Lars Andersson
Martin Hansson

Swedish Meteorological and Hydrological Institute
Oceanographic Laboratory

2015-04-27
Dnr: S/Gbg-2015-57

Report from the SMHI monitoring cruise with R/V Aranda

Survey period: 2015-04-20 - 2015-04-27
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 essentially normal for the season. In the Skagerrak nutrient concentrations in the surface water has risen slightly since the previous survey, while they in the Kattegat showed, for the season, typical concentrations. Phosphate and silicate were generally above normal in most parts of the Baltic proper, while the concentrations of inorganic nitrogen was below the detection limit, in almost the whole area. In the Eastern Gotland Basin, a bloom was ongoing and high fluorescence was registered. In other areas phytoplankton activity was low.
The effects of inflows during December 2014 were now clearly seen in the central part of the Eastern Gotland Basin. In the Western Gotland Basin, the oxygen situation remains serious as acute hypoxia occurred from depths exceeding 70-80 meters and hydrogen sulphide from about 90 meters depth.

The next cruise is planned to start June 12, 2015.

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

Telephone:
+46 11 4958000

E-mail:
Lars.S.Andersson@smhi.se
WWW:
http://www.smhi.se/

SMHI

PRELIMINARY RESULTS

The cruise, performed on board the Finnish research vessel Aranda, began in Helsinki on April 20 and ended in the same port on the 27th. The winds during the expedition were mainly mild to moderate. Air temperatures ranged from 4.5 to 10.5° C. The station BY15 in the Eastern Gotland Basin could not be sampled and was moved somewhat westwards into Swedish waters, due to a Russian navy exercise.
Two researchers from University of Helsinki took part in the expedition in order to study the formation of N_2O in hypoxic waters.

The Skagerrak

The salinity in the surface layer showed small variations around 30 psu. Surface water temperature was normal for the season and varied between 7.1 and 7.8° C. The halocline and thermocline were weakly developed near the coast while they were sharper further west and found at around 10-15 meters depth.
Surface nutrient concentrations had generally increased slightly compared to the previous survey in March, when all nutrients were almost consumed. Phosphate concentrations in the surface water ranged between 0.04 and 0.09 µmol/l, nitrite + nitrate varied from 0.3 to 2.1 µmol/l, while the concentrations of silicate varied between 0.7 and 1.3 µmol/l.
Fluorescence measurements together with oxygen saturation showed low biological activity, except in the outer Skagerrak, where a strong bloom was found at 15 meters depth. Turquoise waters suggest that a diatom bloom of *Emiliania Huxleyi* was ongoing.

The Kattegat and the Sound

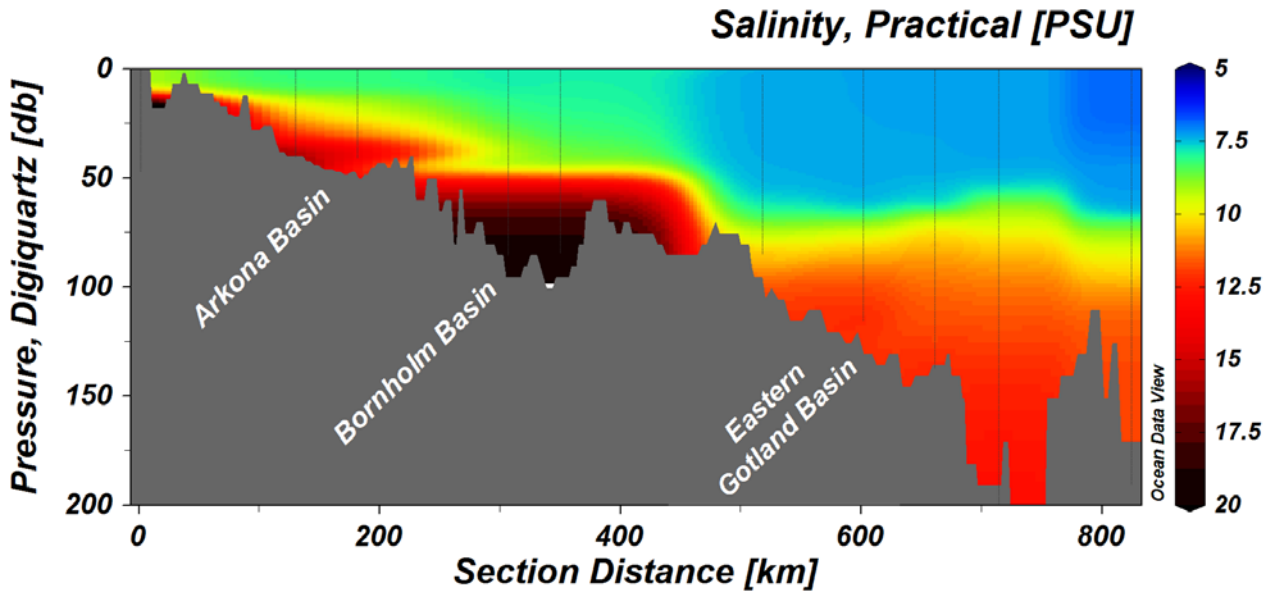
The temperature of the surface water was normal for the season and varied from 8°C in the south to 9°C in the north. In the Kattegat surface salinity was normal, between 20.1 - 23.5 psu. In the Sound, the salinity was slightly lower than normal, about 10 psu. Halocline and thermocline was found at 5 to 15 meters deep.
Concentrations of nutrients in surface waters were normal for the season except for silicate which showed levels above normal. The spring bloom was still ongoing and high fluorescence values were measured adjacent to the halocline. Phosphate concentrations varied from 0.06 µmol/l in the north, to 0.11 µmol/l in the south, while silicate concentrations were in the range 2.9 to 4.0 µmol/l. In the Sound the corresponding values were 0.27 for phosphate and 5.8 µmol/l for silicate. Inorganic nitrogen was below the detection limit (< 0.10 µmol/l) in the southern Kattegat and the Sound, but showed a concentration of 0.39 µmol/l in the northern Kattegat. The lowest oxygen concentrations were measured at Anholt E in the Kattegat, 5.6 ml/l, and at W Landskrona in the Sound, 4.9 ml/l.

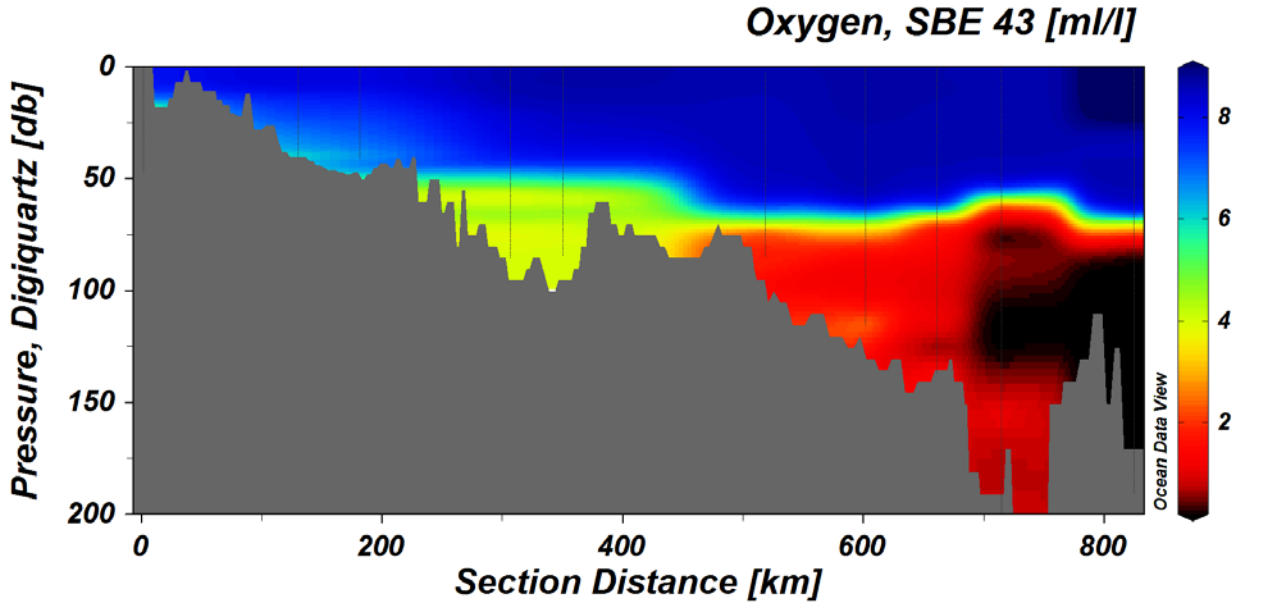
The Baltic Proper

The temperature in the surface layer was slightly above average for the season and ranged from 4.1°C in the northeast to 7.0°C in the southwest. Surface salinity was slightly above normal in the Arkona and Bornholm Basin and ranged from 6.8 psu in the northeast to 8.3 psu. The halocline was found at 60-70 m depth in the western and eastern Gotland Basins, while it was shallower in the south, at depths between 30 and 50 meters.
Phosphate and silicate concentrations were generally above normal and ranged between 0.3 - 0.7 µmol/l and 10 - 18 µmol/l respectively. The concentration of inorganic nitrogen was below the detection limit throughout the area, except in the Southeast where the levels were around 1.2 µmol/l.

The spring bloom was ongoing in the northern parts of the Eastern Gotland Basin, where high fluorescence was recorded at 5-25 meters depth. In other areas the phytoplankton activity was low.

