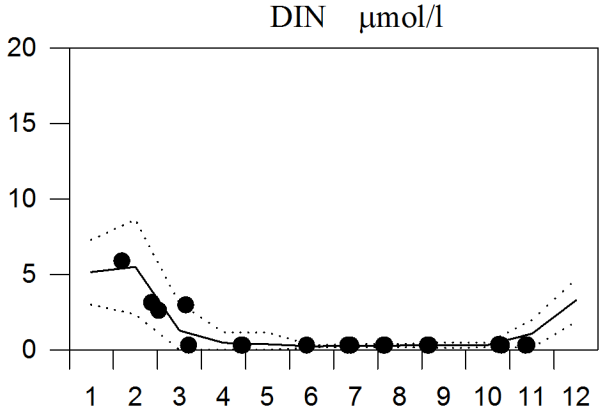
Salinity psu



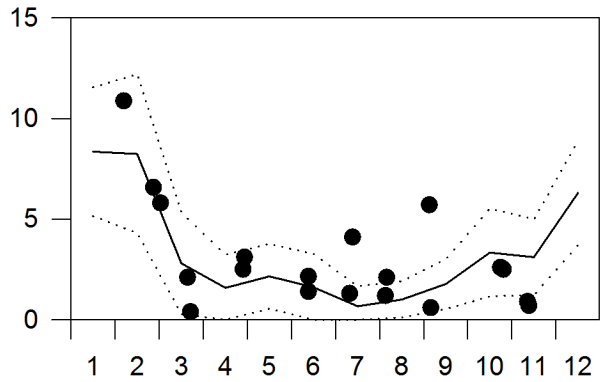
PO_4 µmol/l



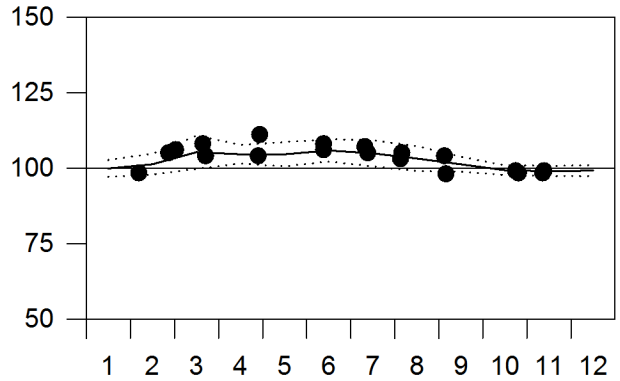
DIN µmol/l



SiO_3 µmol/l

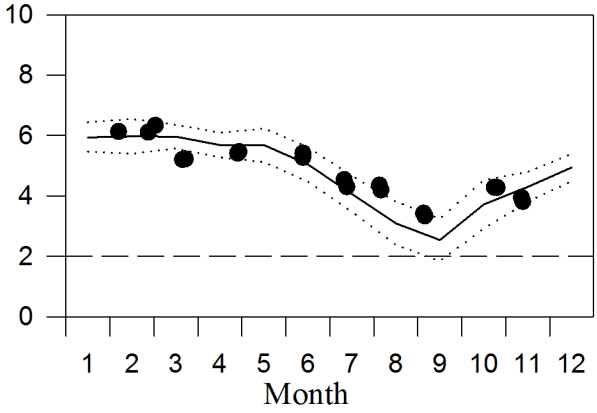


O_2 saturation %

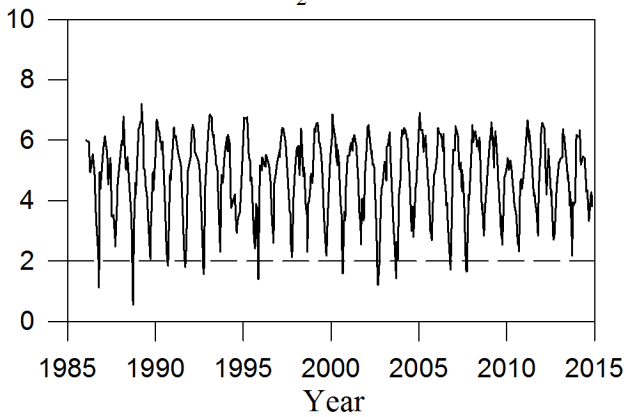


OXYGEN IN BOTTOM WATER (depth > 50m)

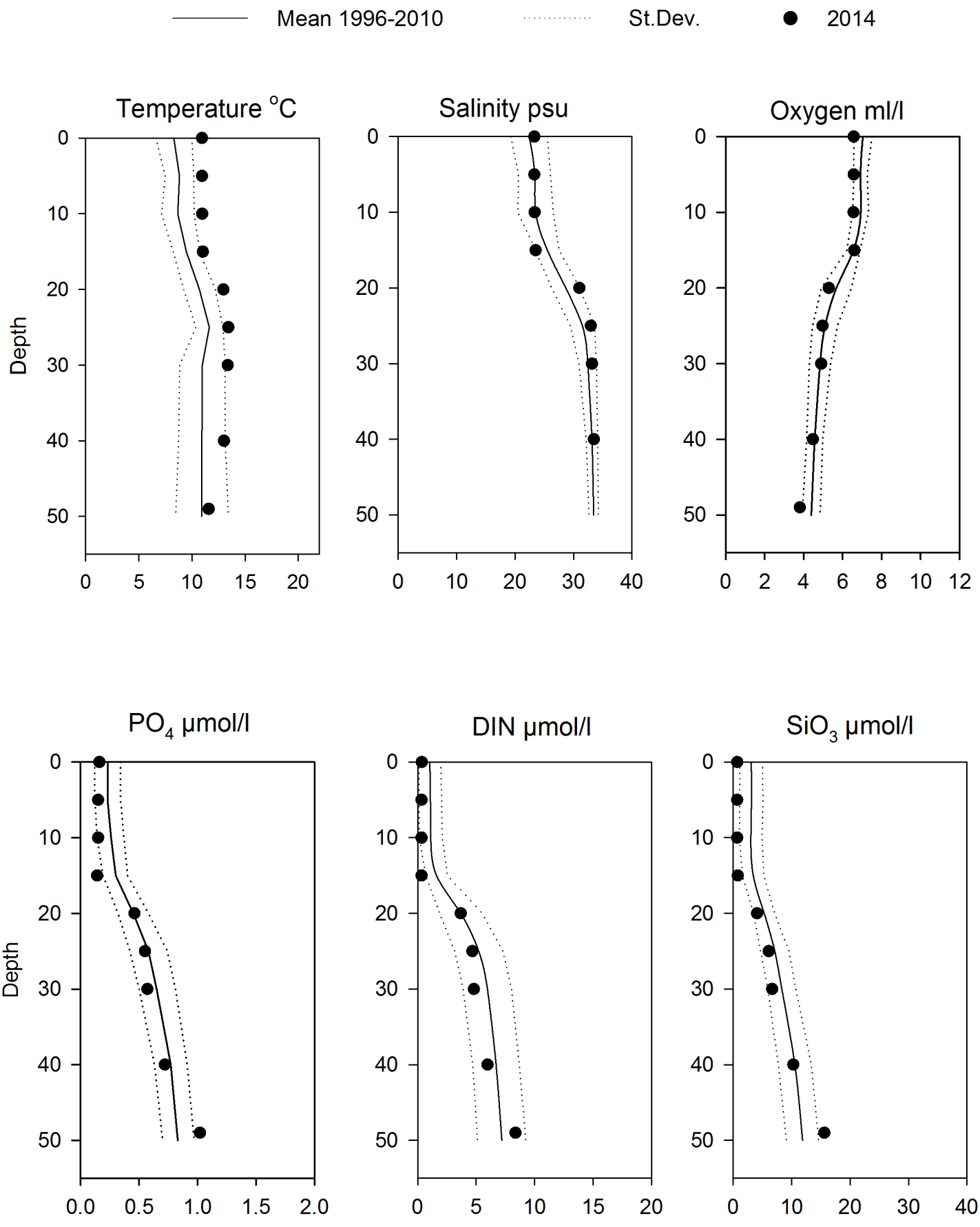
O_2 ml/l



O_2 ml/l



Vertical profiles Anholt E November

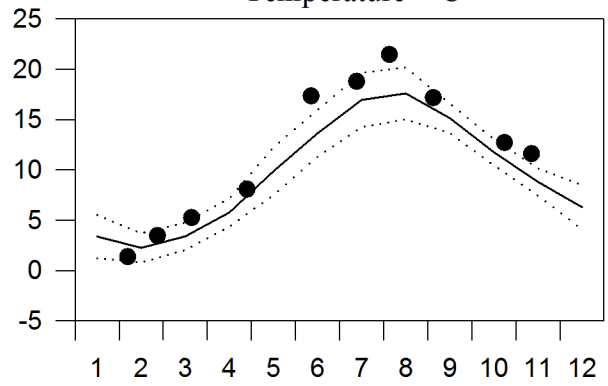


STATION W LANDSKRONA SURFACE WATER

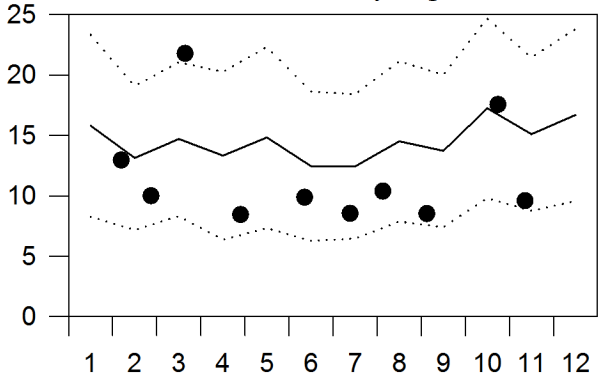
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2014

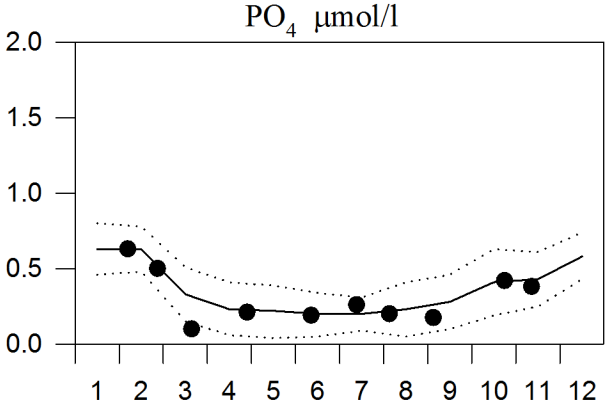
Temperature °C



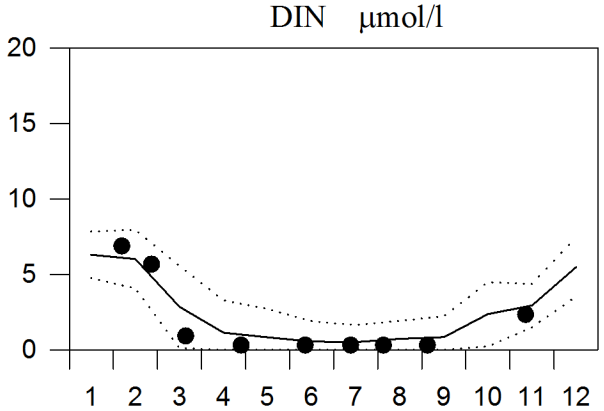
Salinity psu



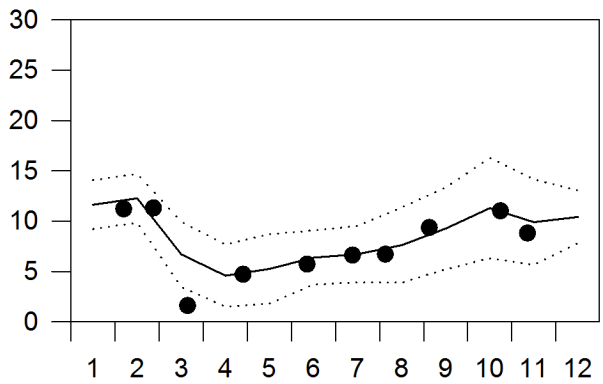
PO_4 µmol/l



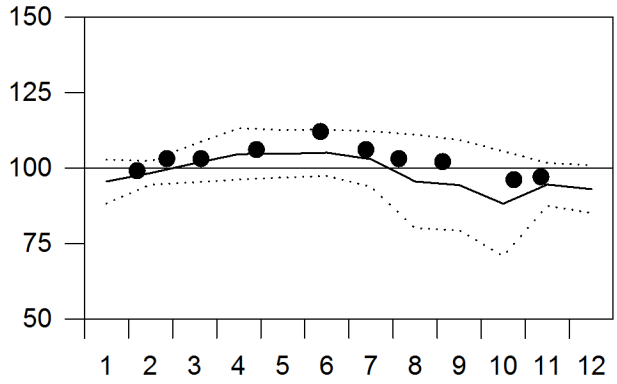
DIN µmol/l



SiO_3 µmol/l

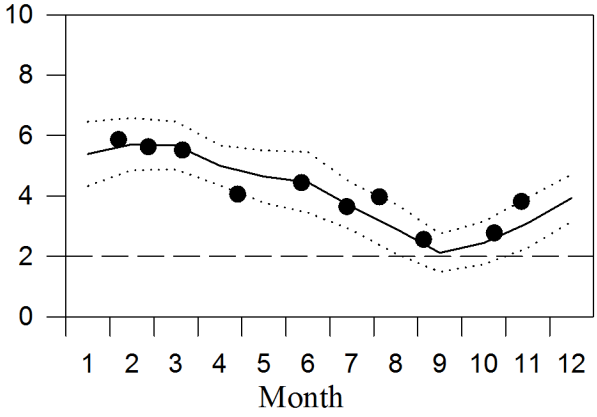


O_2 saturation %

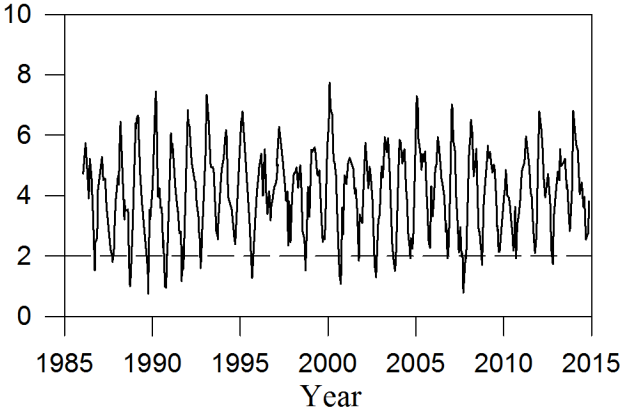


OXYGEN IN BOTTOM WATER (depth >40m)

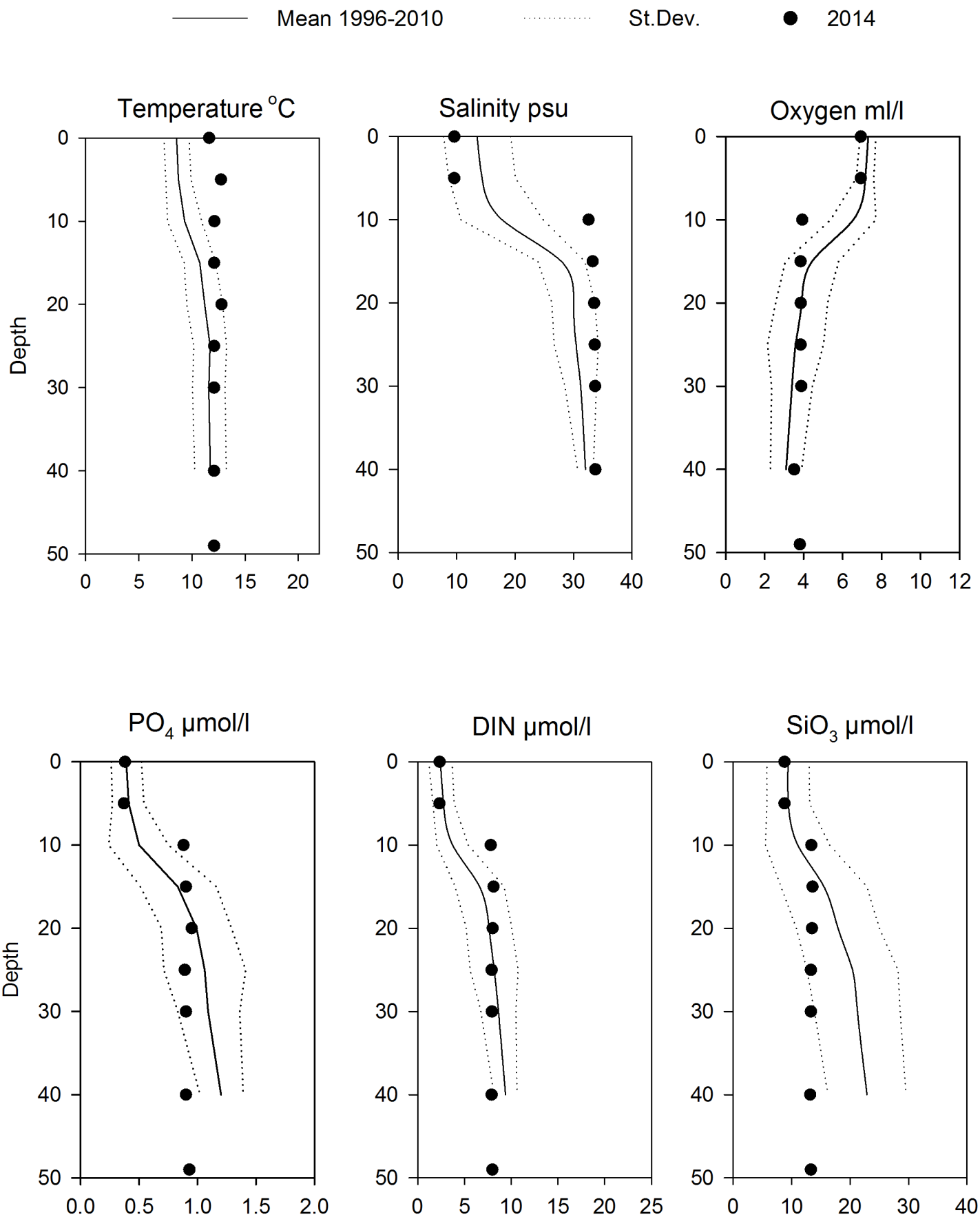
O_2 ml/l



O_2 ml/l



Vertical profiles W Landskrona November

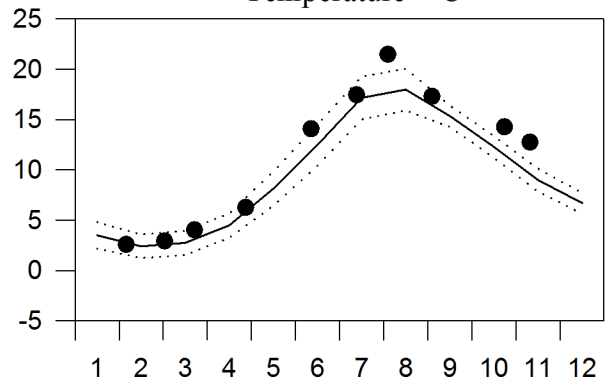


STATION BY1 SURFACE WATER

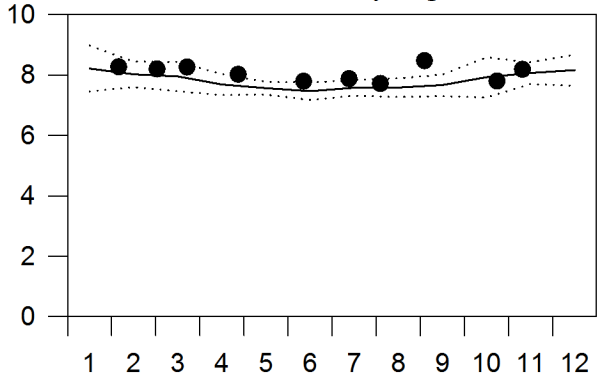
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2014