The inflow to the Baltic Sea that occurred in December 2014 had now reached the central parts of Eastern Gotland Basin. At the Gotland Deep acute hypoxia occurred from 70 meters depth and hydrogen sulfide (oxygen-free conditions) at intermediate depths, 125-150 meters. Below this anoxic layer bottom water was oxygenated and oxygen levels had increased from about 1 ml/l to around 3 ml/l since the previous survey in March. The salinity of the bottom water had also increased with about 0.5 psu. In the northern part of the Eastern Gotland Basin no effects of the inflow were seen and hydrogen sulphide was recorded from depths exceeding 90 meters.
In the Bornholm Basin, Arkona Basin and Hanö Bight there were no lack of oxygen in the bottom waters but oxygen concentrations had decreased since the previous measurement with 0.5-1 ml/l.
In Western Gotland Basin, the oxygen situation remains serious. Anoxic conditions was recorded from 90 meters and acute hypoxia (<2ml/l) from about 70 meters.





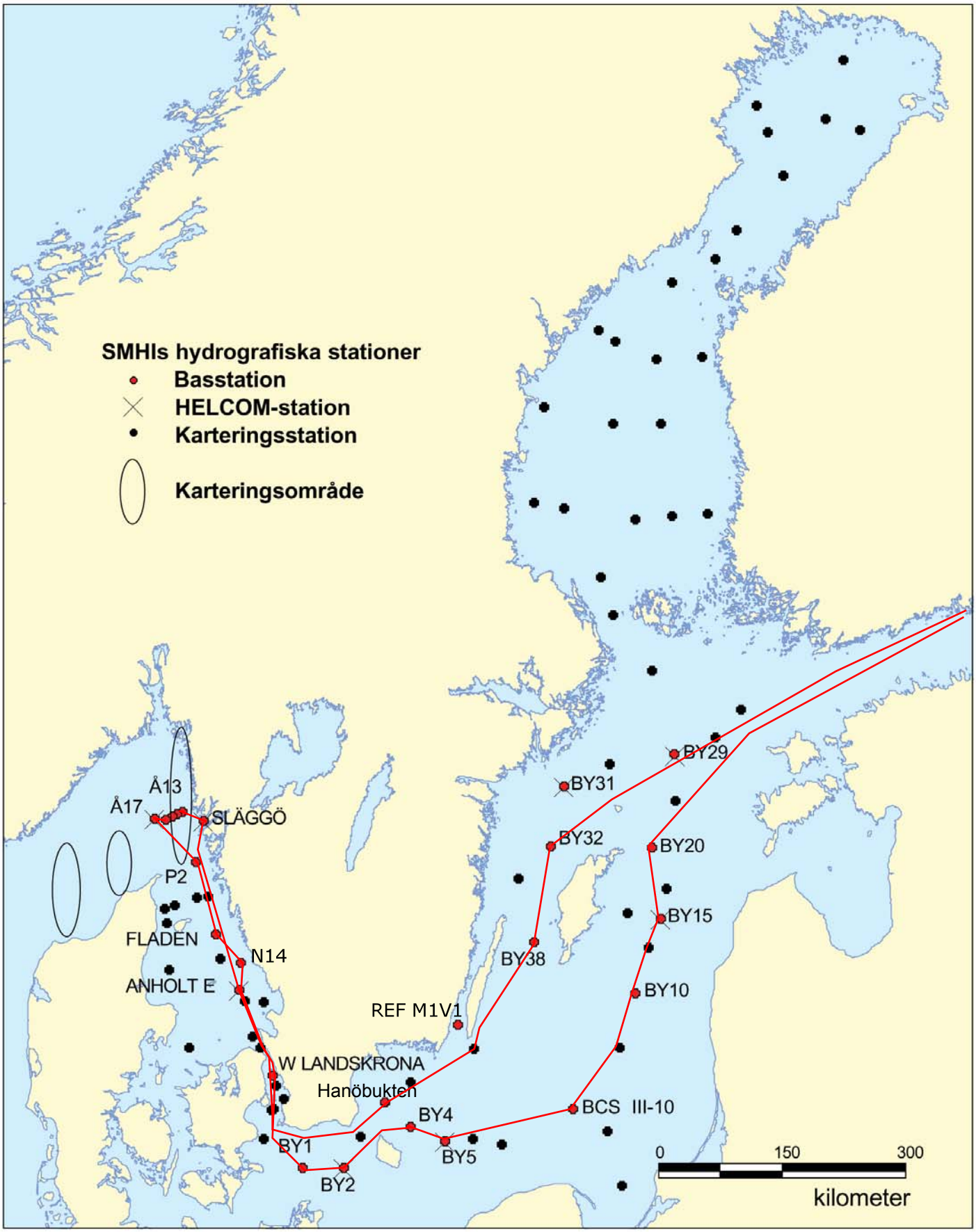
PARTICIPANTS

Name		Institute
Lars Andersson	Chief scientist	SMHI
Daniel Bergman-Sjöstrand		SMHI
Martin Hansson (Lysekil-Helsingfors)		SMHI
Sara Johansson		SMHI
Johan Kronsell		SMHI
Sari Sipilä		SMHI
Magnus Wenzer (Helsingfors-Lysekil)		SMHI
Jukka-Pekka Myllykangas		University of Helsinki
Gunnar Jacobs		University of Helsinki

APPENDICES

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

TRACKCHART
Country: Sweden
Ship: R/V ARANDA
Date: 20150420-20150427
Series: 0177-0206



SMHI ***** Hydrographic Ship: 01-Aranda ****** Date: 2015-04-27
Ocean enh ***** series Year: 2015 ****** Time: 06:14