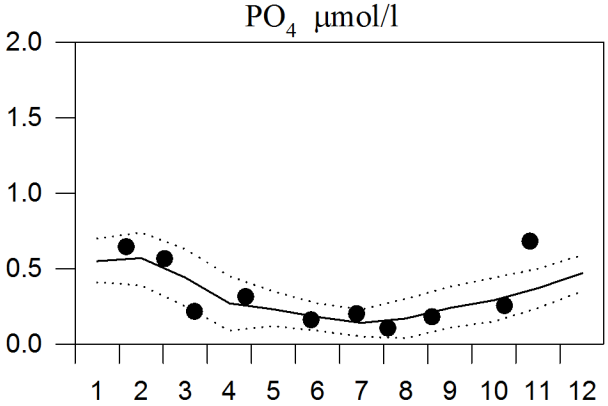
Temperature °C



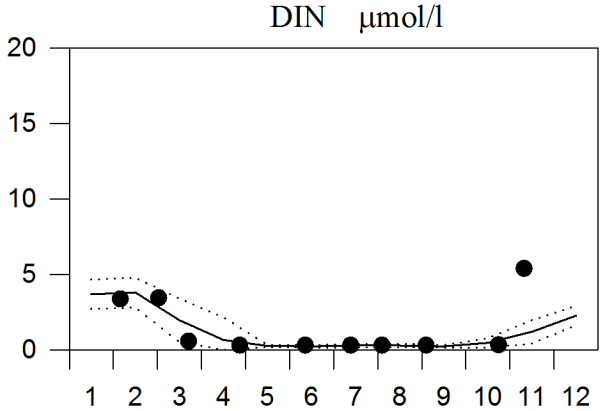
Salinity psu



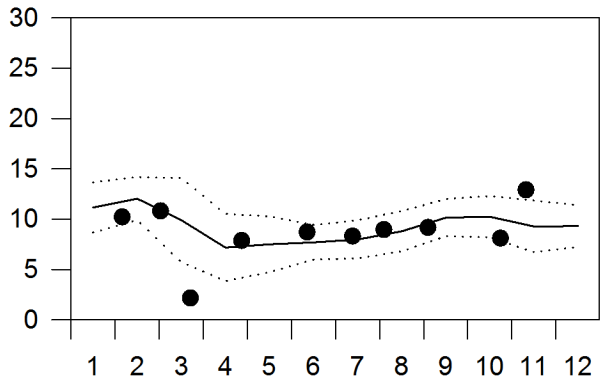
PO_4 µmol/l



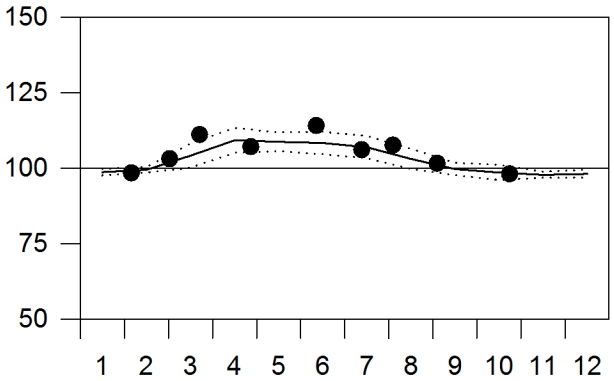
DIN µmol/l



SiO_3 µmol/l

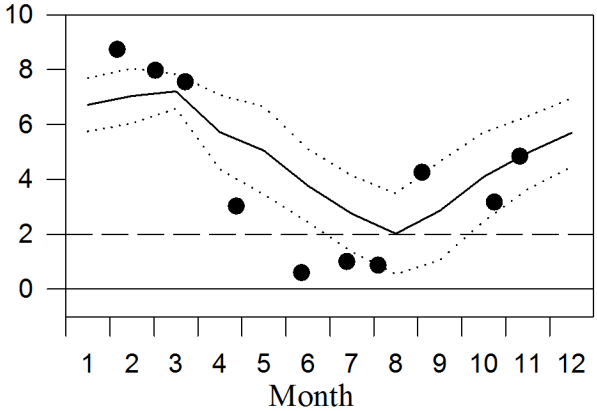


O_2 saturation %

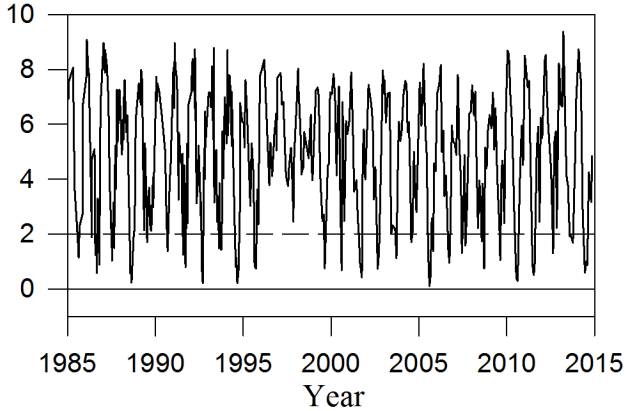


OXYGEN IN BOTTOM WATER (depth >40m)

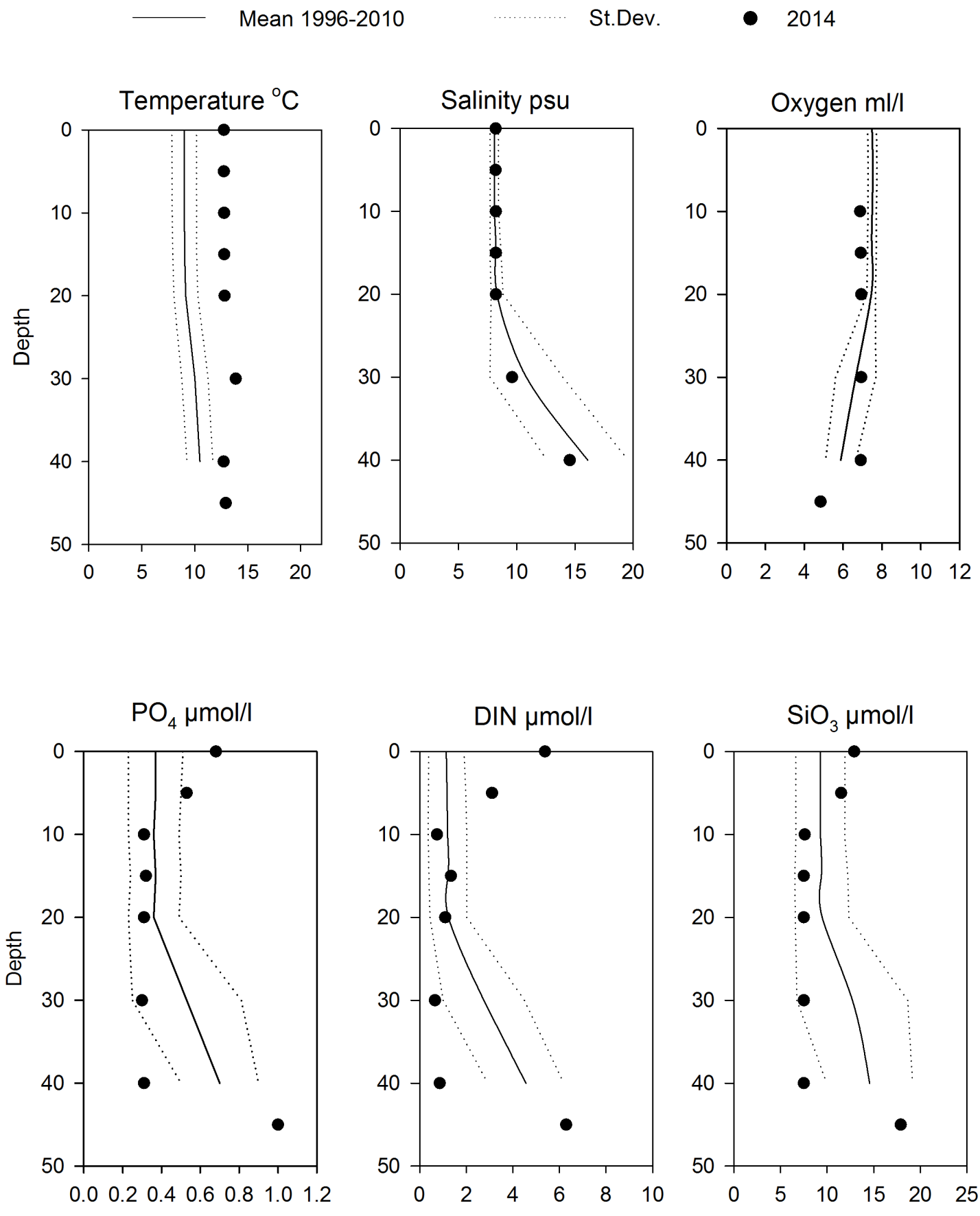
O_2 ml/l



O_2 ml/l



Vertical profiles BY1 November

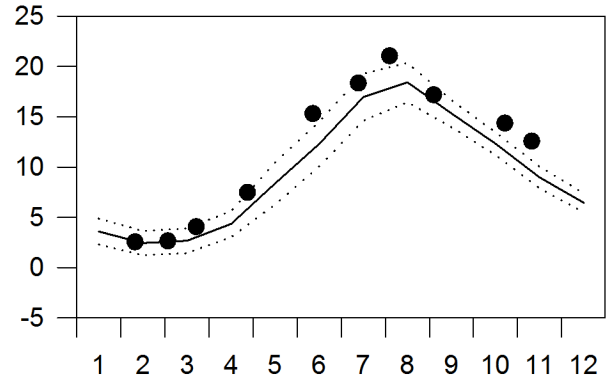


STATION BY2 SURFACE WATER

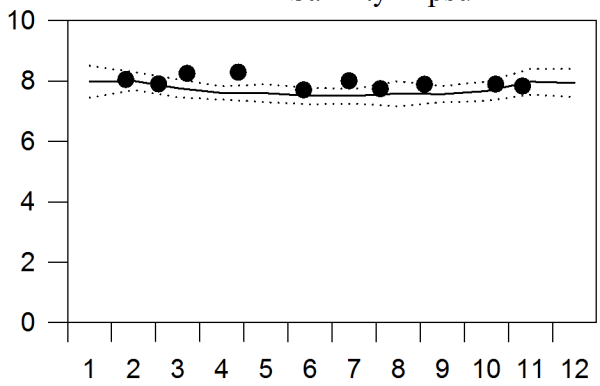
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2014

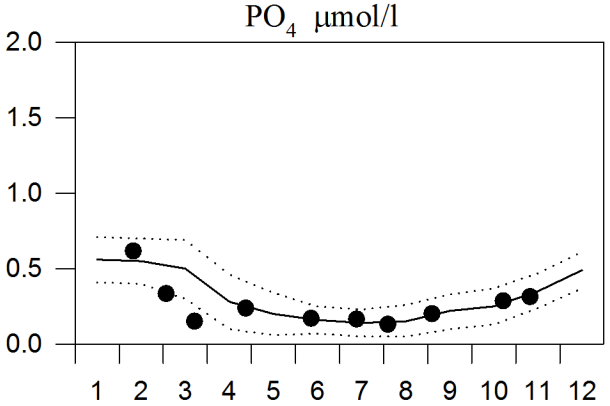
Temperature °C



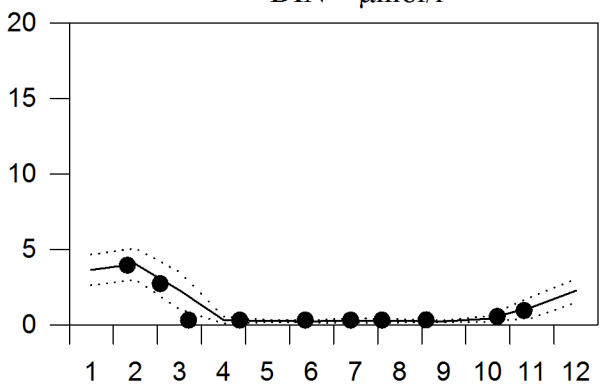
Salinity psu



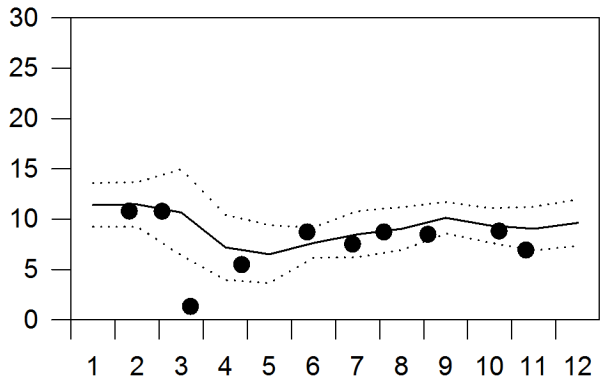
PO_4 µmol/l



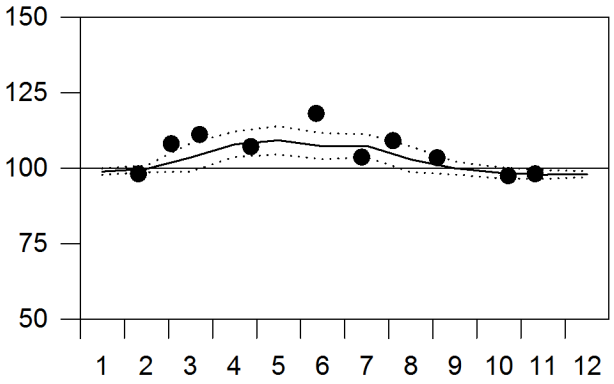
DIN µmol/l



SiO_3 µmol/l

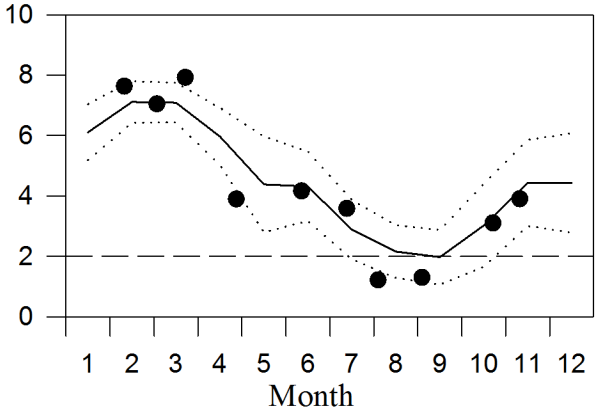


O_2 saturation %

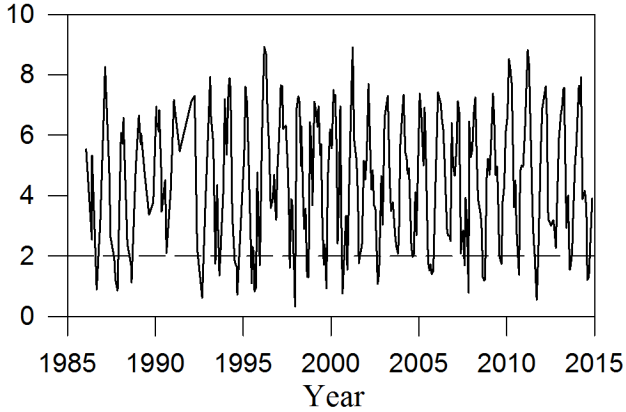


OXYGEN IN BOTTOM WATER (depth >40m)

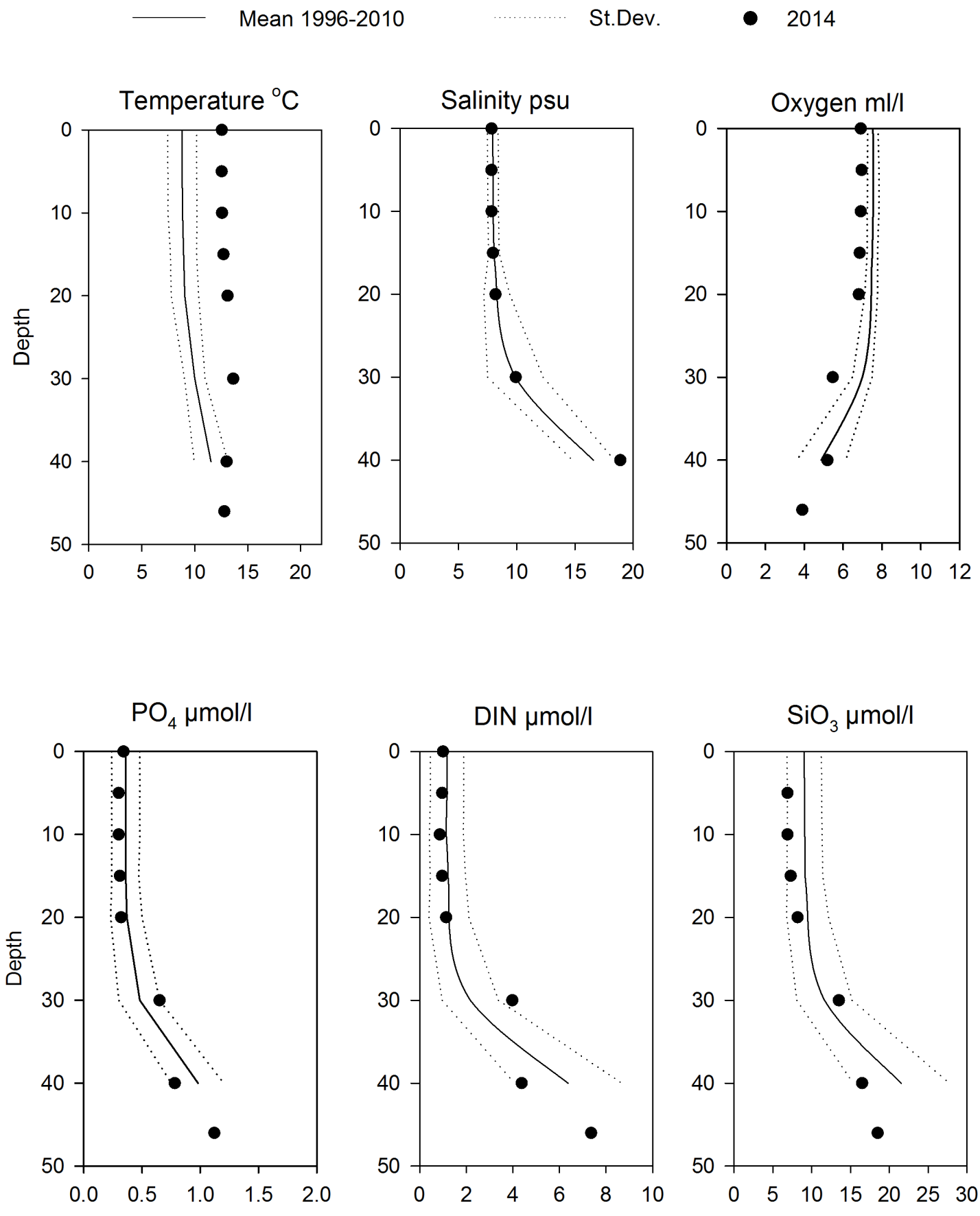
O_2 ml/l



O_2 ml/l



Vertical profiles BY2 November

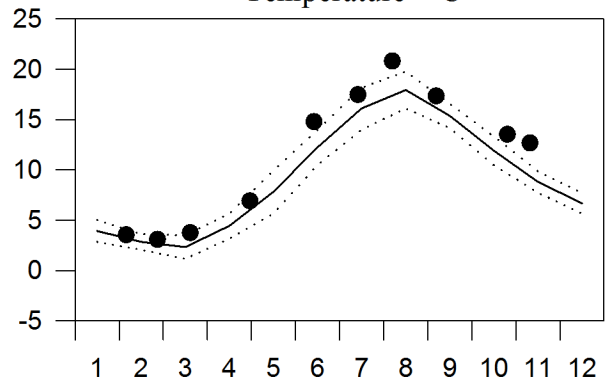


STATION HANÖBUKTEN SURFACE WATER

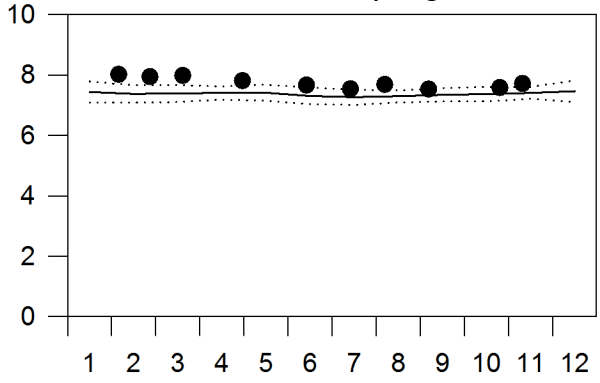
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2014

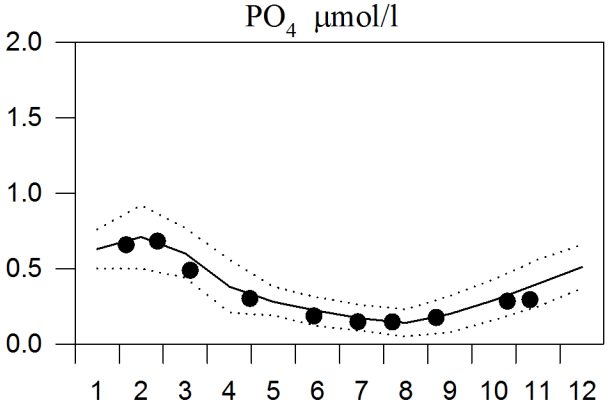
Temperature °C



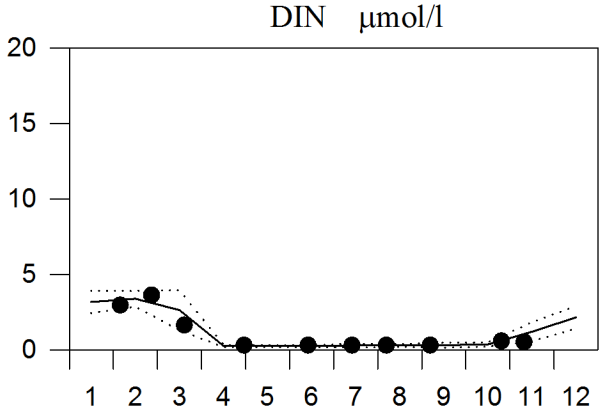
Salinity psu



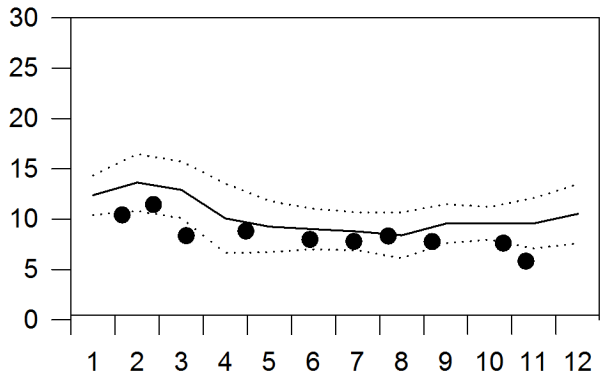
PO_4 µmol/l



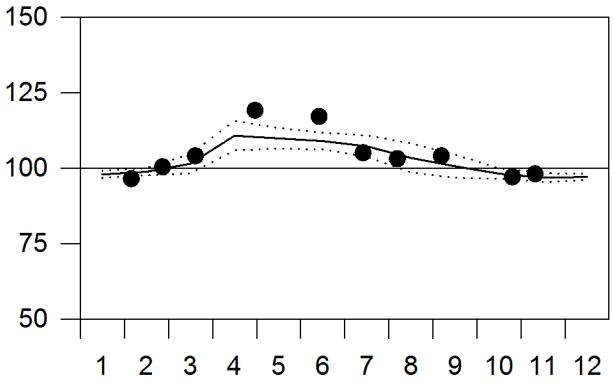
DIN µmol/l



SiO_3 µmol/l

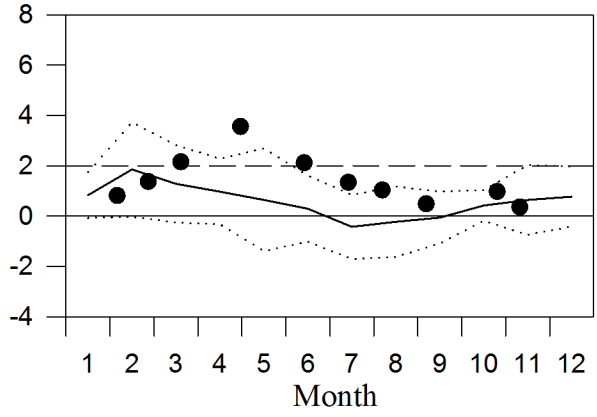


O_2 saturation %

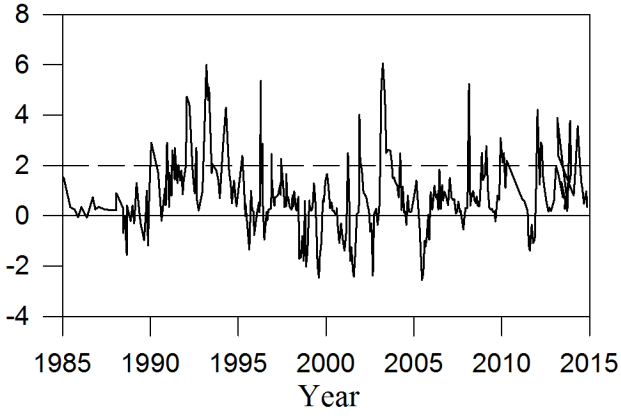


OXYGEN IN BOTTOM WATER (depth > 70m)

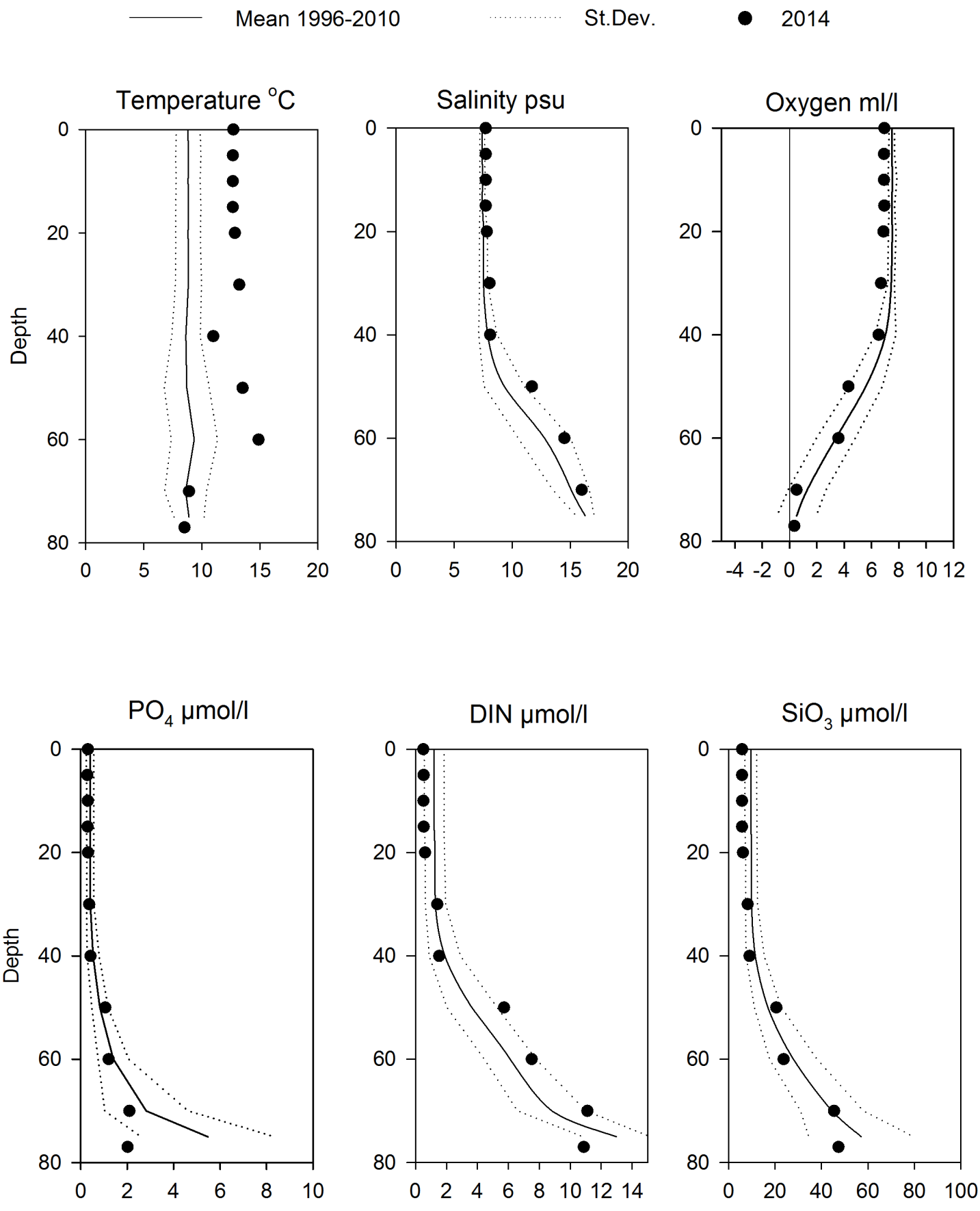
O_2 ml/l



O_2 ml/l



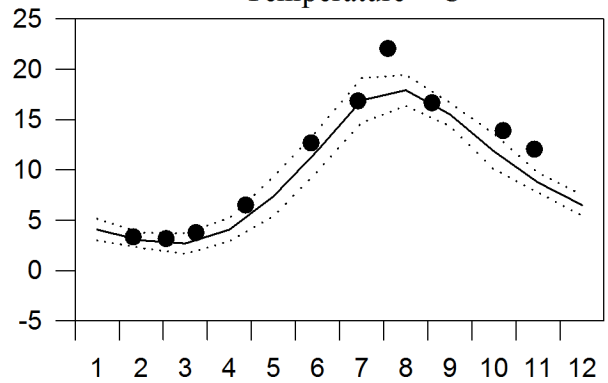
Vertical profiles Hanöbukten November



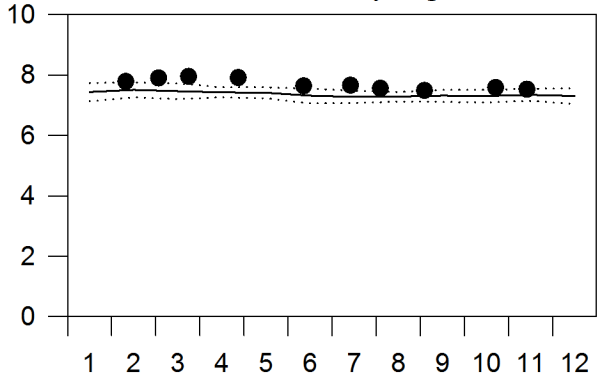
STATION BY4 SURFACE WATER

Annual Cycles

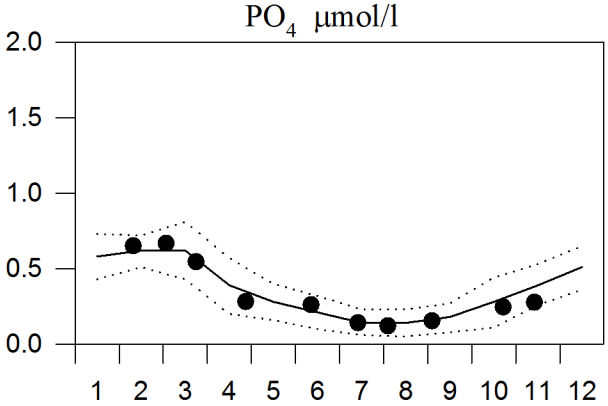
Temperature °C



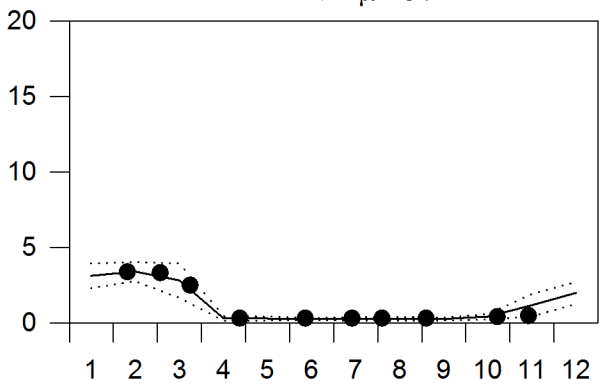
Salinity psu



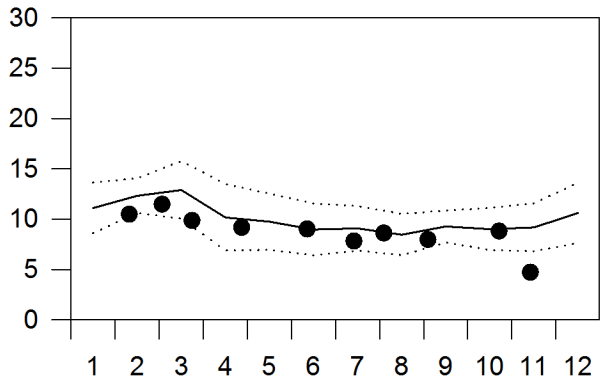
PO_4 µmol/l



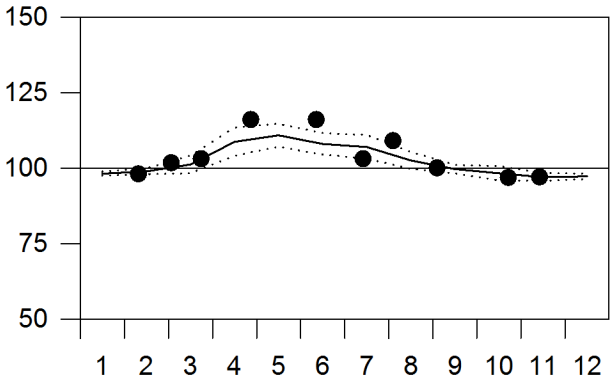
DIN µmol/l



SiO_3 µmol/l

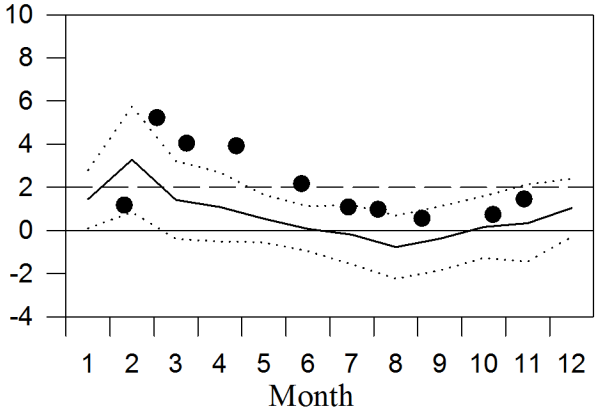


O_2 saturation %

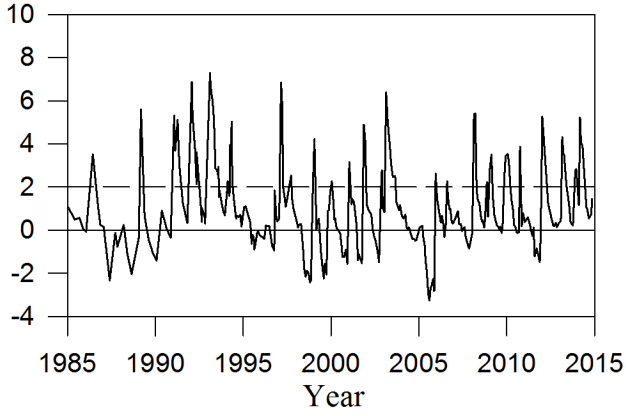


OXYGEN IN BOTTOM WATER (depth >80m)