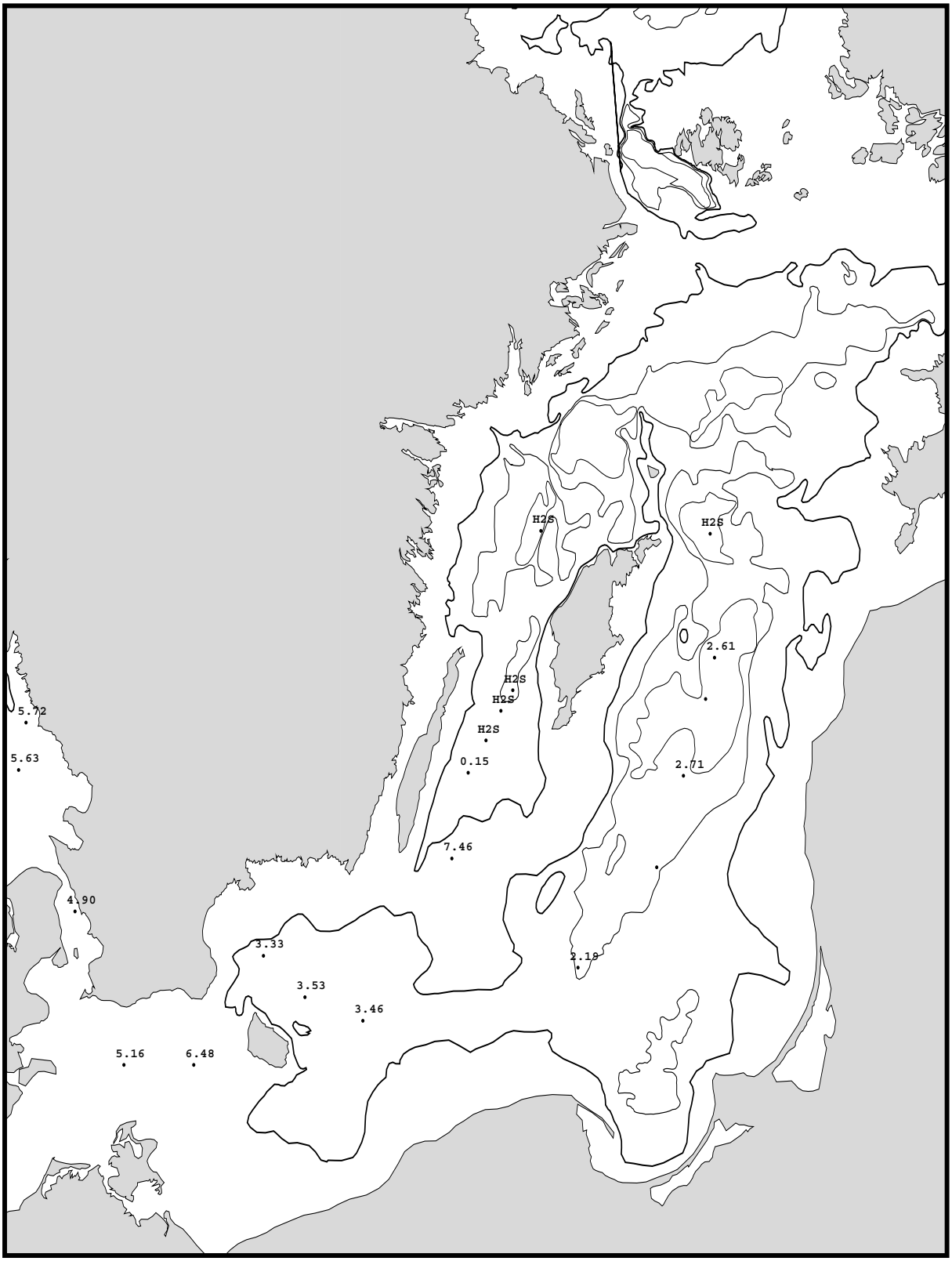
Ser no	Stat code	Proj	Station	Lat	Lon	Date yyyymmdd	Time hhmm utc	Bottom depth m	Secchi depth m	Wind dir	Wind vel	Air temp C	Air pres hPa	WCSI eloae tuhd	Cted	PPCPZZT Hrhhoor Cilyooa motPBw PrP l	Node	Tem p	Sal in	pH	Oxy g	H2S	PO4P	Tot P	NOx2N	NOx3N	NH4N	Tot N	Alk l	SiO3	Hum us	Lign in	POC	TOC	Comm
0177	BPEX26BAS	BY20	FÅRÖDJ	N5800	E1953	20150421	0420	195		35	10	4.7	1018	1230	x	--x----	17	x	x	-	x	x	x	x	x	x	x	-	x	-	-	-	-	-	x
0178	BPEX21BAS	BY15	W	N5718.79	E1956.09	20150421	0811	224	9	36	8	4.9	1020	0030	x	-xxxx--	18	x	x	x	x	x	x	x	x	x	x	x	x	x	-	-	-	-	-	x
0179	BPEX21EXT	BY15	W	N5718.79	E1956.09	20150421	0945	224		36	8	5.0	1021	1130	x	-------	6	x	x	-	x	x	x	x	x	x	x	-	x	-	-	-	-	-	x
0180	BPEX14BAS	BY11		N5704	E1950	20150421	1130	205	13	36	8	4.9	1021	1130	x	-------	18	x	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x
0181	BPEX13BAS	BY10		N5638	E1935	20150421	15	144	17	02	6	4.8	1021	0030	x	--x----	15	x	x	-	x	-	x	x	x	x	x	x	-	x	-	-	-	-	-	x
0182	BPSE12BAS	BY9	KLAIPEDA	N5607.5	E1917	20150421	1900	120						9990	x	-------	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x
0183	BPSE11BAS	BCS III-10		N5533.3	E1824	20150421	2358	90		32	3	4.7	1023	9990	x	--x----	12	x	x	-	x	-	x	x	x	x	x	-	x	x	-	-	-	-	-	-
0184	BPSB07BAS	BY5	BORNHOLMSDJ	N5515	E1559	20150422	0735	89		18	3	7.0	1023	1320	x	-xxxx--	12	x	x	x	x	-	x	x	x	x	x	x	x	x	-	-	-	-	-	-
0185	BPSB06BAS	BY4	CHRISTIANSÖ	N5523	E1520	20150422	1107	92	12	18	2	10.5	1023	1310	x	--x----	12	x	x	-	x	-	x	x	x	x	x	x	-	x	-	-	-	-	-	-
0186	BPSA03BAS	BY2	ARKONA	N5500	E1405	20150422	1704	48		25	8	7.5	1021	1130	x	--xxx--	8	x	x	-	x	-	x	x	x	x	x	x	-	x	-	-	-	-	-	-
0187	BPSA02BAS	BY1		N5500	E1318	20150422	2040	47		25	7	8.0	1020	9990	x	--x----	8	x	x	-	x	-	x	x	x	x	x	x	-	x	-	-	-	-	-	-
0188	SOCX39BAS	W LANDSKRONA		N5552.0	E1245.0	20150423	0240	51		28	6	8.5	1014	9990	x	--x----	9	x	x	-	x	-	x	x	x	x	x	x	-	x	-	-	-	-	-	x
0189	KAEX29BAS	ANHOLT E		N5640.0	E1207.0	20150423	0830	63		28	14	8.3	1012	2740	x	-xxx---	10	x	x	x	x	-	x	x	x	x	x	x	x	x	x	-	-	-	-	-	x
0190	KANX50BAS	N14 FALKENBERG		N5656.40	E1212.70	20150423	1100	31	4	27	13	8.4	1010	2740	x	-xxxx--	7	x	x	x	x	-	x	x	x	x	x	x	x	x	-	-	-	-	-	-
0191	KANX25BAS	FLADEN		N5711.5	E1140	20150423	1405	85	5	28	11	9.9	1009	1140	x	--x----	12	x	x	-	x	-	x	x	x	x	x	x	-	x	-	-	-	-	-	-
0192	SKEX23BAS	P2		N5752	E1118	20150423	1830	94		27	15	7.7	1006	1450	x	--x----	10	x	x	-	x	-	x	x	x	x	x	x	-	x	-	-	-	-	-	-
0193	SKEX18BAS	Å17		N5816.5	E1030.8	20150423	2310	350		30	10	8.3	1006	9990	x	--xxx--	15	x	x	x	x	-	x	x	x	x	x	x	x	x	-	-	-	-	-	-
0194	SKEX17BAS	Å16		N5816	E1043.5	20150424	0040	203		28	11	7.6	1006	9990	x	-------	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0195	SKEX16BAS	Å15		N5817.7	E1051	20150424	0240	137		28	10	7.5	1006	9990	x	--x----	12	x	x	-	x	-	x	x	x	x	x	x	-	x	-	-	-	-	-	x
0196	SKEX15BAS	Å14		N5819	E1056.5	20150424	0400	113		27	12	7.3	1006	2840	x	-------	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0197	SKEX14BAS	Å13		N5820.2	E1102	20150424	0505	93		27	11	7.2	1005	2840	x	--x----	10	x	x	-	x	-	x	x	x	x	x	x	-	x	-	-	-	-	-	-
0198	FIBG27BAS	SLÄGGÖ		N5815.5	E1126.0	20150424	0720	73		26	11	7.6	1006	2720	x	--xxx--	9	x	x	-	x	-	x	x	x	x	x	x	-	x	-	-	-	-	-	-
0199	KAEX29BAS	ANHOLT E		N5640.0	E1207.0	20150424	1930	63		14	6	8.1	1007	1520	x	--xxx--	10	x	x	x	x	-	x	x	x	x	x	x	x	x	x	-	-	-	-	-	-
0200	BPSH05BAS	HANÖBUKTEN		N5537	E1452	20150425	1130	80	11	20	8	8.1	1005	2820	x	--x----	11	x	x	-	x	-	x	x	x	x	x	x	-	x	-	-	-	-	-	-
0201	BPSE00EXT	4.4NE ÖLANDS SÖDRA		N5610.06	E1659	20150425	1745	58		24	5	7.8	1004	4820	x	-------	9	x	x	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x
0202	BPWX00EXT	14SE KAPELLUDDEN		N5639.50	E1710.13	20150425	2145	83		20	8	6.4	1003	6990	x	-------	11	x	x	-	x	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0203	BPWX00EXT	16.5E KAPELLUDDEN		N5650.20	E1722.09	20150425	2325	93		20	7	6.8	1002	6990	x	-------	12	x	x	-	x	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x

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	Weath	Cloud	Sea	Ice	Ctd	PHC	PrimP	Chlor	PhytP	ZooP	ZooB	Trawl	No de	Temp	Salin	Ph	Oxyg	H2S	PO4P	TotP	NO2N	NO3N	NH4N	TotN	Alkal	SiO3	Humus	Ligni	PON	POC	TOC	Comm
0204	BPWX	00	EXT 17E KLAPPERVALL	N5700.02	E1732.40	20150426	0055	107		21	7	6.7	1002	6	9	9	0	x	-	-	-	-	-	-	-	14	x	x	-	x	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0205	BPWX	45	BAS BY38 KARLSÖDJ	N5707	E1740	20150426	0250	110		22	7	6.6	1002	9	9	9	0	x	-	-	x	-	-	-	-	14	x	x	-	x	x	x	x	x	x	x	x	-	x	-	-	-	-	-	x
0206	BPWX	38	BAS BY32 NORRKÖPINGSDJ	N5801	E1759	20150426	0800	201	7	22	5	6.5	1001	4	3	2	0	x	-	-	x	-	-	-	-	17	x	x	-	x	x	x	x	x	x	x	x	-	x	-	-	-	-	-	x

E

Bottom water oxygen concentration (ml/l)

Country: Finland
Ship : Aranda
Date : 20150421-20150426
Series : 0177-0206

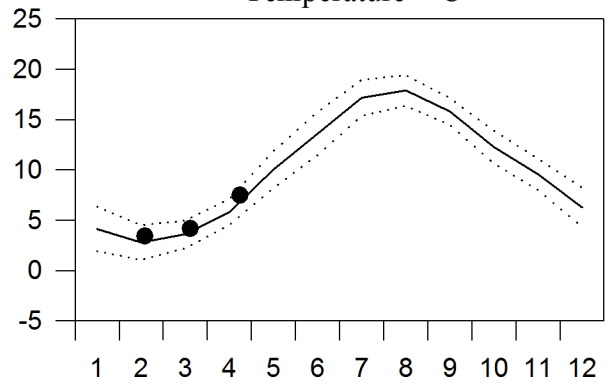


STATION P2 SURFACE WATER

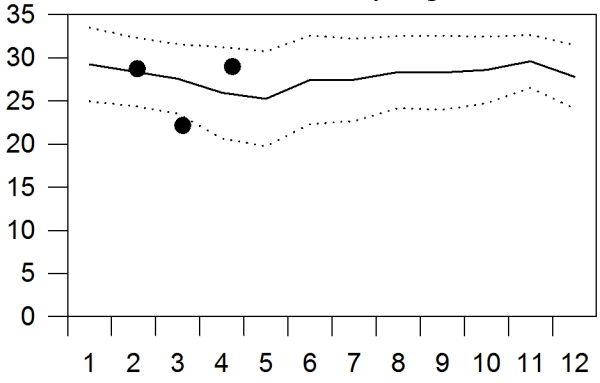
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