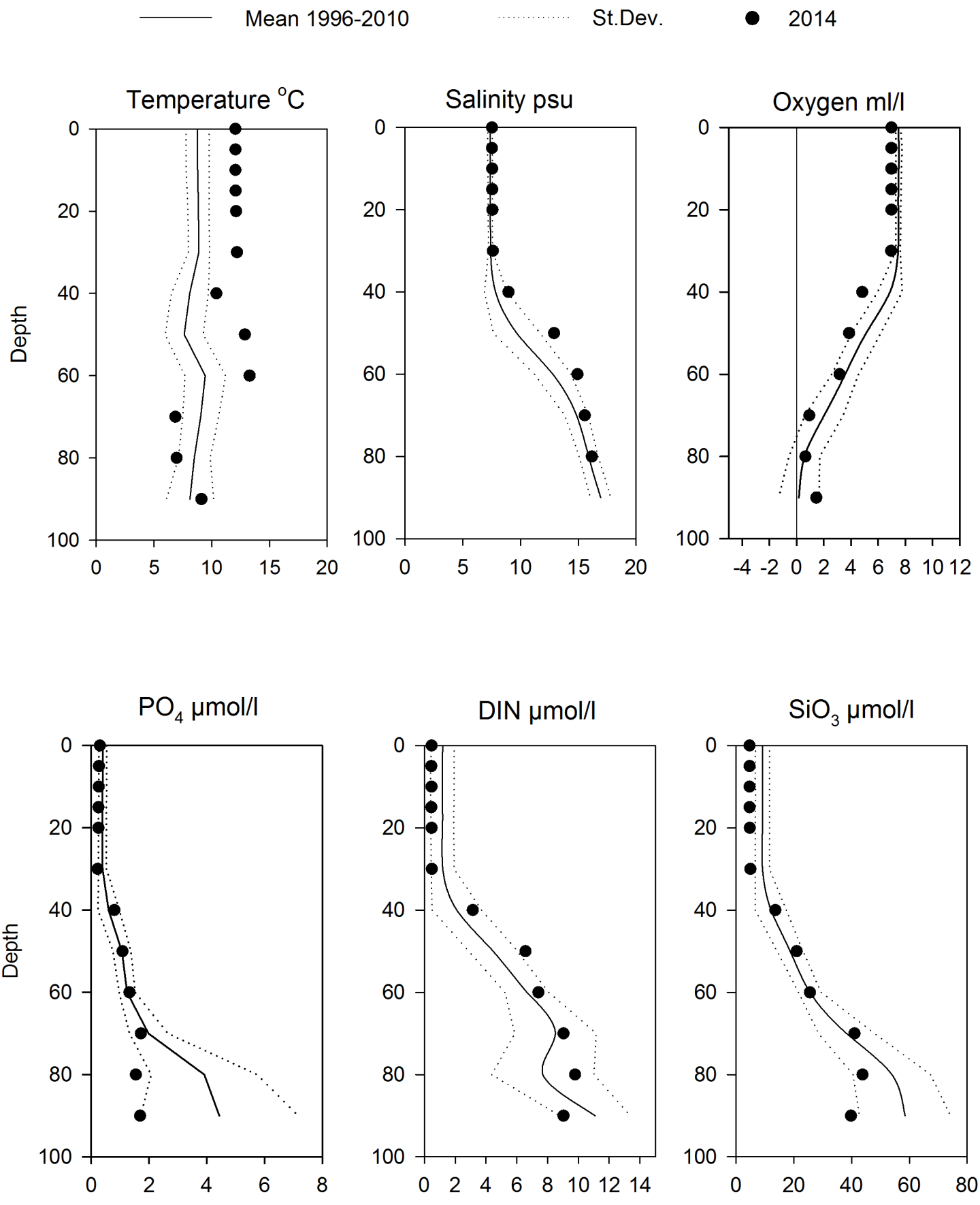
O_2 ml/l



O_2 ml/l



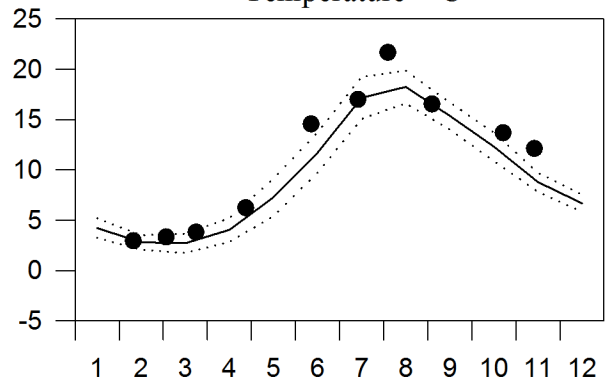
Vertical profiles BY4 November



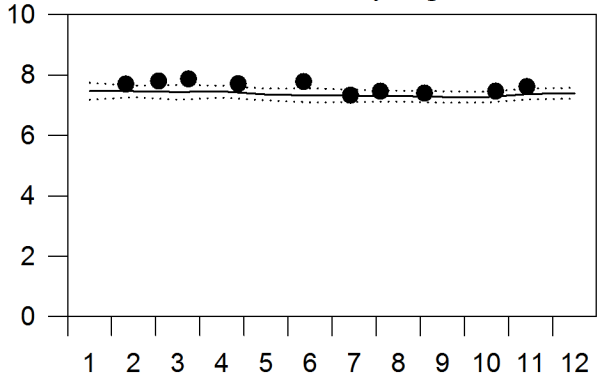
STATION BY5 SURFACE WATER

Annual Cycles

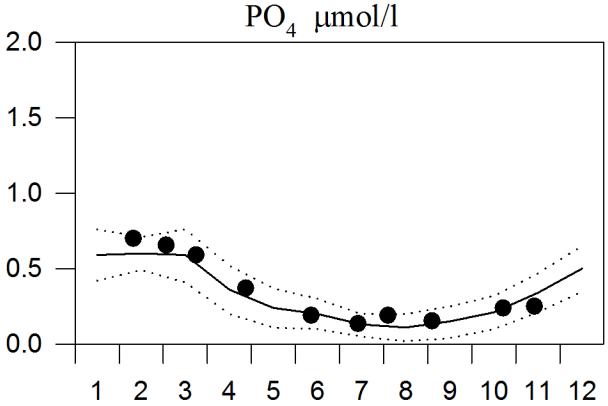
Temperature °C



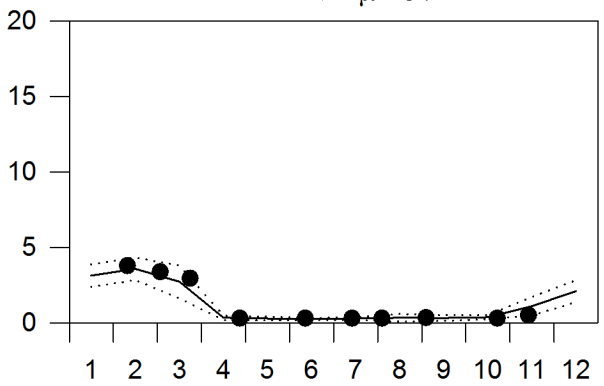
Salinity psu



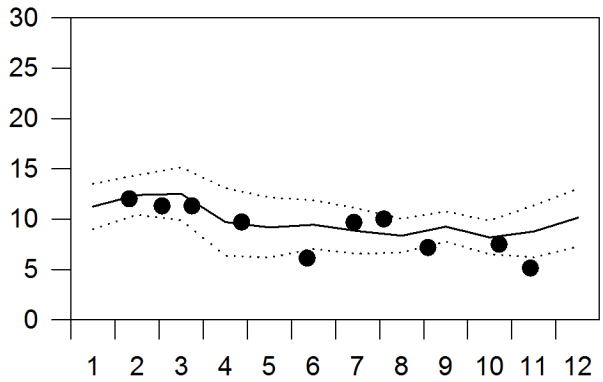
PO_4 µmol/l



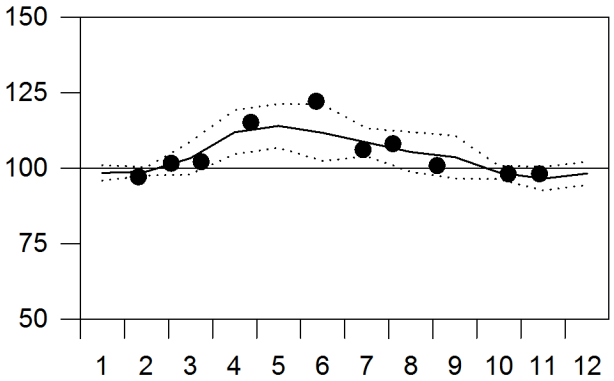
DIN µmol/l



SiO_3 µmol/l

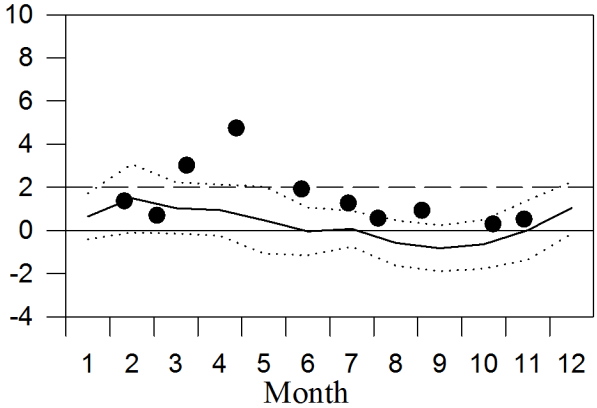


O_2 saturation %

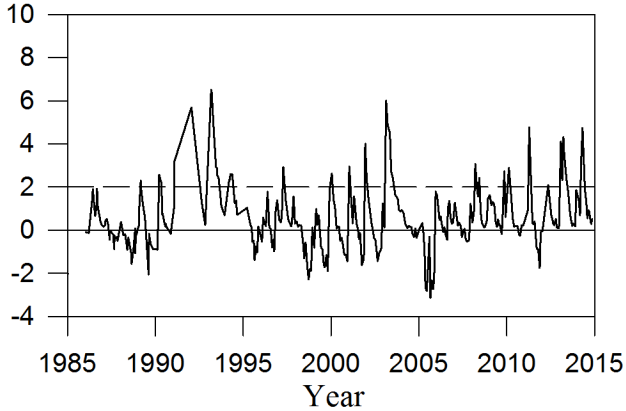


OXYGEN IN BOTTOM WATER (depth >80m)

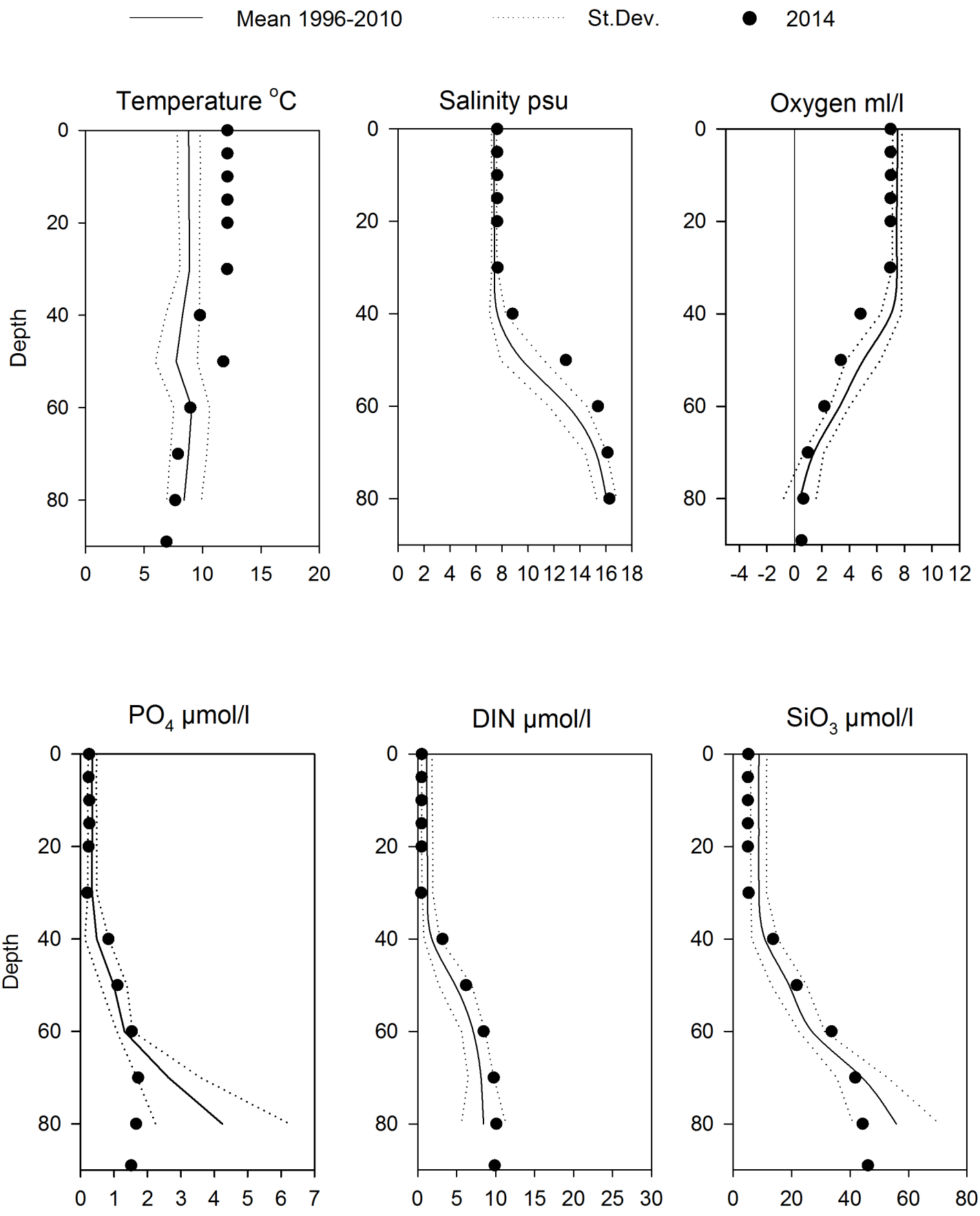
O_2 ml/l



O_2 ml/l



Vertical profiles BY5 November

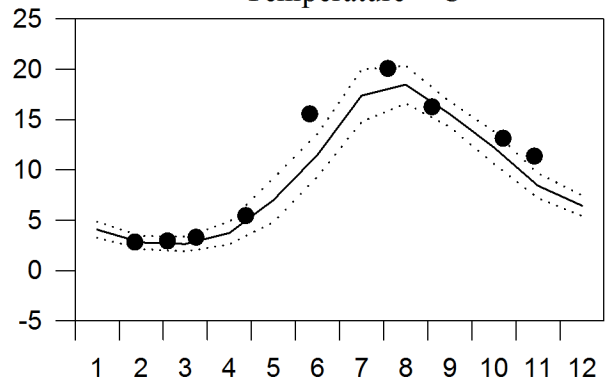


STATION BCS III-10 SURFACE WATER

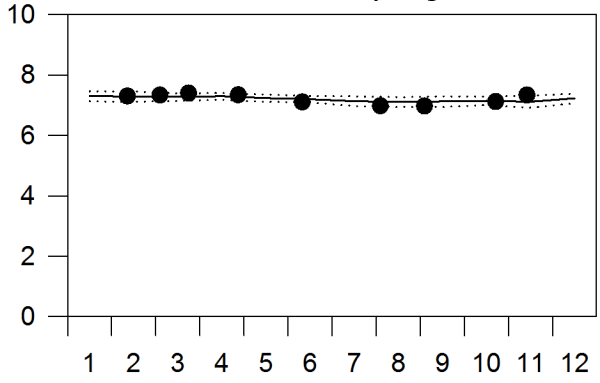
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2014

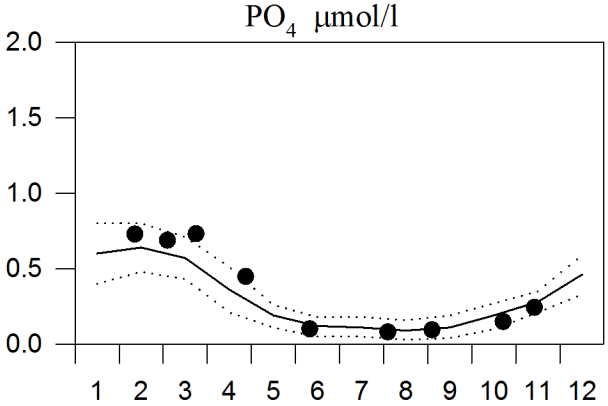
Temperature °C



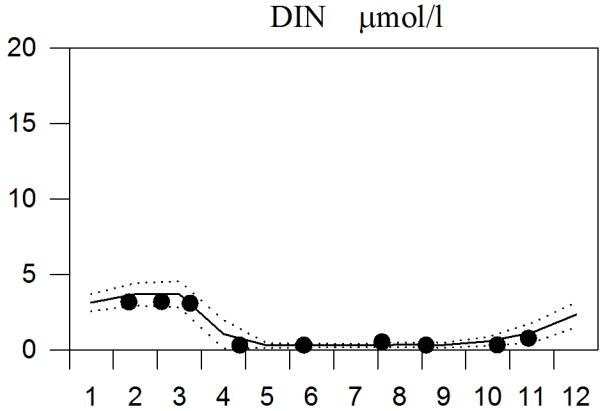
Salinity psu



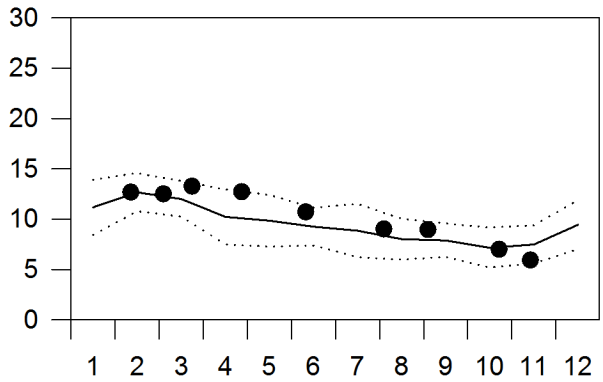
PO_4 µmol/l



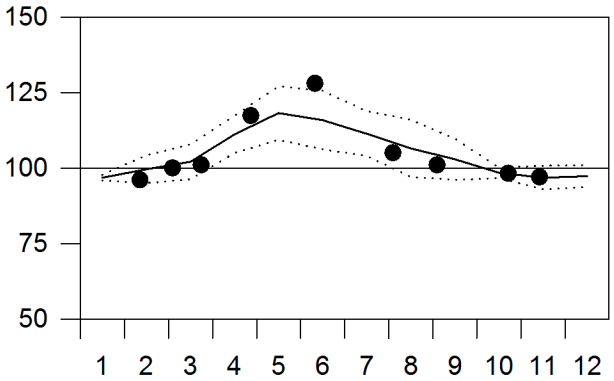
DIN µmol/l



SiO_3 µmol/l

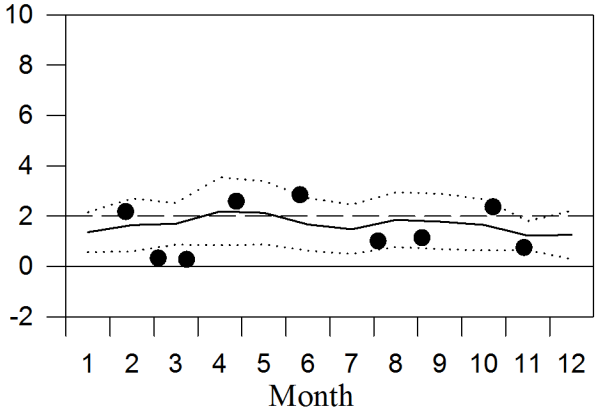


O_2 saturation %

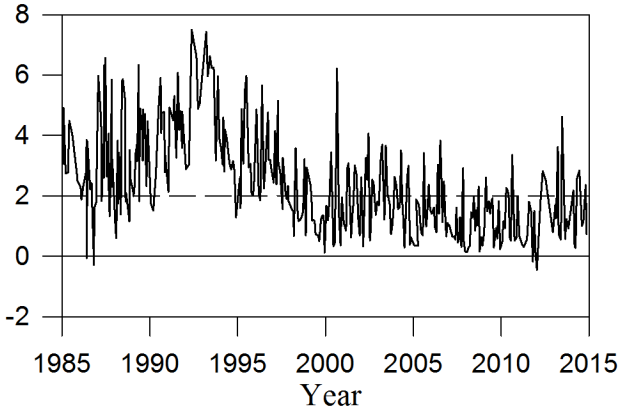


OXYGEN IN BOTTOM WATER (depth > 80m)

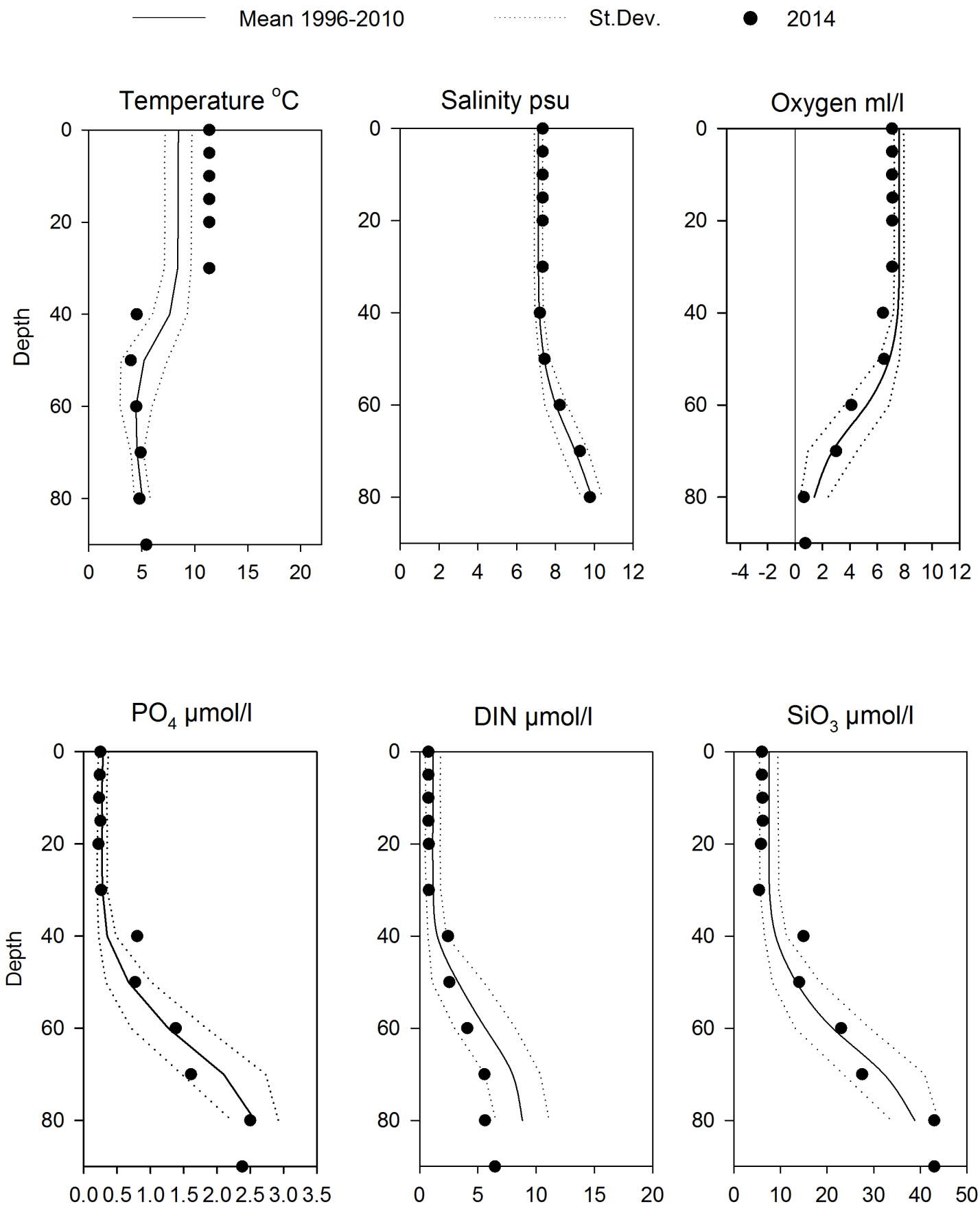
O_2 ml/l



O_2 ml/l



Vertical profiles BCS III-10 November

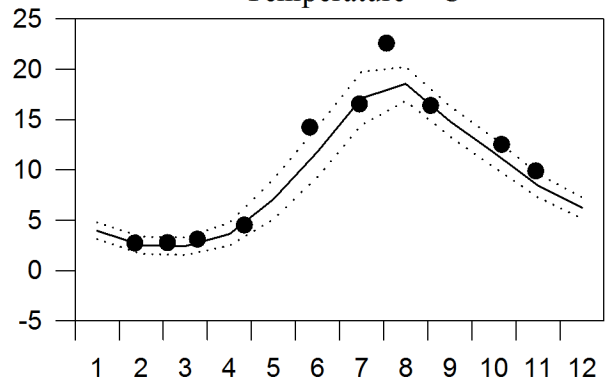


STATION BY10 SURFACE WATER

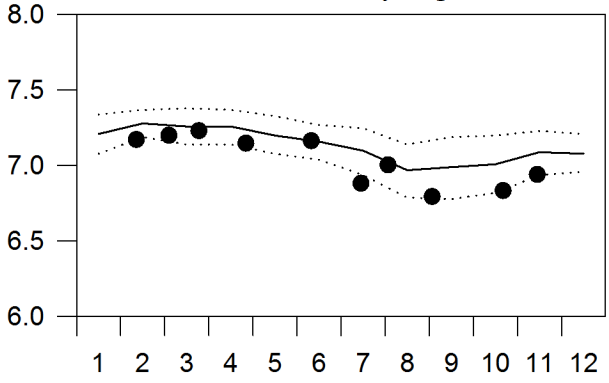
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2014

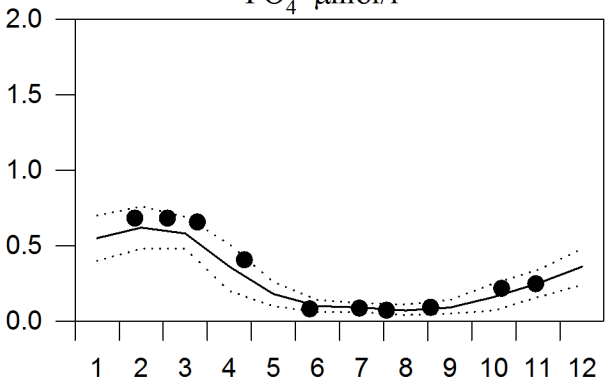
Temperature °C



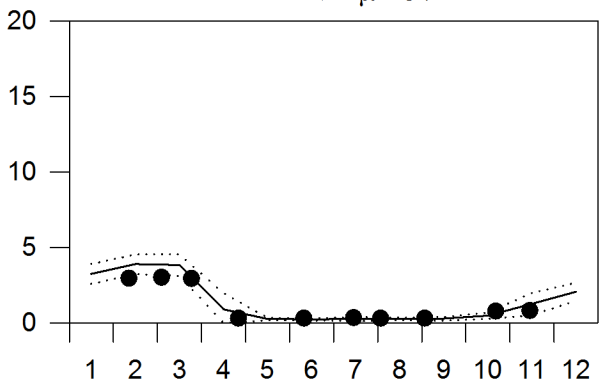
Salinity psu



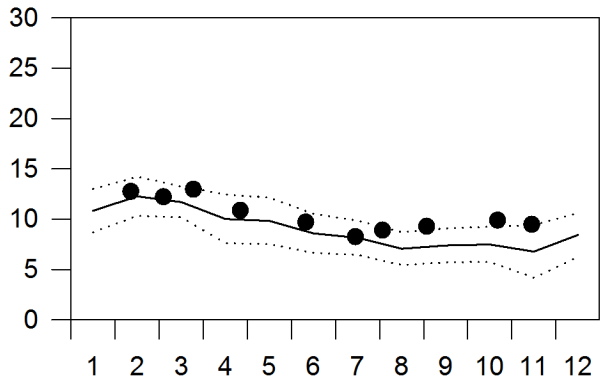
PO_4 µmol/l



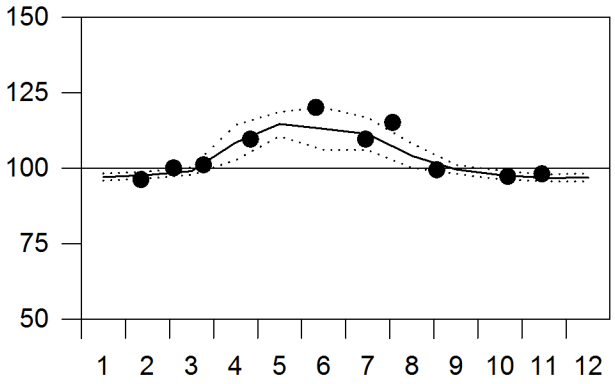
DIN µmol/l



SiO_3 µmol/l

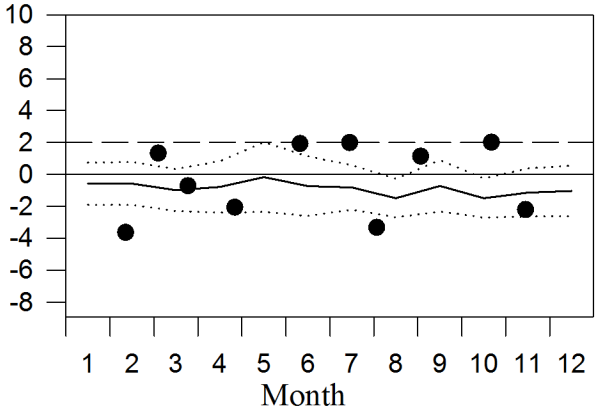


O_2 saturation %

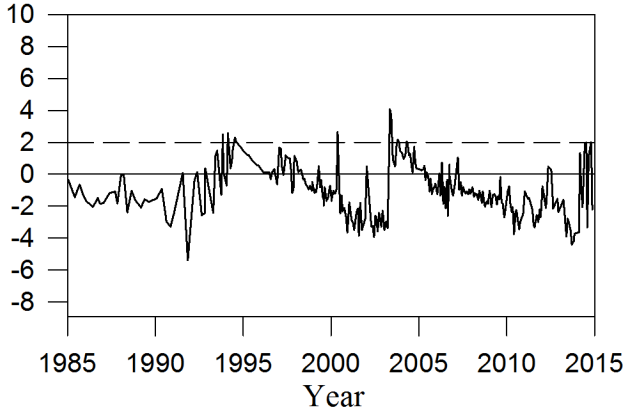


OXYGEN IN BOTTOM WATER (depth >125m)

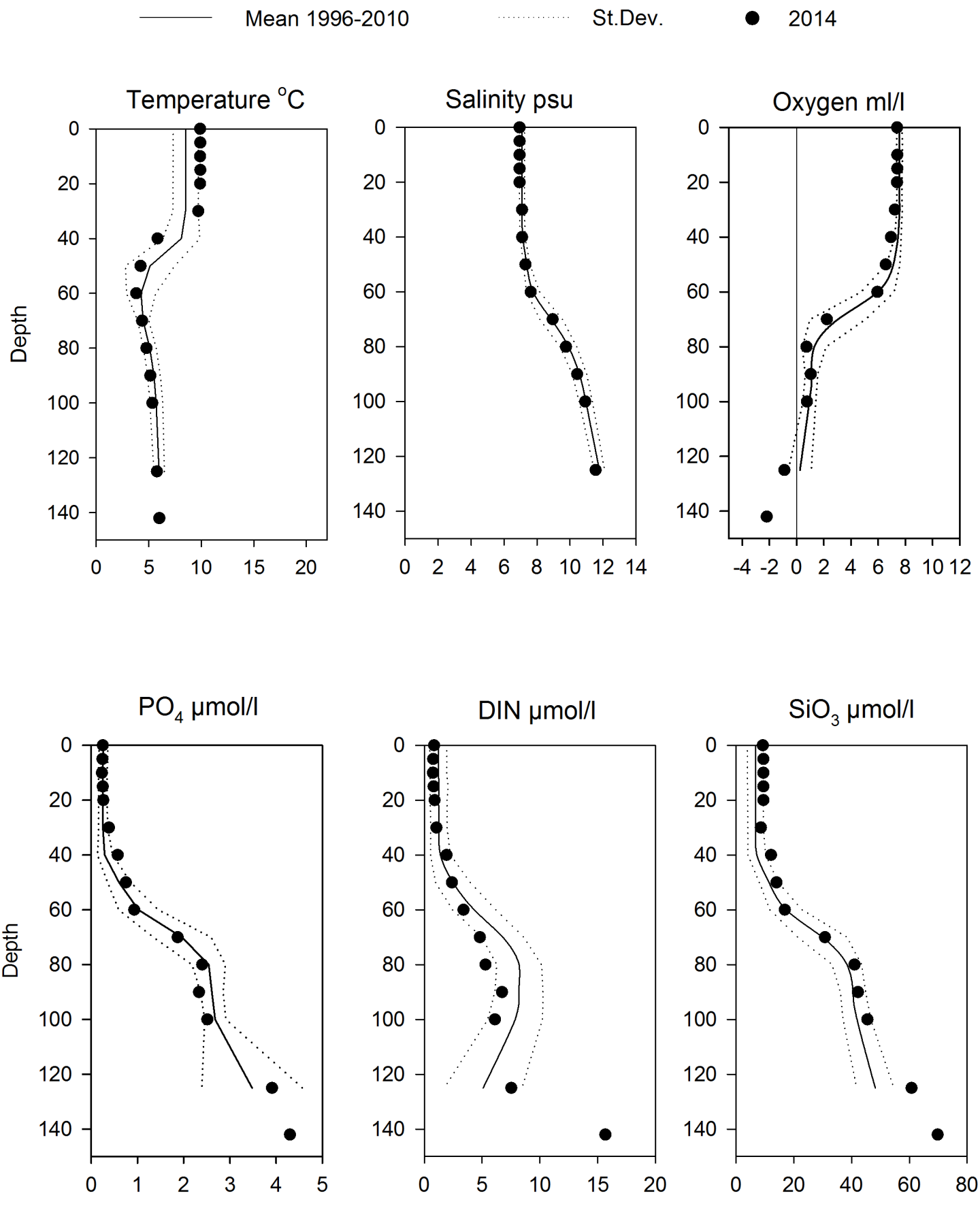
O_2 ml/l



O_2 ml/l



Vertical profiles BY10 November

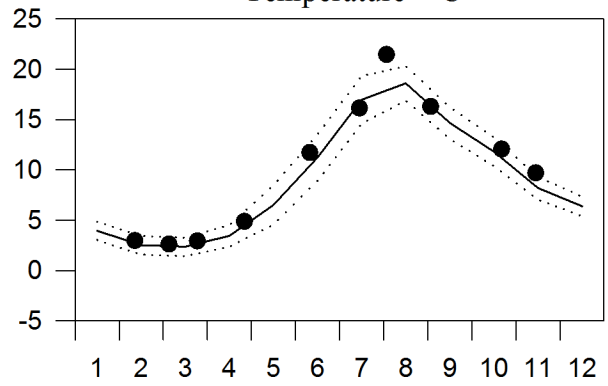


STATION BY15 SURFACE WATER

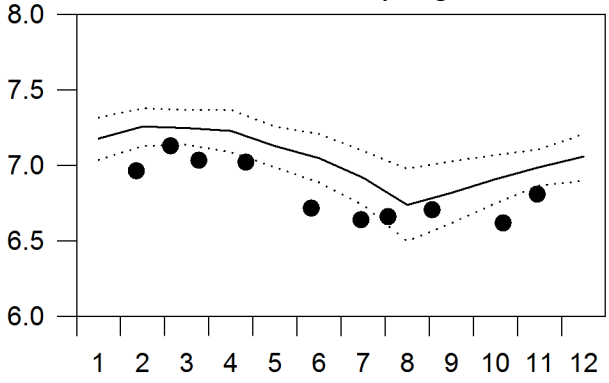
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2014

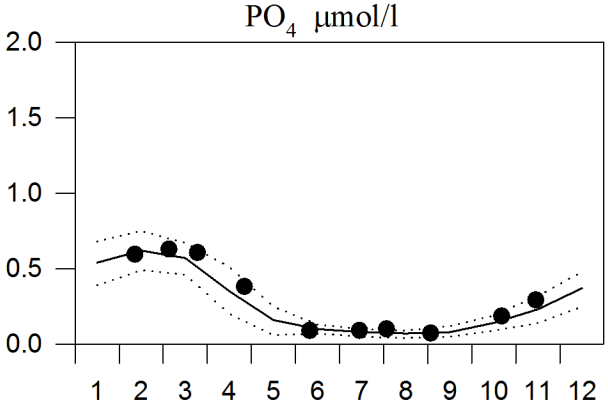
Temperature °C



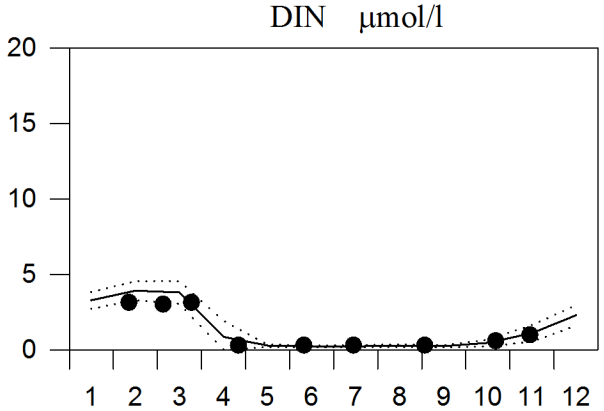
Salinity psu



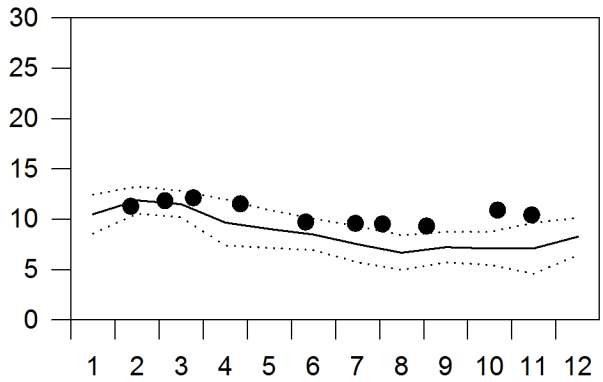
PO_4 µmol/l



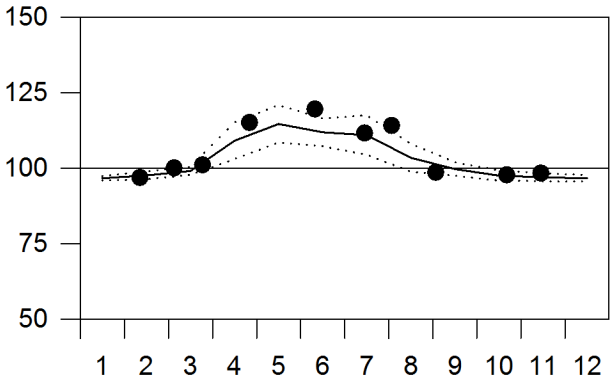
DIN µmol/l



SiO_3 µmol/l

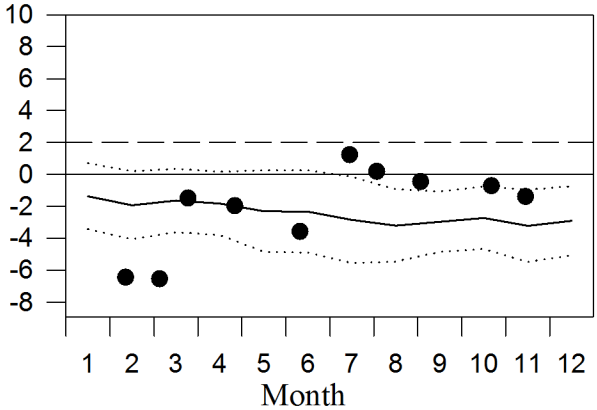


O_2 saturation %

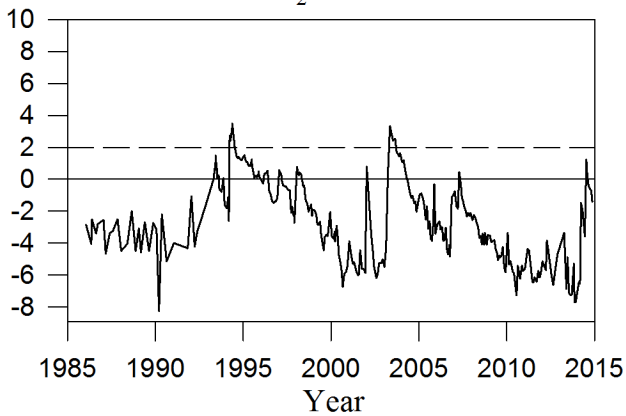


OXYGEN IN BOTTOM WATER (depth >225m)