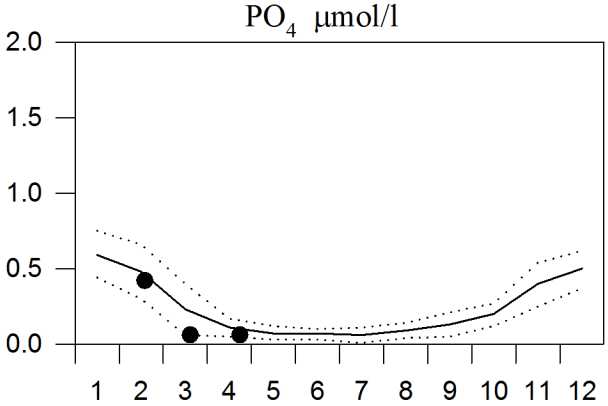
Temperature °C



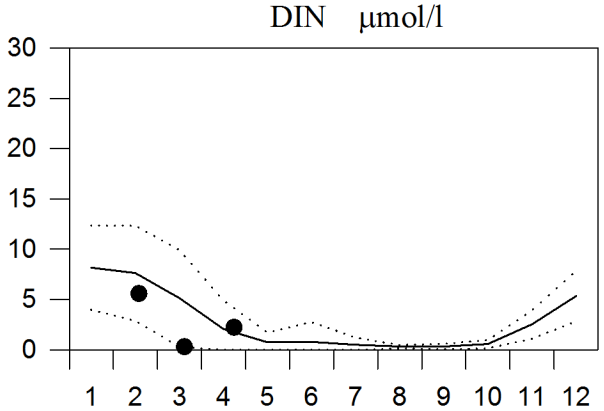
Salinity psu



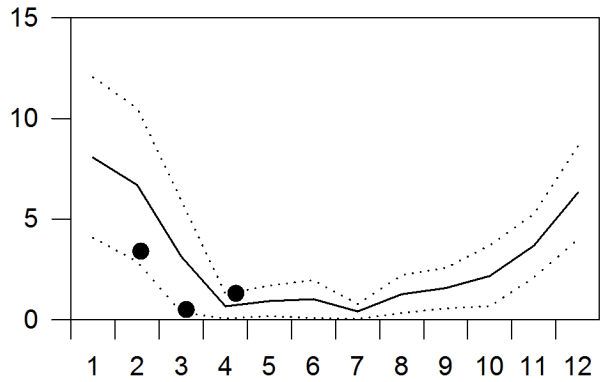
PO_4 µmol/l



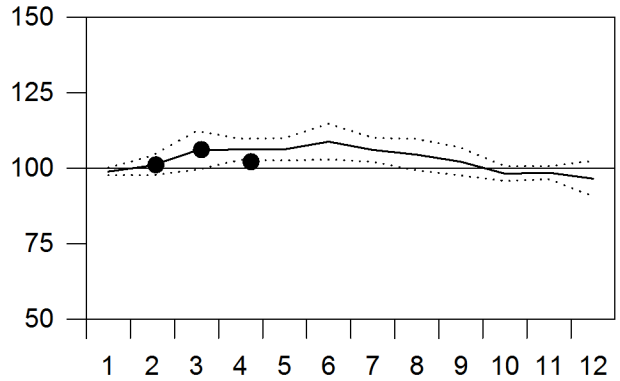
DIN µmol/l



SiO_3 µmol/l

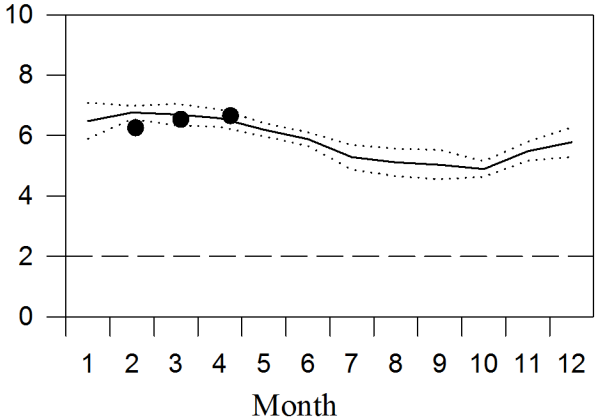


O_2 saturation %

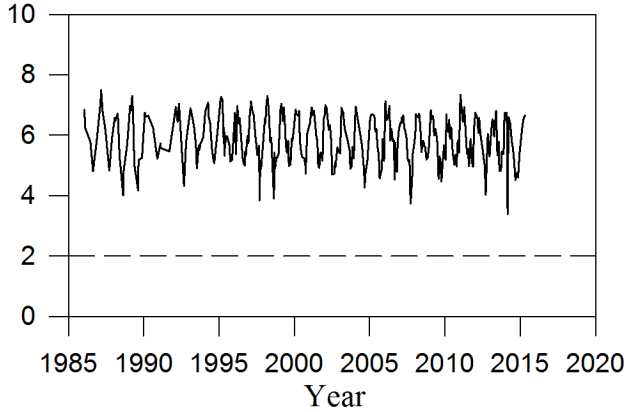


OXYGEN IN BOTTOM WATER (depth >75m)

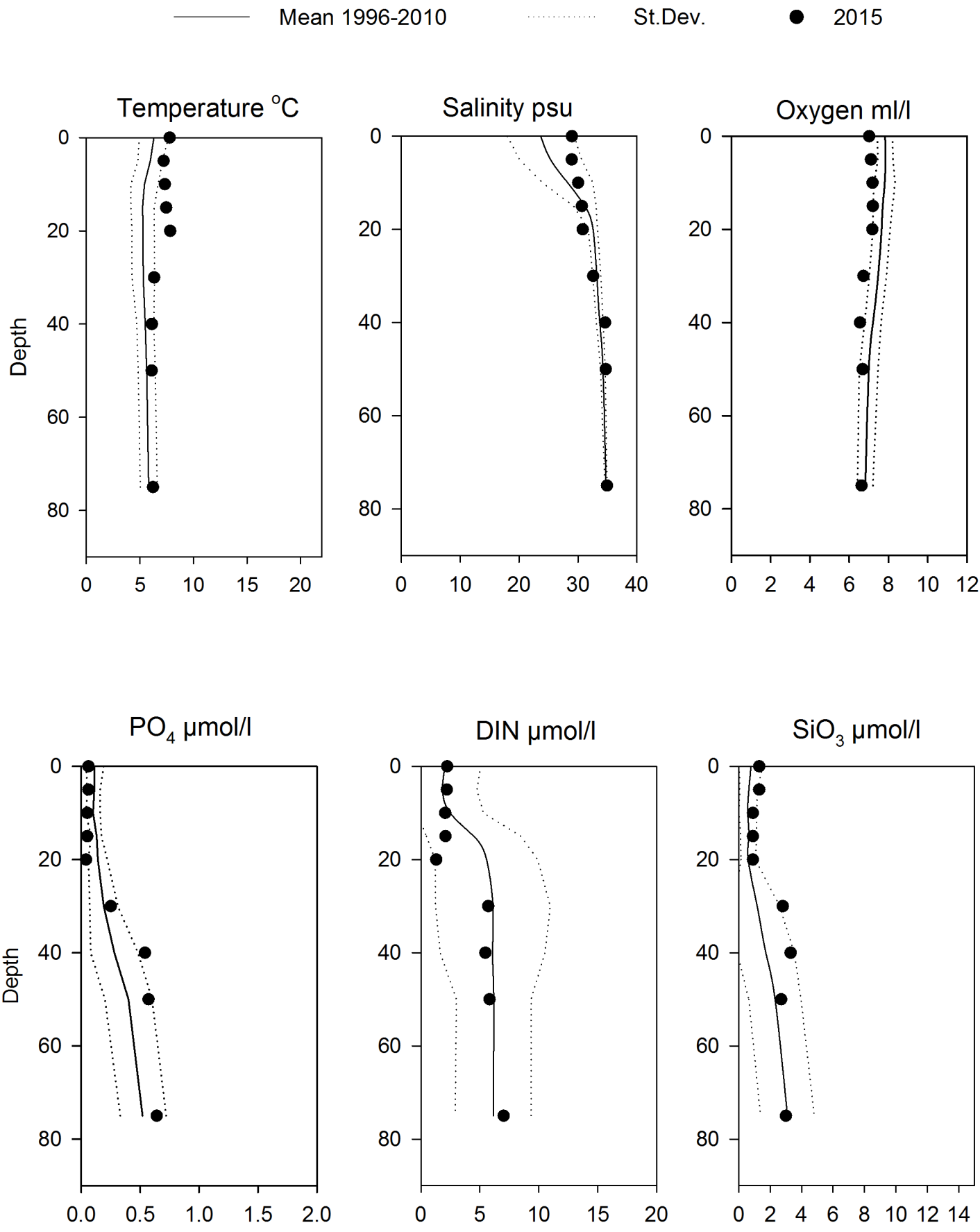
O_2 ml/l



O_2 ml/l



Vertical profiles P2 April

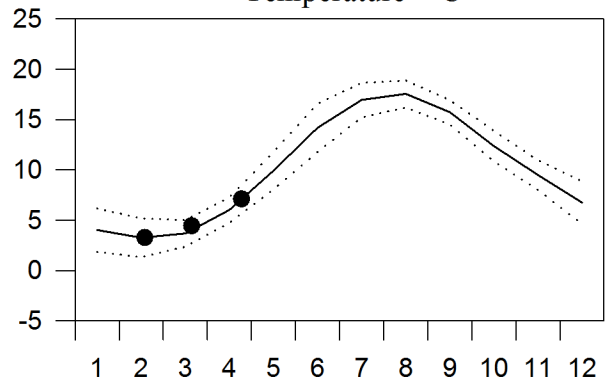


STATION Å13 SURFACE WATER

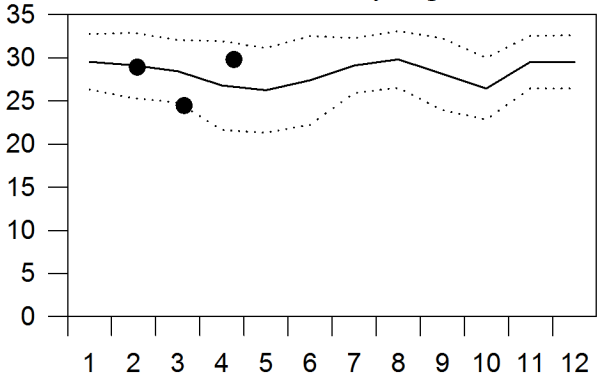
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