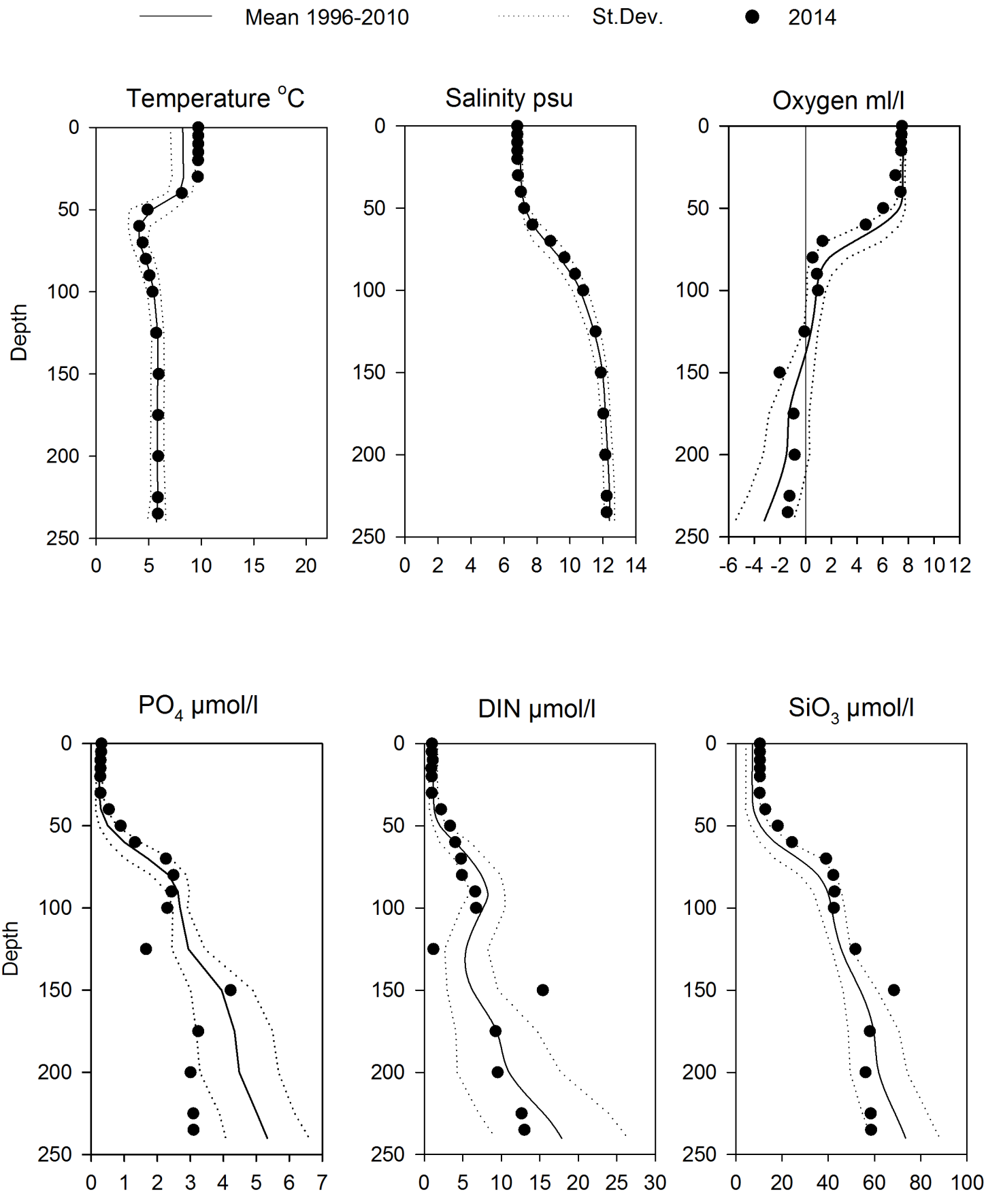
O_2 ml/l



O_2 ml/l



Vertical profiles BY15 November

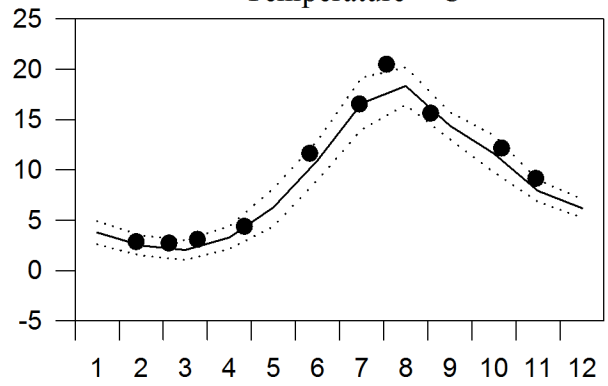


STATION BY20 SURFACE WATER

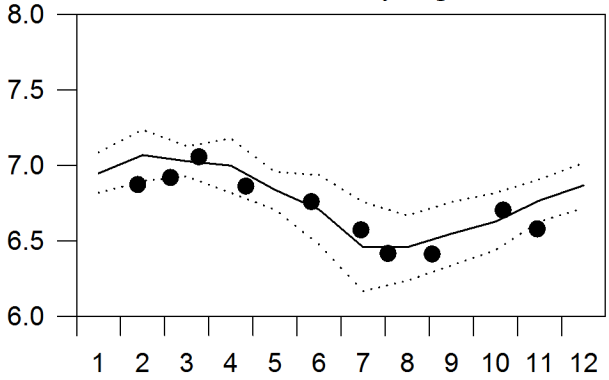
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2014

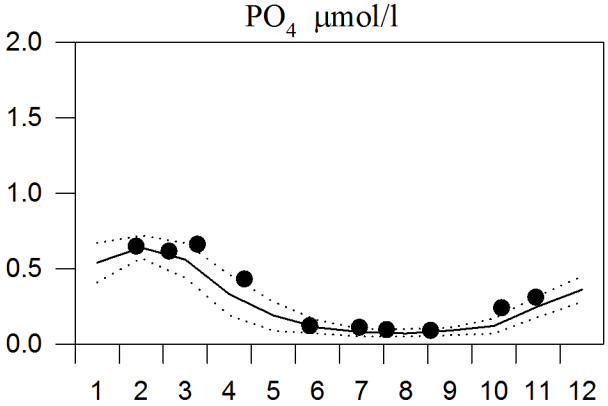
Temperature °C



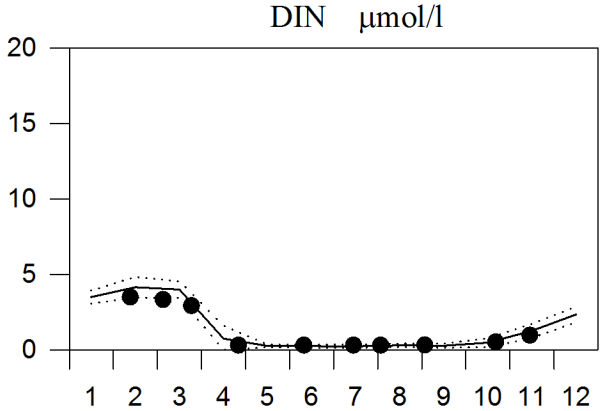
Salinity psu



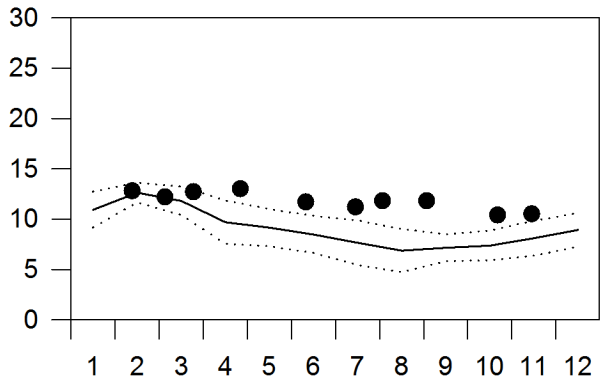
PO_4 µmol/l



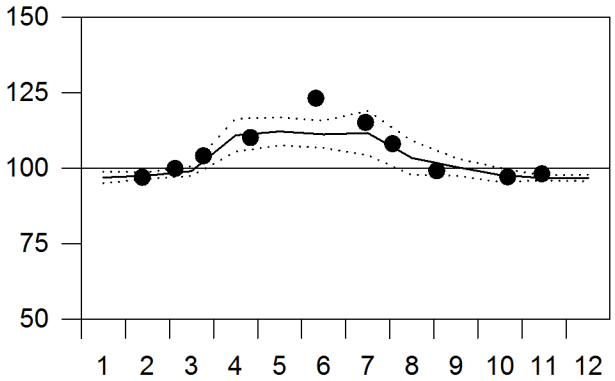
DIN µmol/l



SiO_3 µmol/l

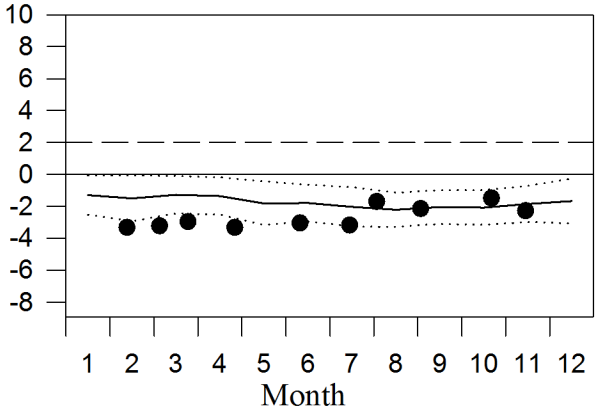


O_2 saturation %

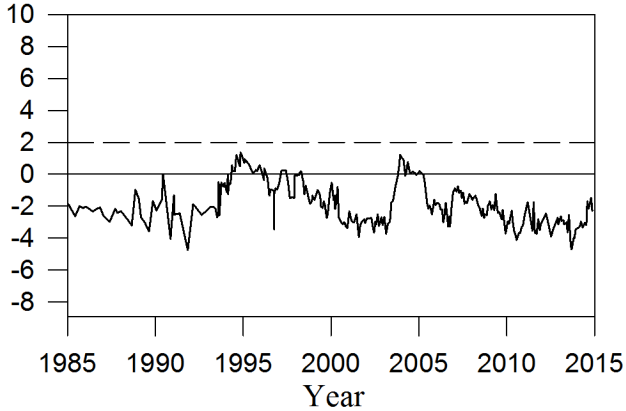


OXYGEN IN BOTTOM WATER (depth >175m)

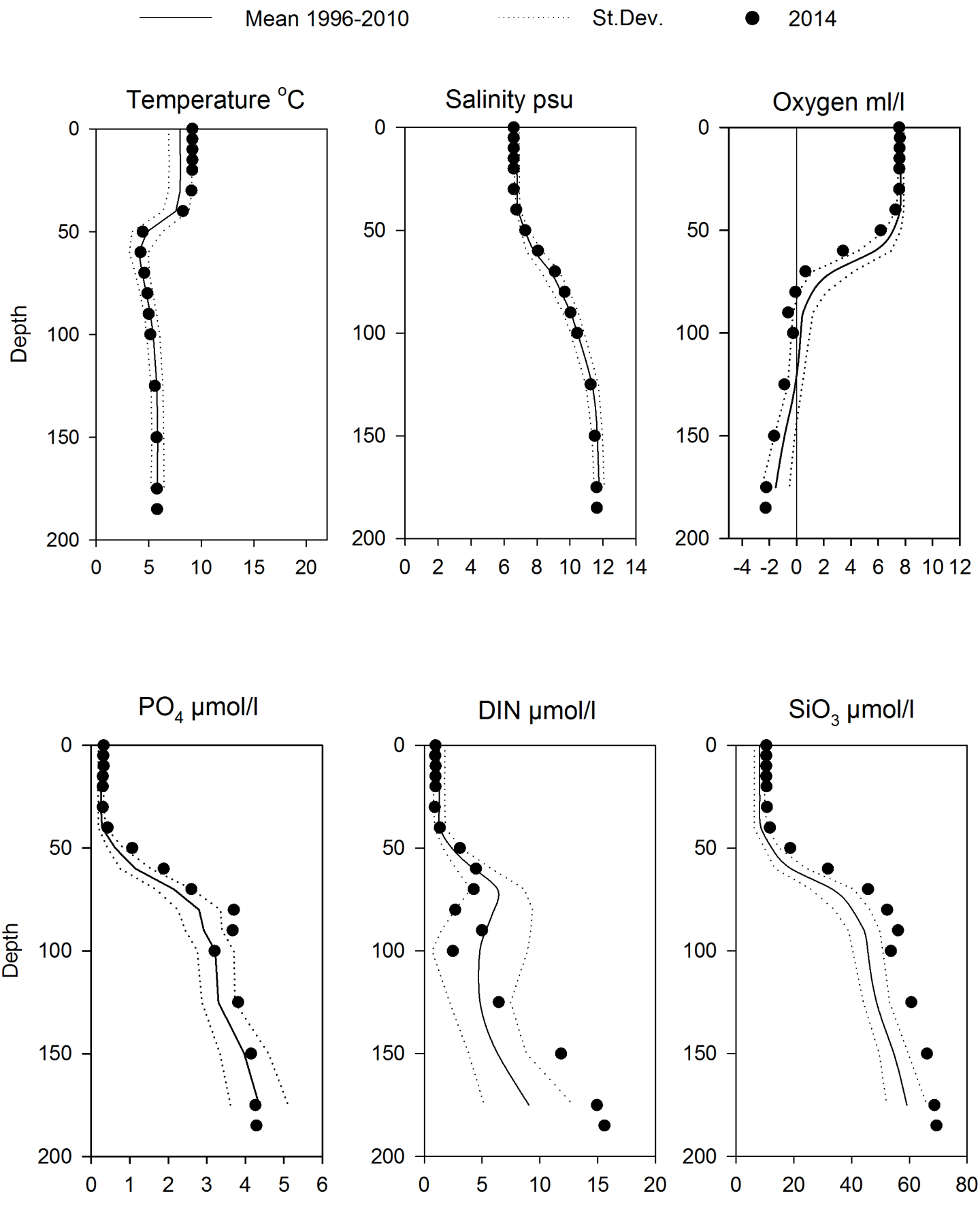
O_2 ml/l



O_2 ml/l



Vertical profiles BY20 November

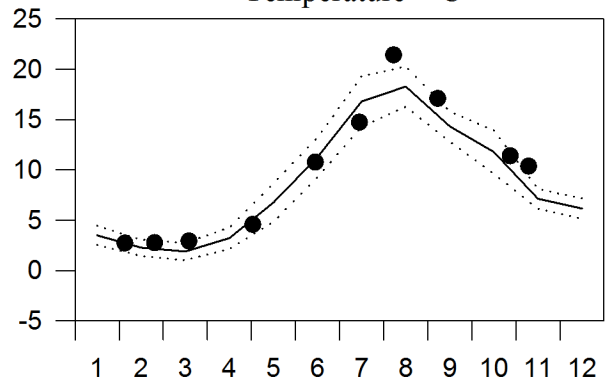


STATION BY32 SURFACE WATER

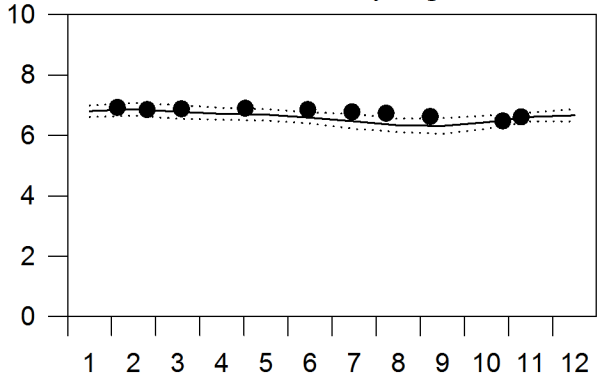
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2014

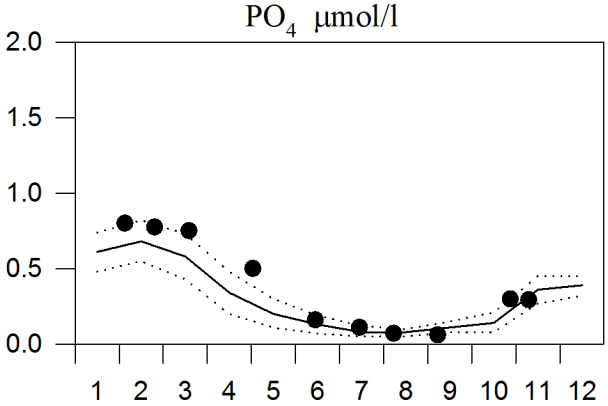
Temperature °C



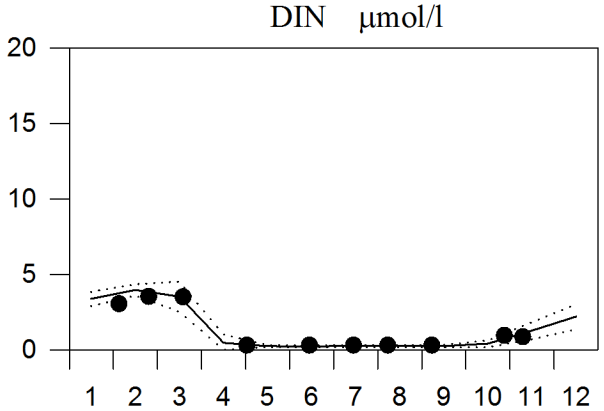
Salinity psu



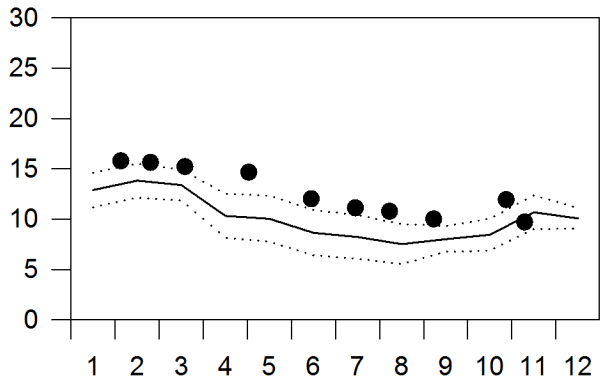
PO_4 µmol/l



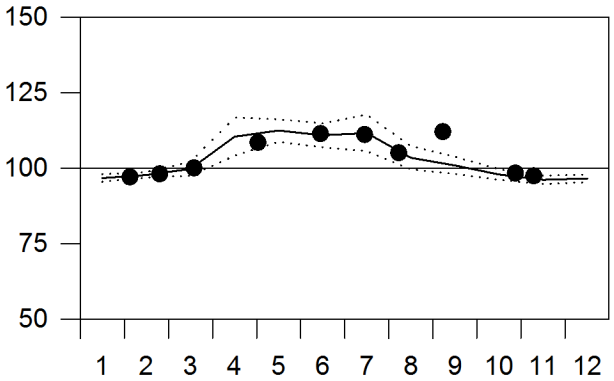
DIN µmol/l



SiO_3 µmol/l

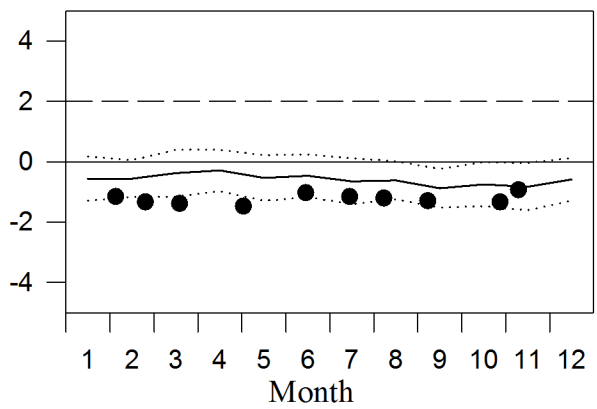


O_2 saturation %

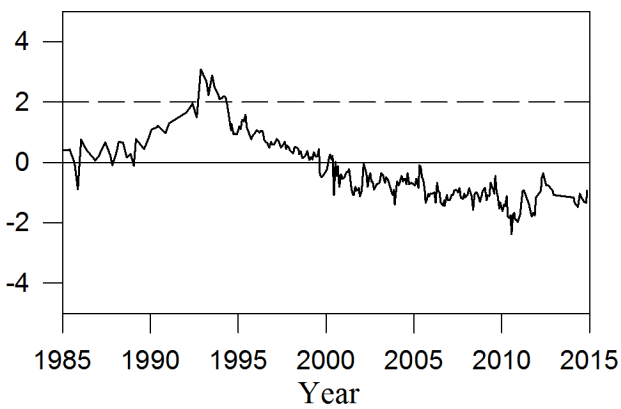


OXYGEN IN BOTTOM WATER (depth > 175m)

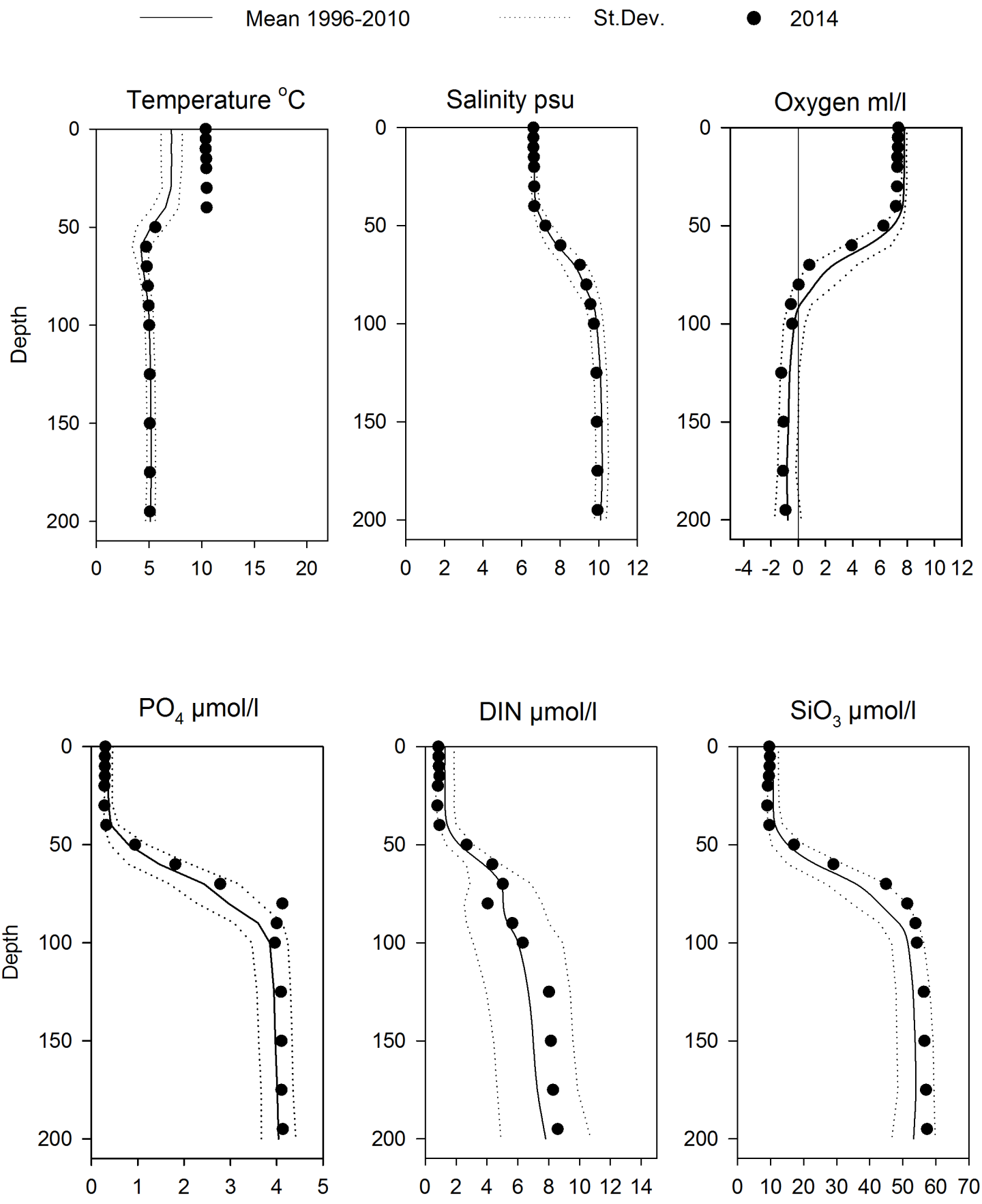
O_2 ml/l



O_2 ml/l



Vertical profiles BY32 November

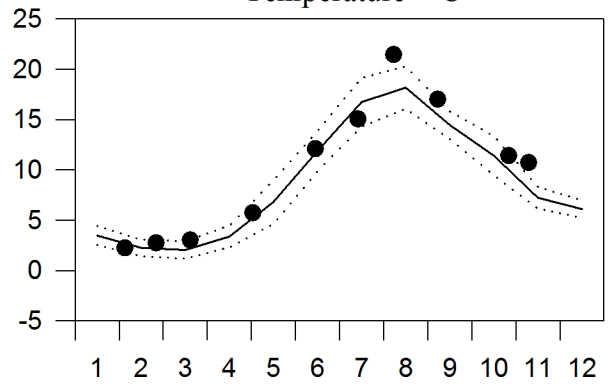


STATION BY38 SURFACE WATER

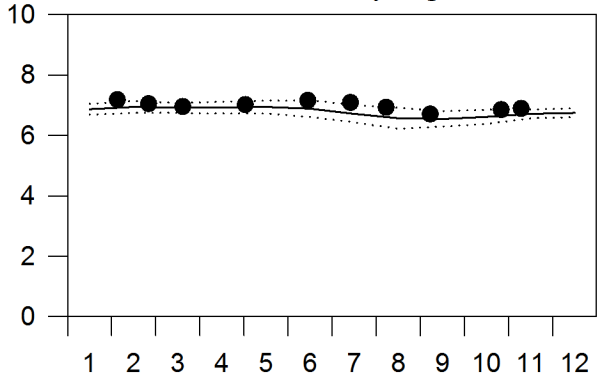
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2014

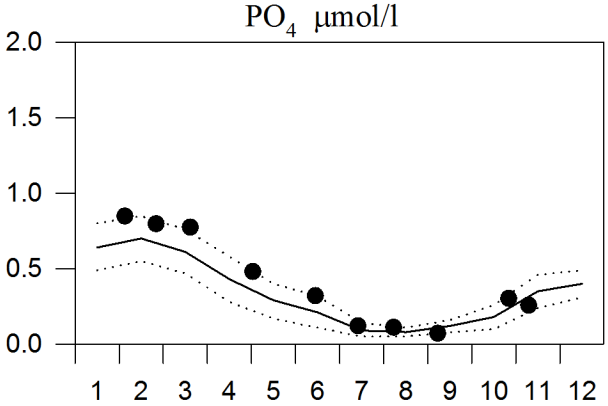
Temperature °C



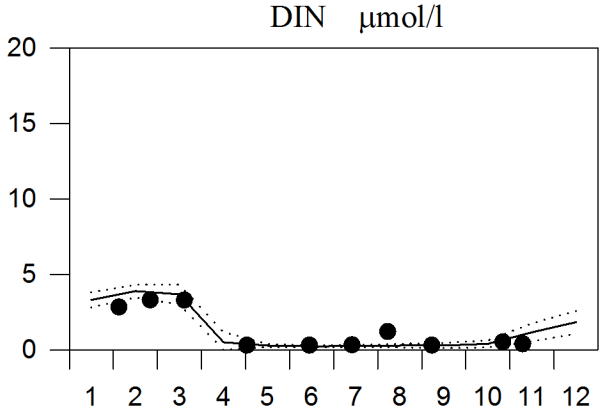
Salinity psu



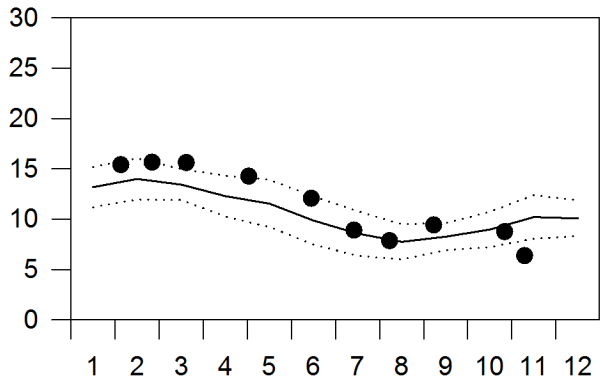
PO_4 µmol/l



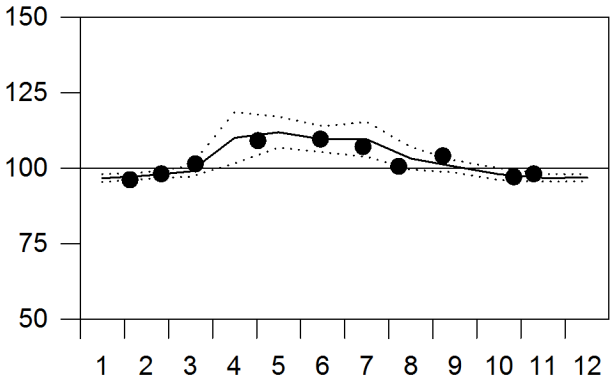
DIN µmol/l



SiO_3 µmol/l

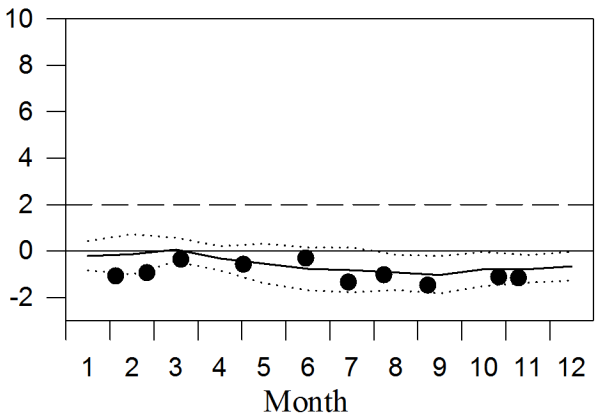


O_2 saturation %

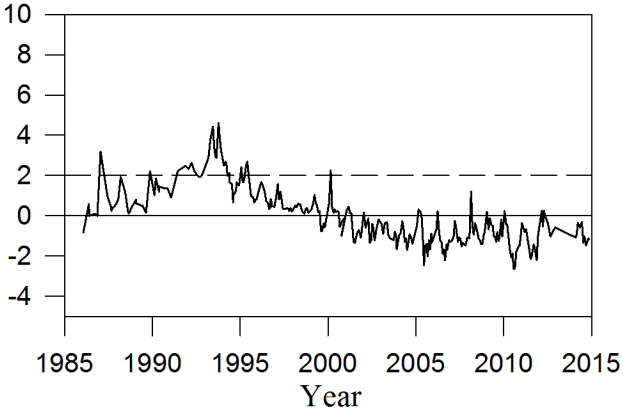


OXYGEN IN BOTTOM WATER (> 100m)

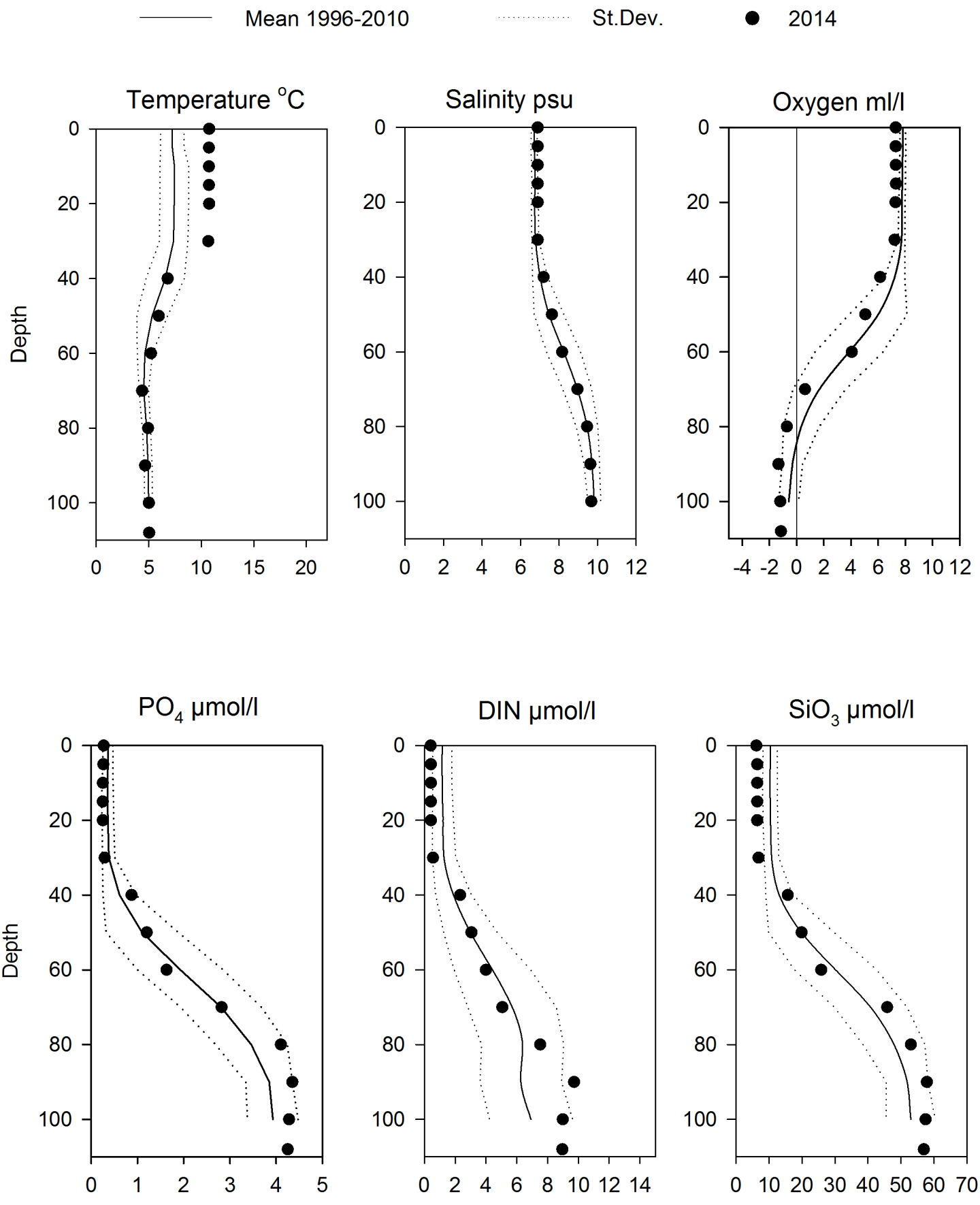
O_2 ml/l



O_2 ml/l



Vertical profiles BY38 November

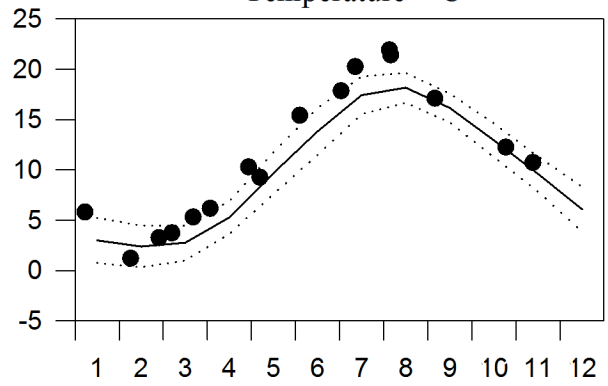


STATION SLÄGGÖ SURFACE WATER

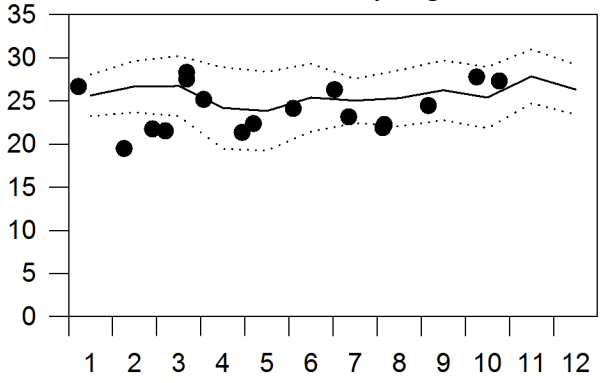
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2014

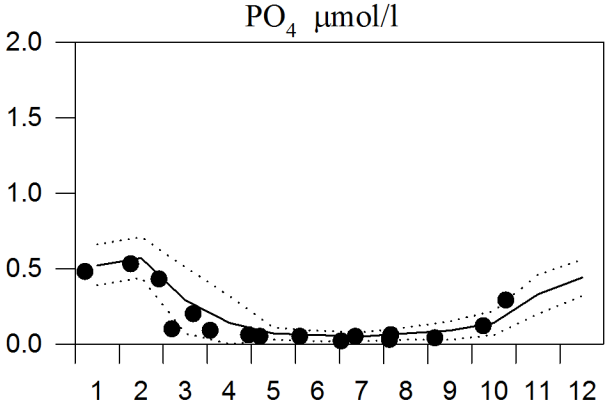
Temperature °C



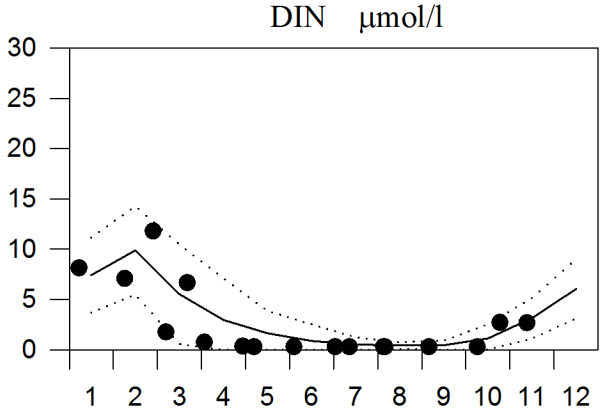
Salinity psu



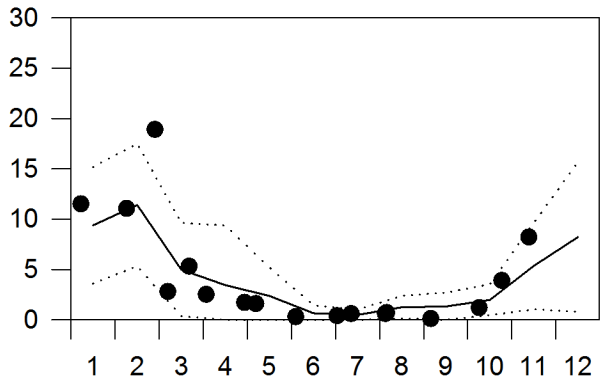
PO_4 µmol/l



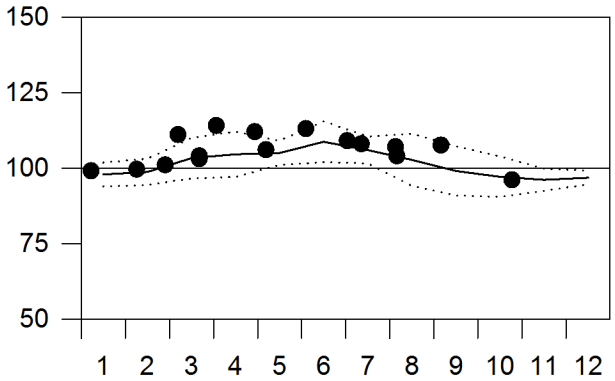
DIN µmol/l



SiO_3 µmol/l

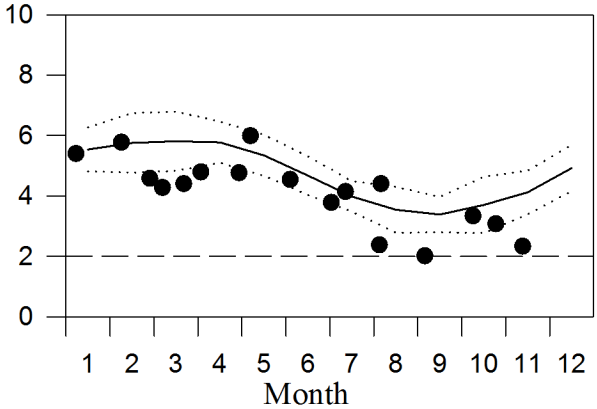


O_2 saturation %

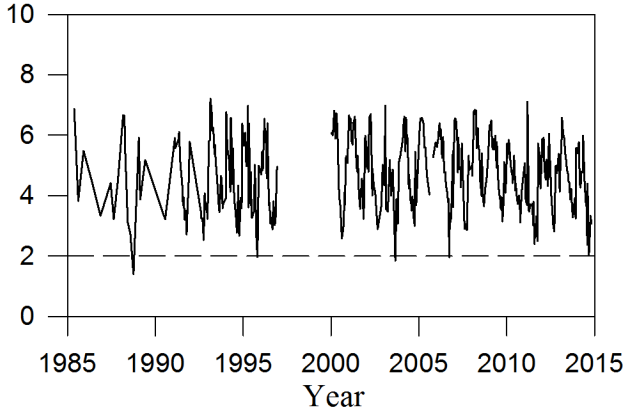


OXYGEN IN BOTTOM WATER (depth >50m)