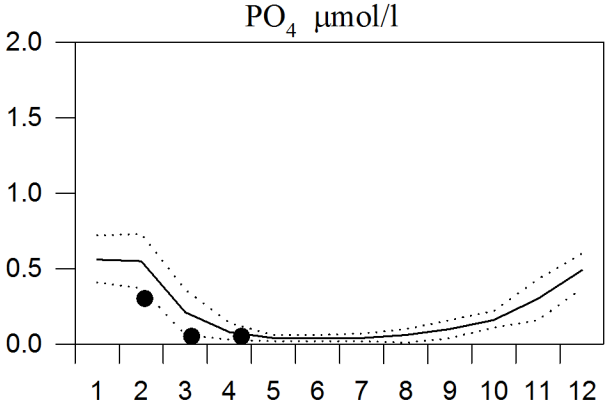
Temperature °C



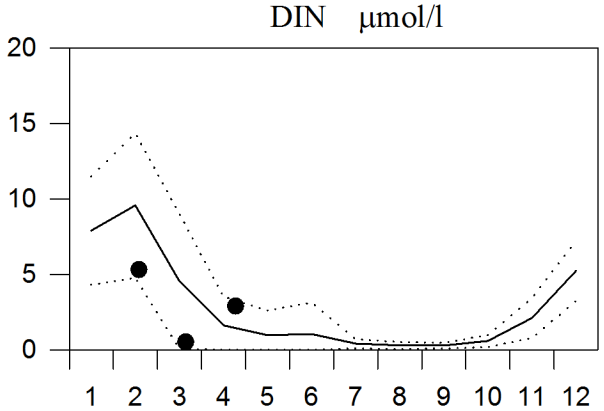
Salinity psu



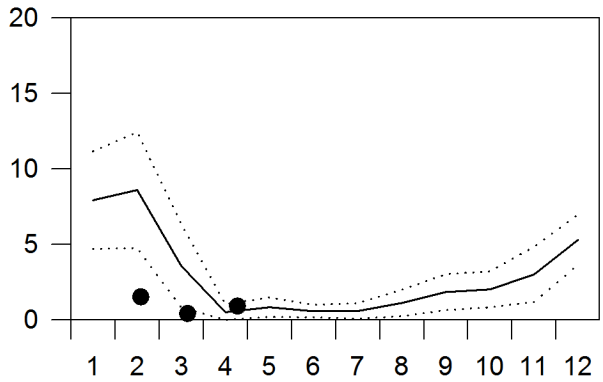
PO_4 µmol/l



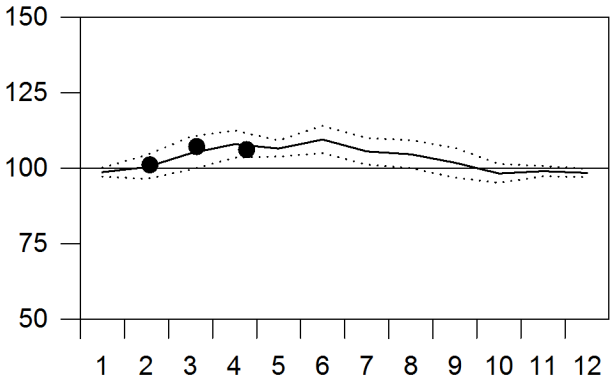
DIN µmol/l



SiO_3 µmol/l

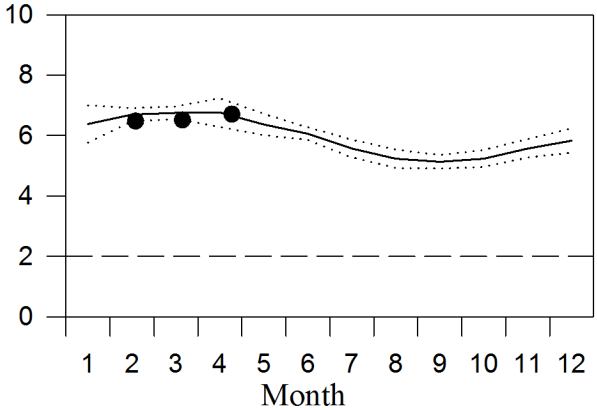


O_2 saturation %

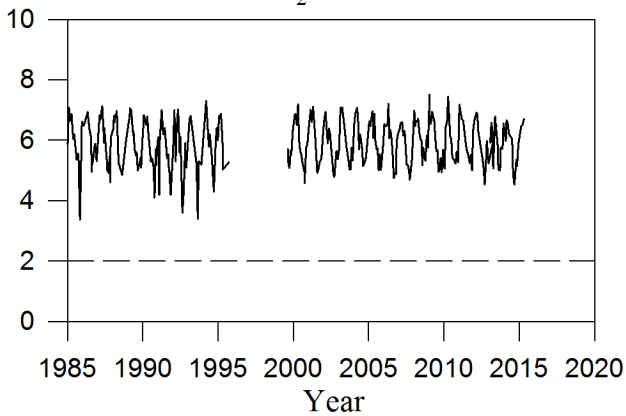


OXYGEN IN BOTTOM WATER (depth >=75m)