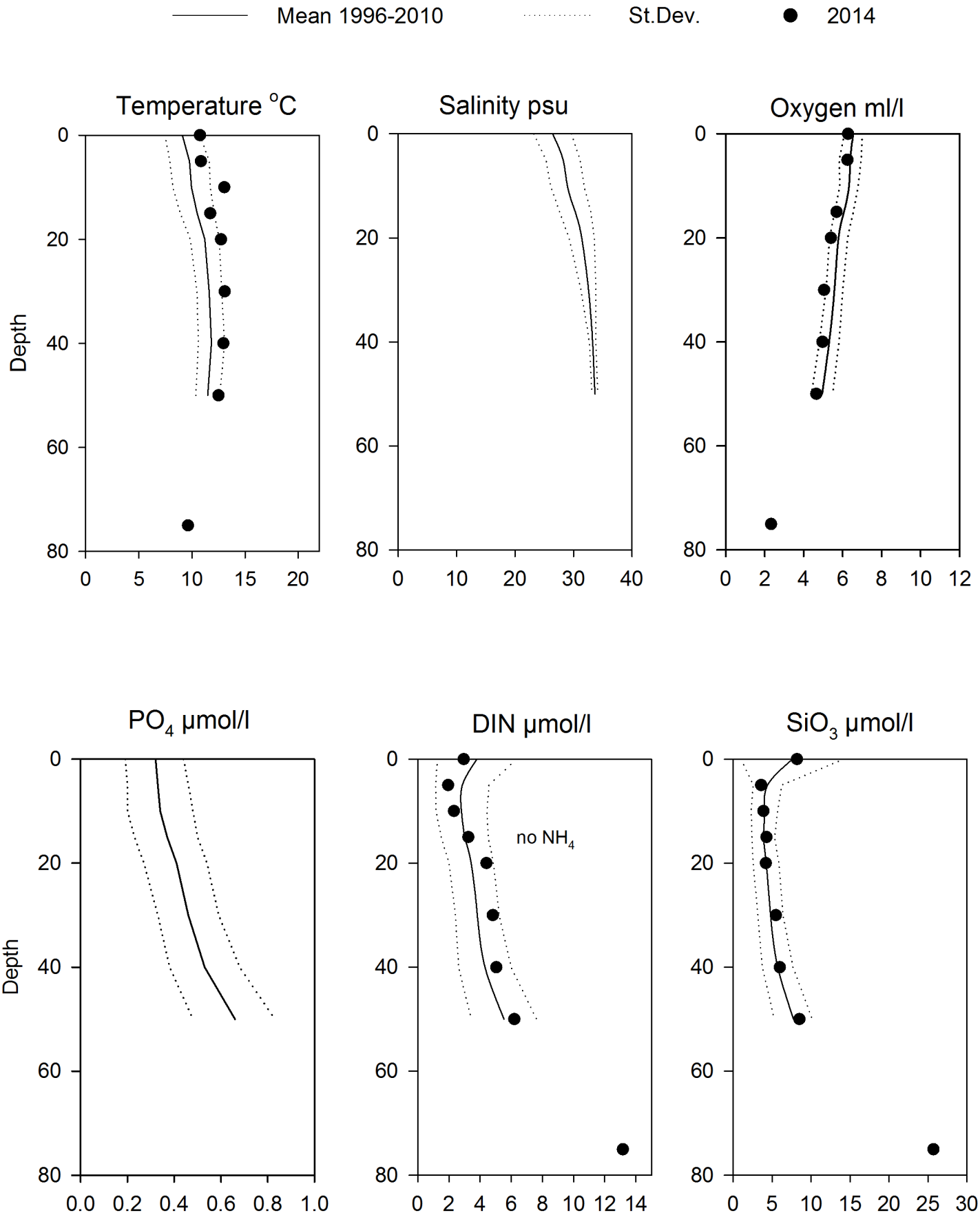
O_2 ml/l



O_2 ml/l

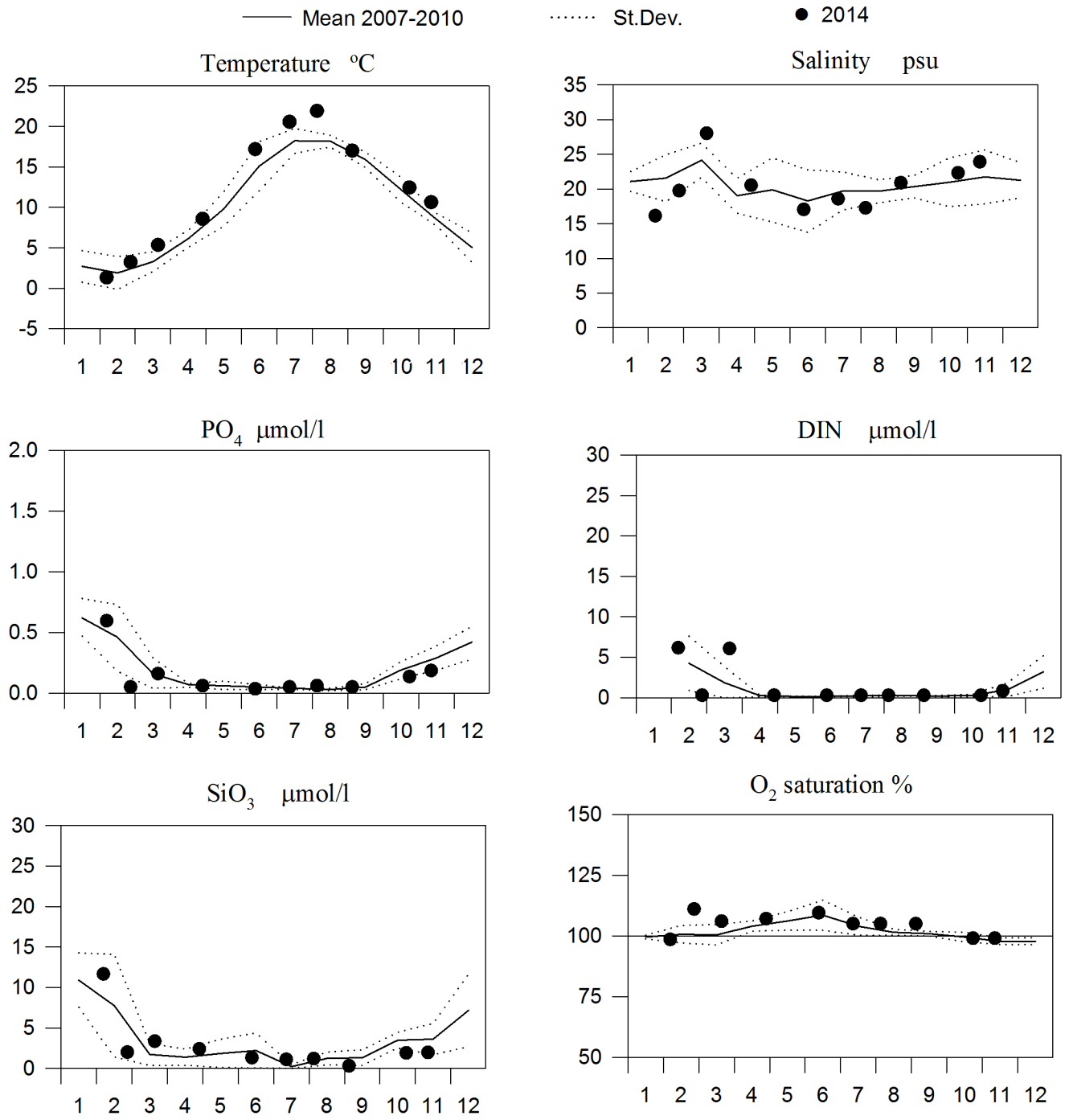


Vertical profiles Släggö November

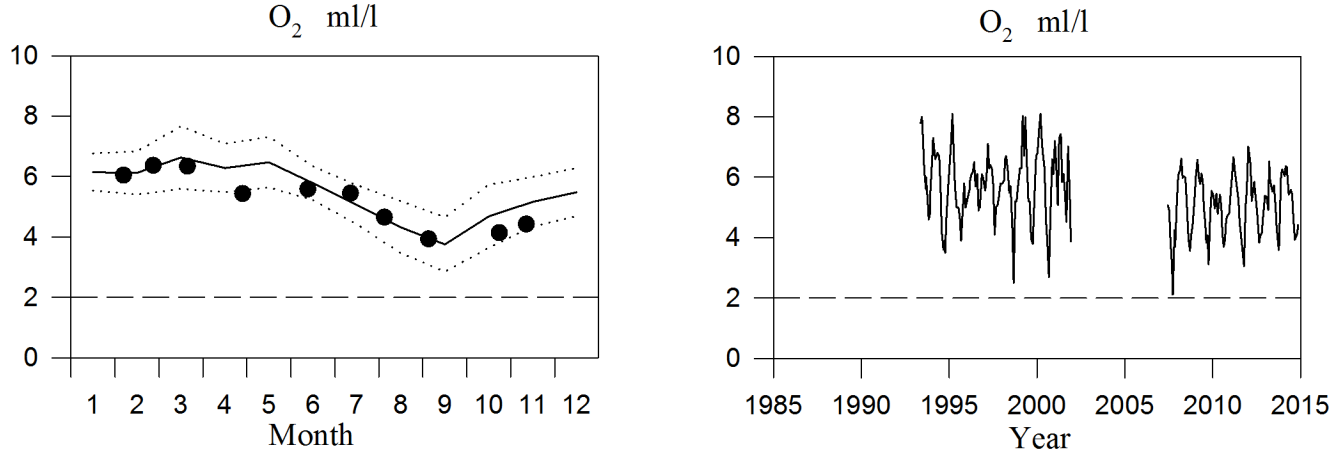


STATION N14 Falkenberg SURFACE WATER

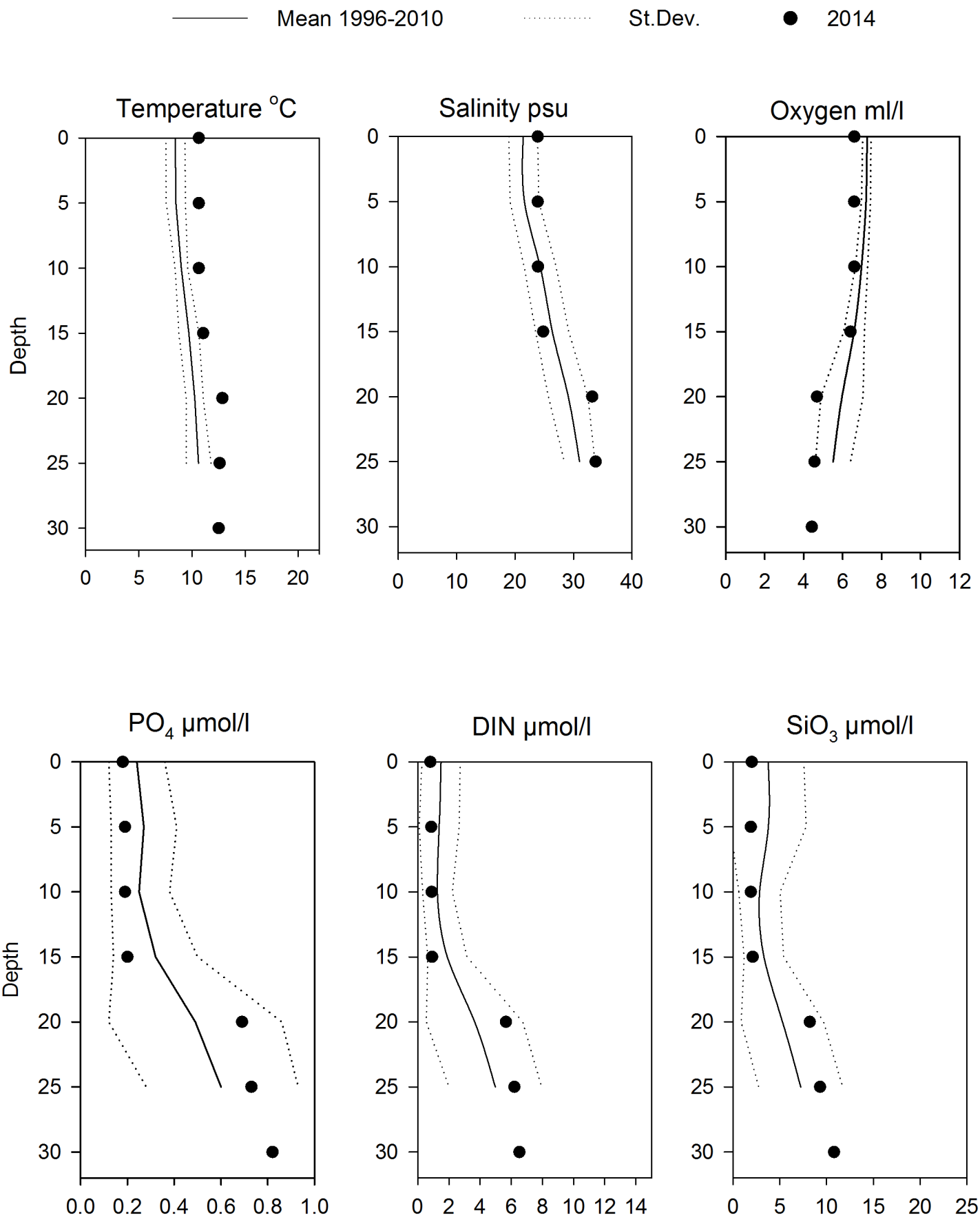
Annual Cycles



OXYGEN IN BOTTOM WATER (depth > 25m)



Vertical profiles N14 Falkenberg November

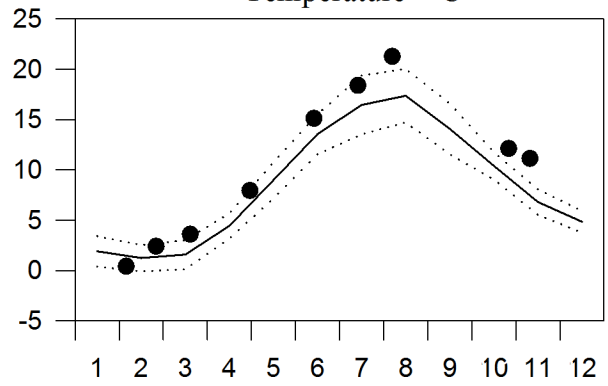


STATION REF M1V1 SURFACE WATER

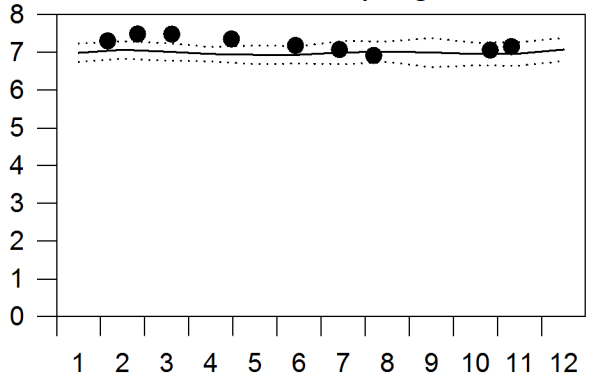
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2014

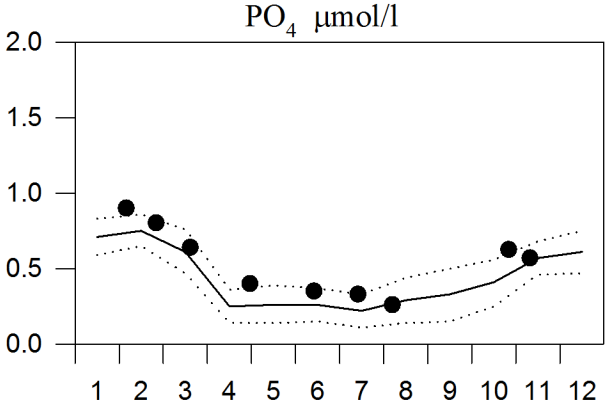
Temperature °C



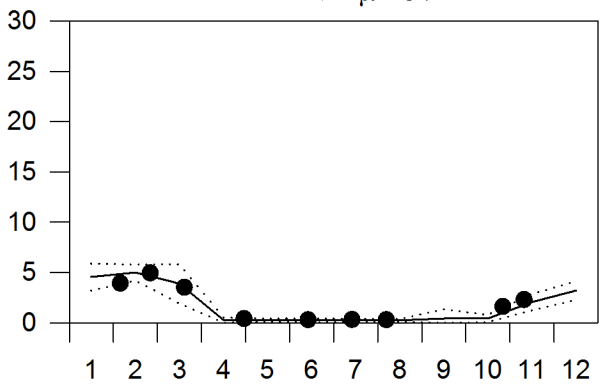
Salinity psu



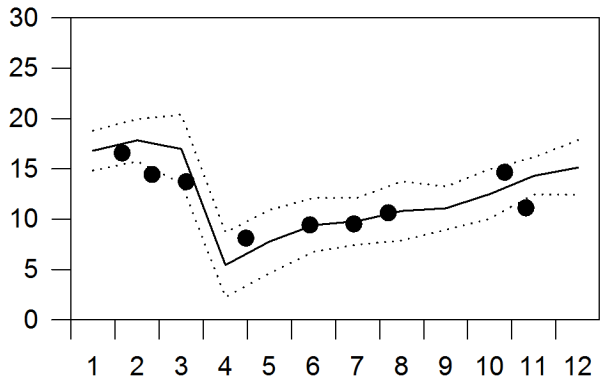
PO_4 µmol/l



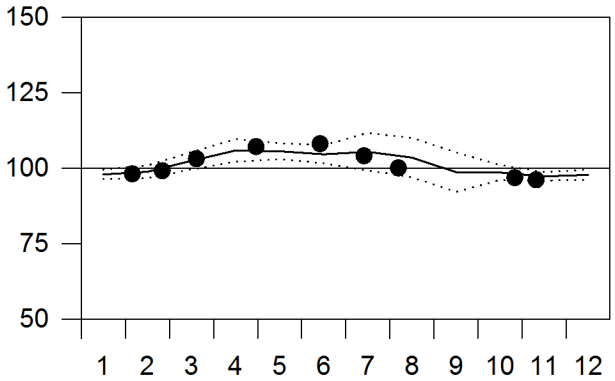
DIN µmol/l



SiO_3 µmol/l

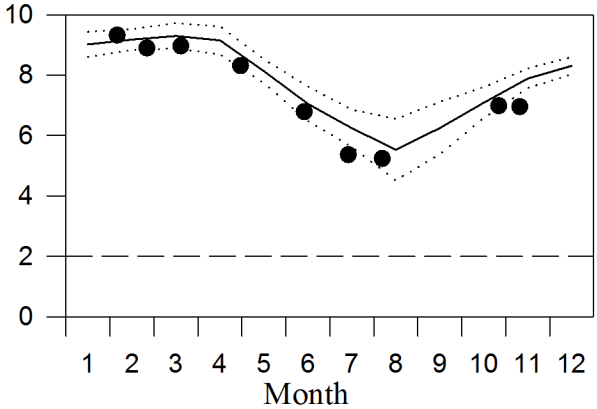


O_2 saturation %

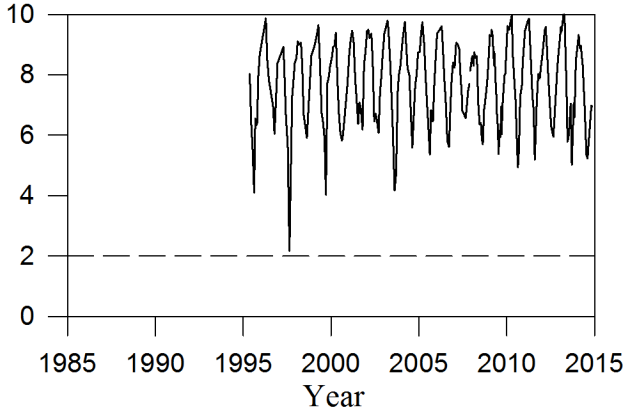


OXYGEN IN BOTTOM WATER (depth >15m)

O_2 ml/l



O_2 ml/l



Vertical profiles Ref M1V1 November