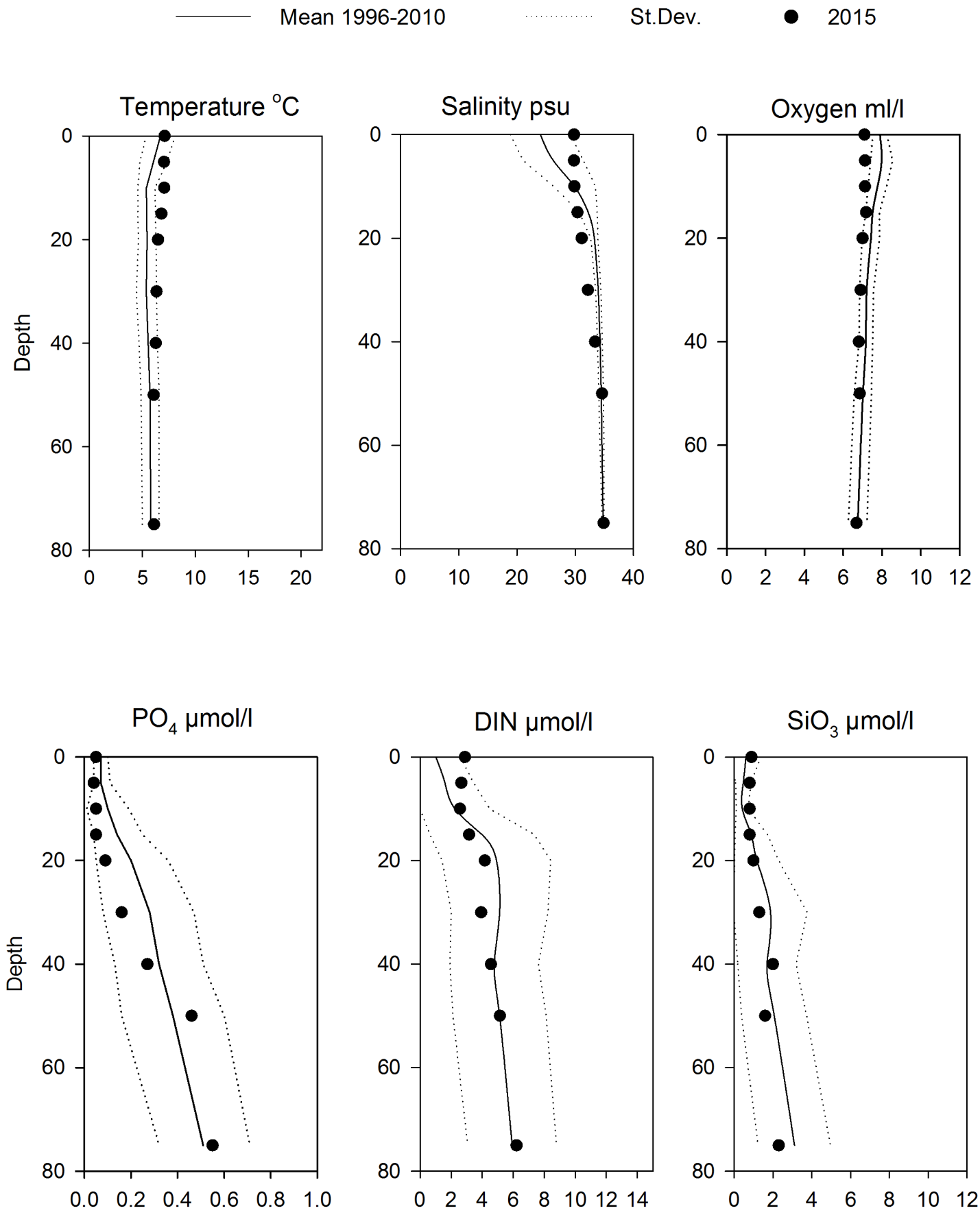
O_2 ml/l



O_2 ml/l



Vertical profiles Å13 April

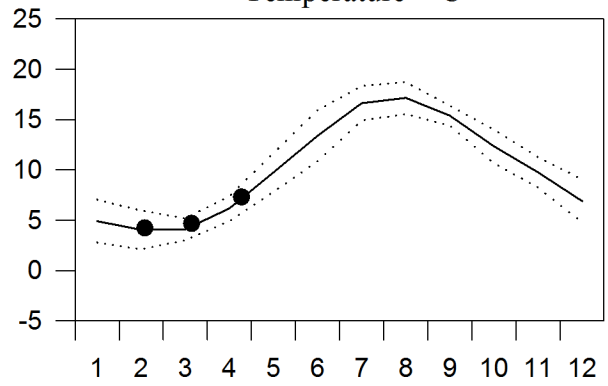


STATION Å15 SURFACE WATER

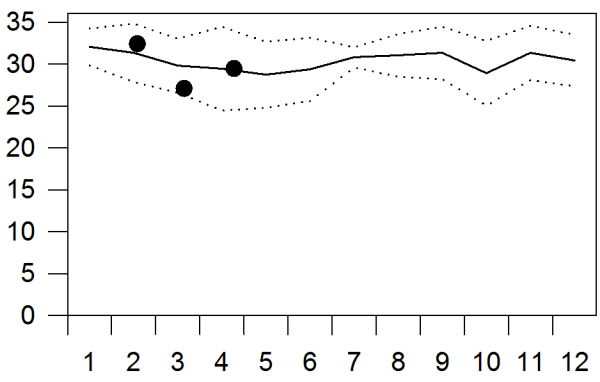
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

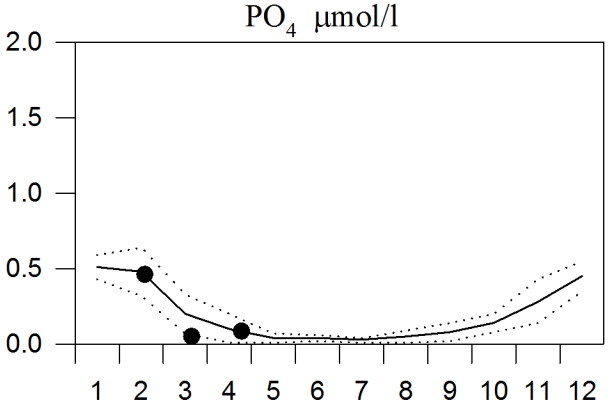
Temperature °C



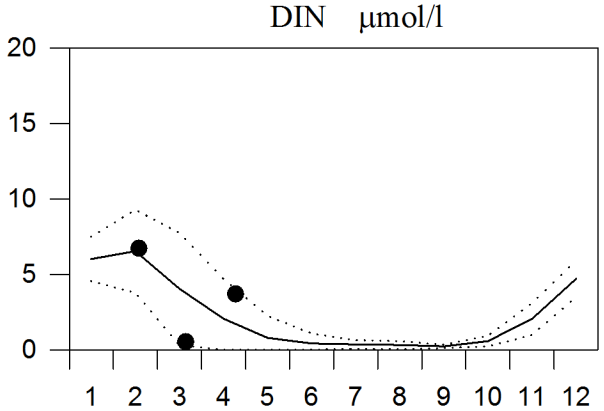
Salinity psu



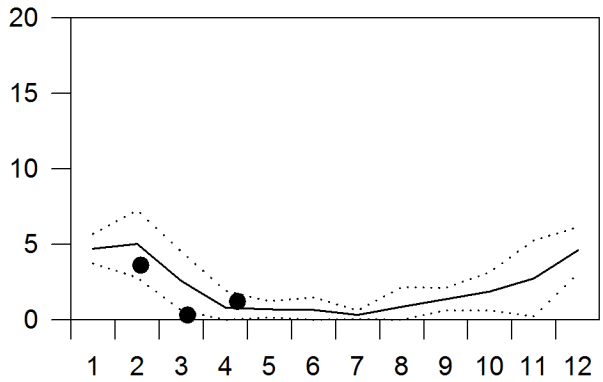
PO_4 µmol/l



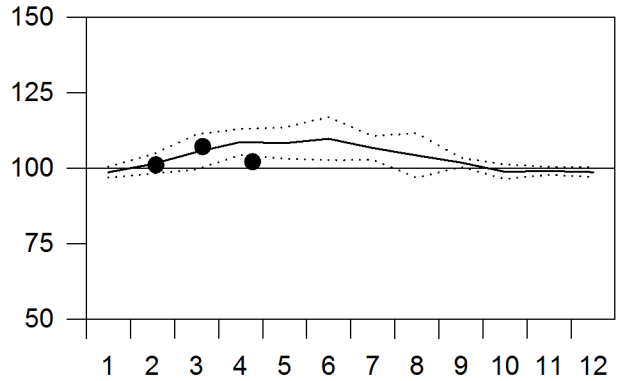
DIN µmol/l



SiO_3 µmol/l

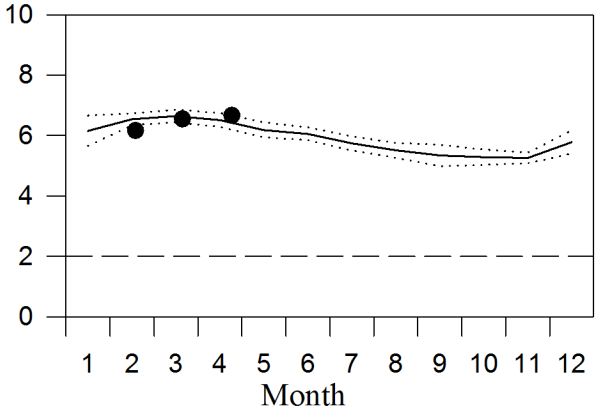


O_2 saturation %

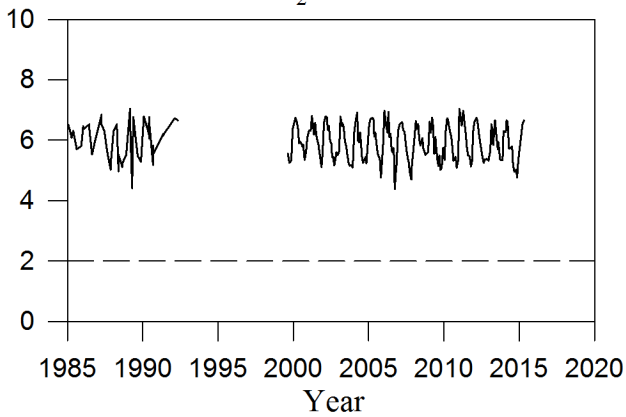


OXYGEN IN BOTTOM WATER (depth >=125m)

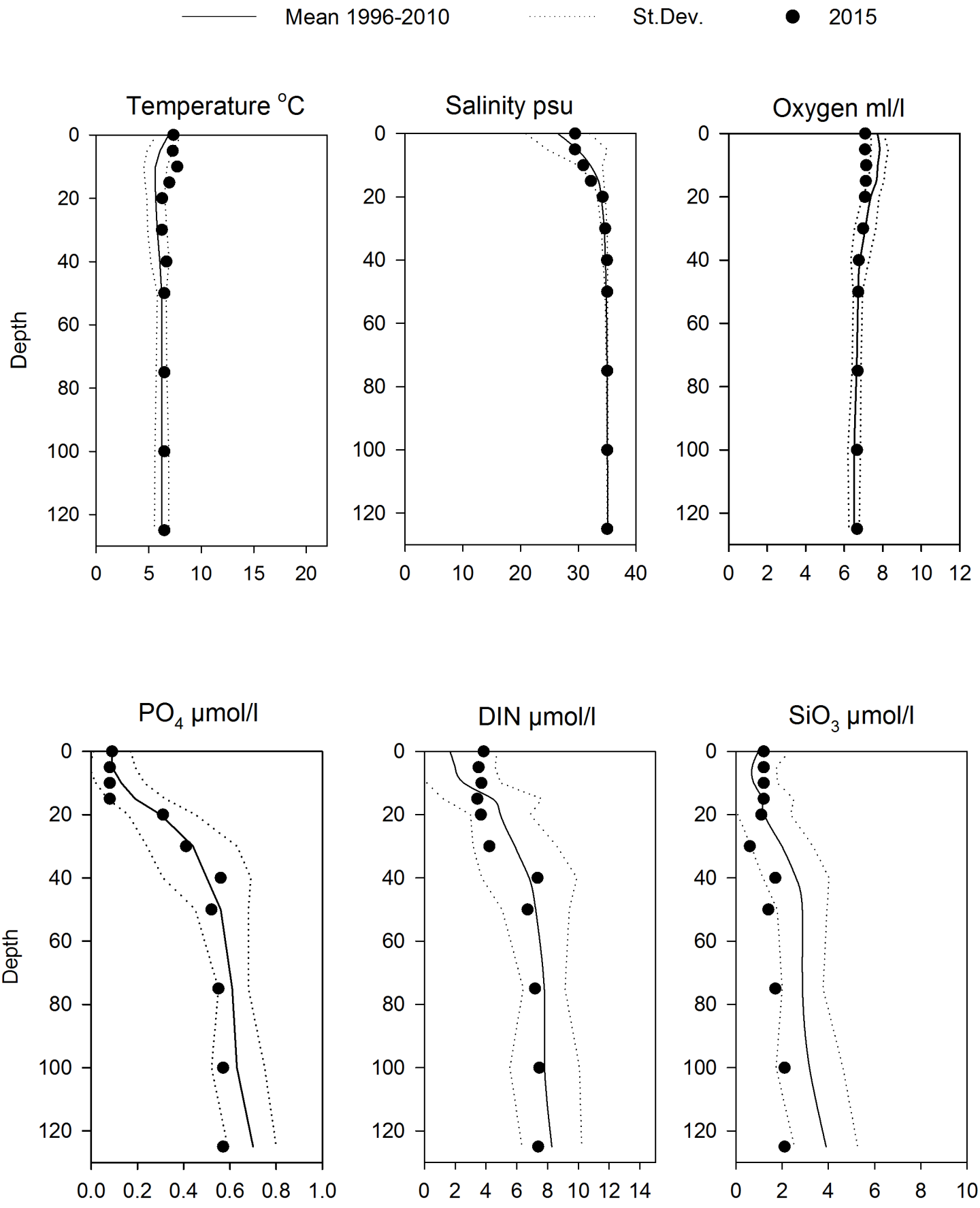
O_2 ml/l



O_2 ml/l



Vertical profiles Å15 April

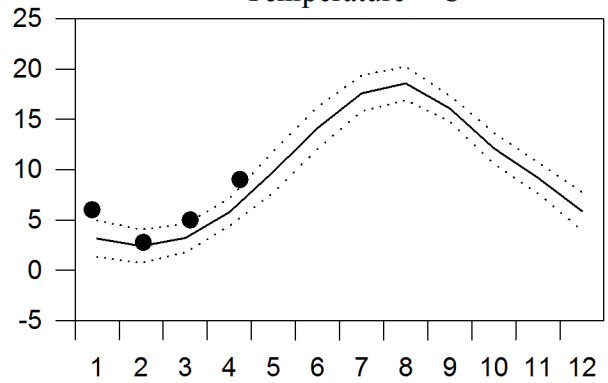


STATION FLADEN SURFACE WATER

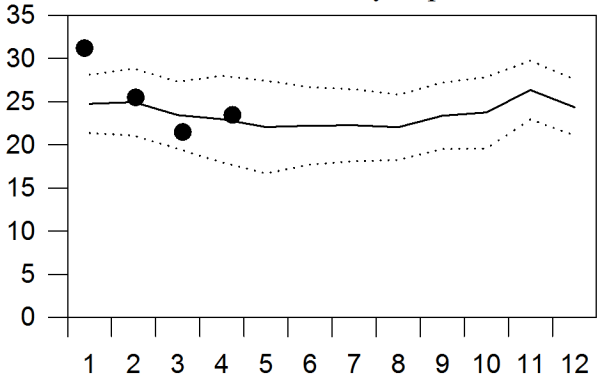
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

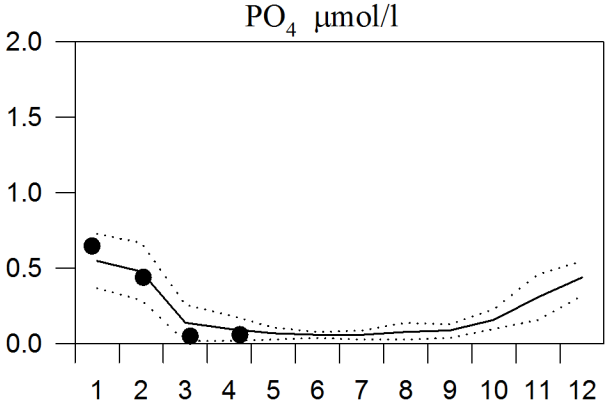
Temperature °C



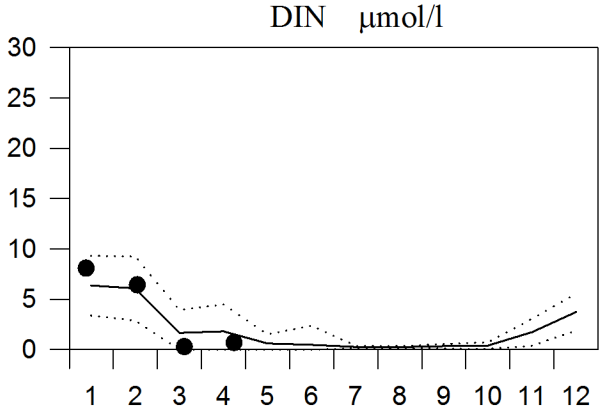
Salinity psu



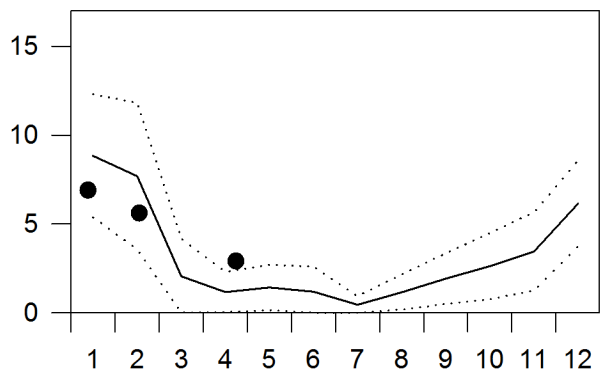
PO_4 µmol/l



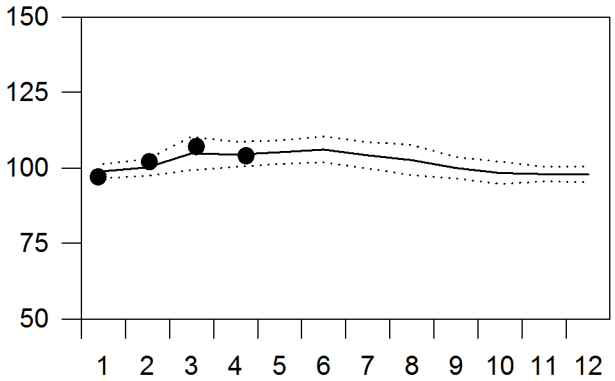
DIN µmol/l



SiO_3 µmol/l

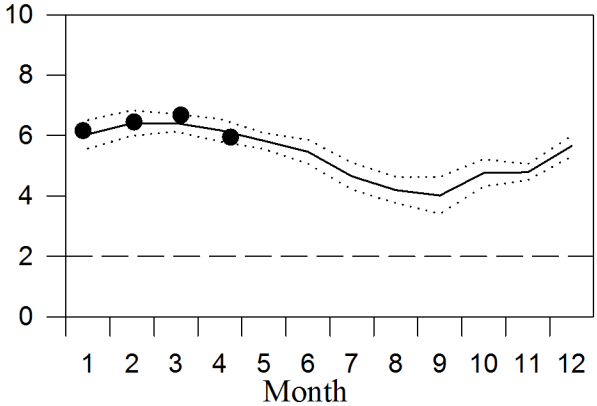


O_2 saturation %

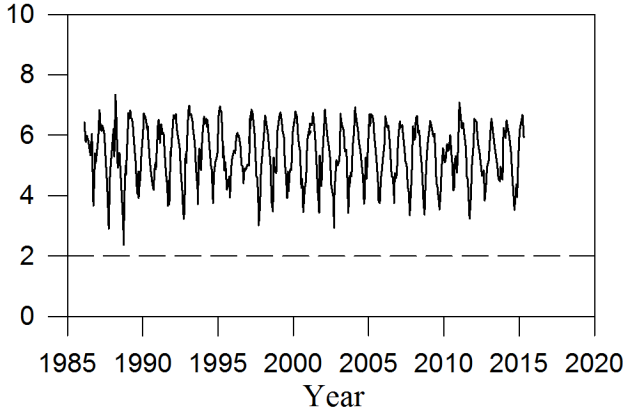


OXYGEN IN BOTTOM WATER (depth > 70m)

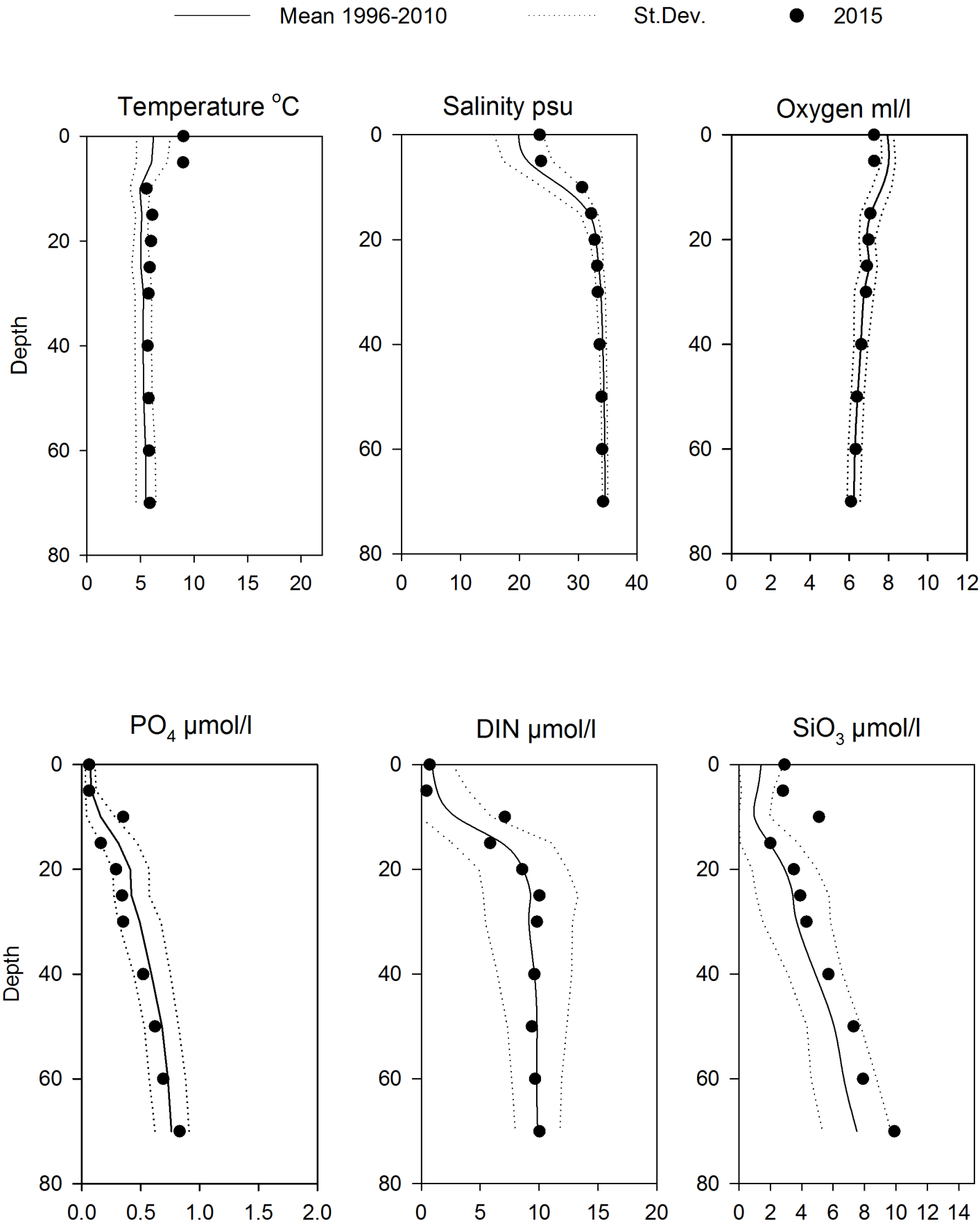
O_2 ml/l



O_2 ml/l



Vertical profiles Fladen April

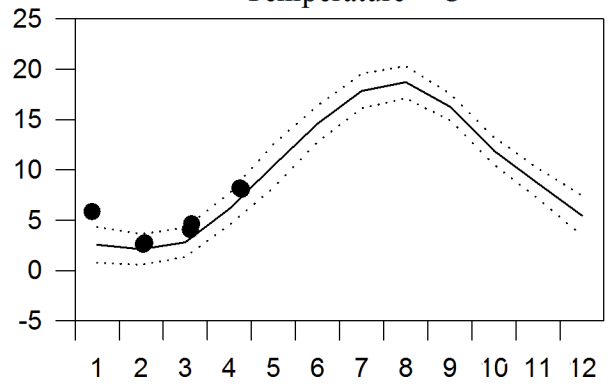


STATION ANHOLT E SURFACE WATER

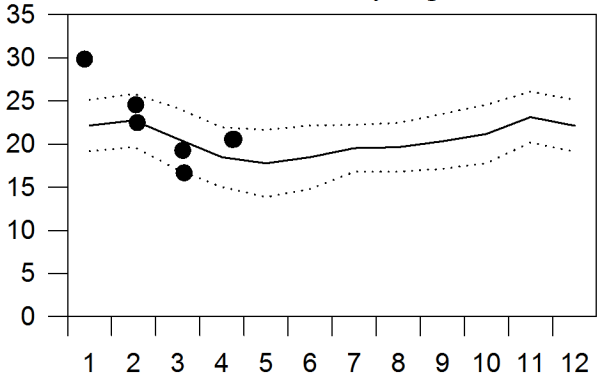
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

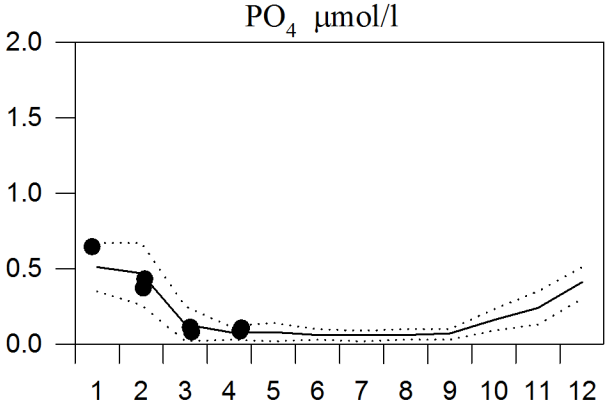
Temperature °C



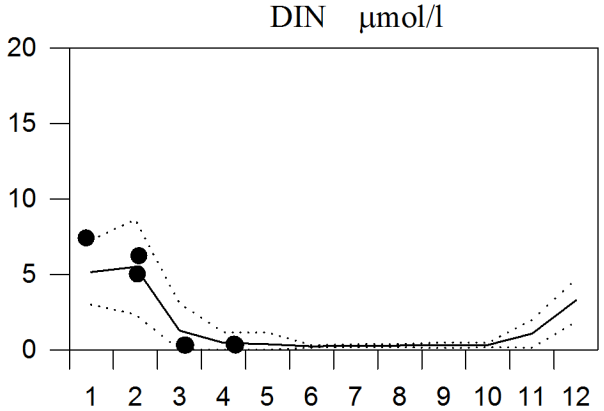
Salinity psu



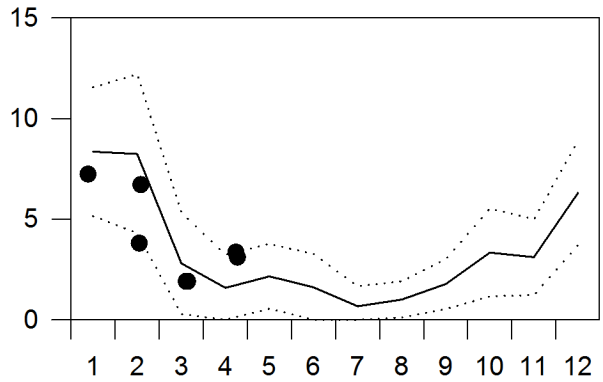
PO_4 µmol/l



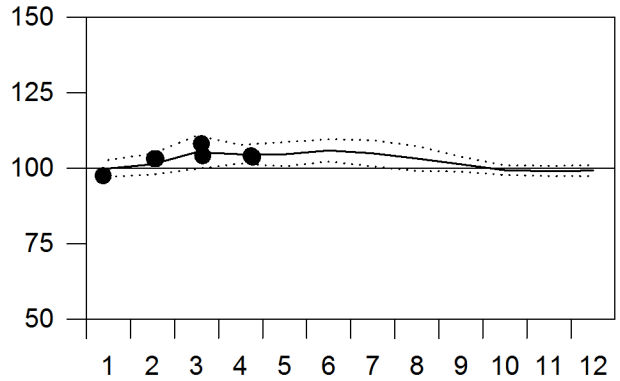
DIN µmol/l



SiO_3 µmol/l

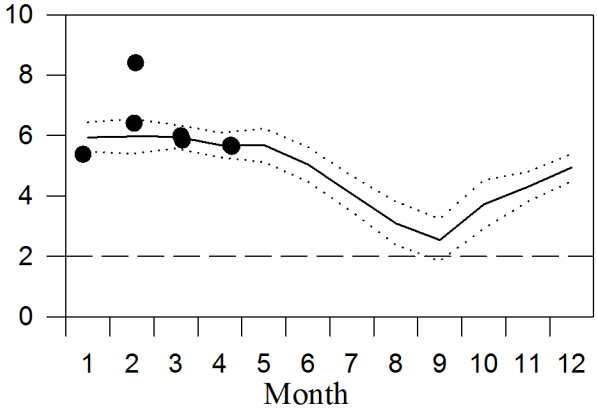


O_2 saturation %

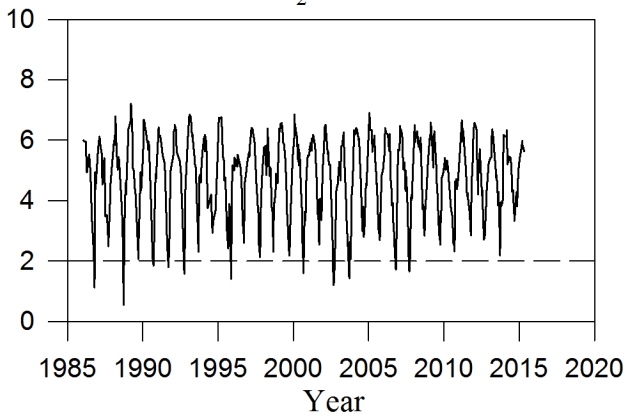


OXYGEN IN BOTTOM WATER (depth > 50m)

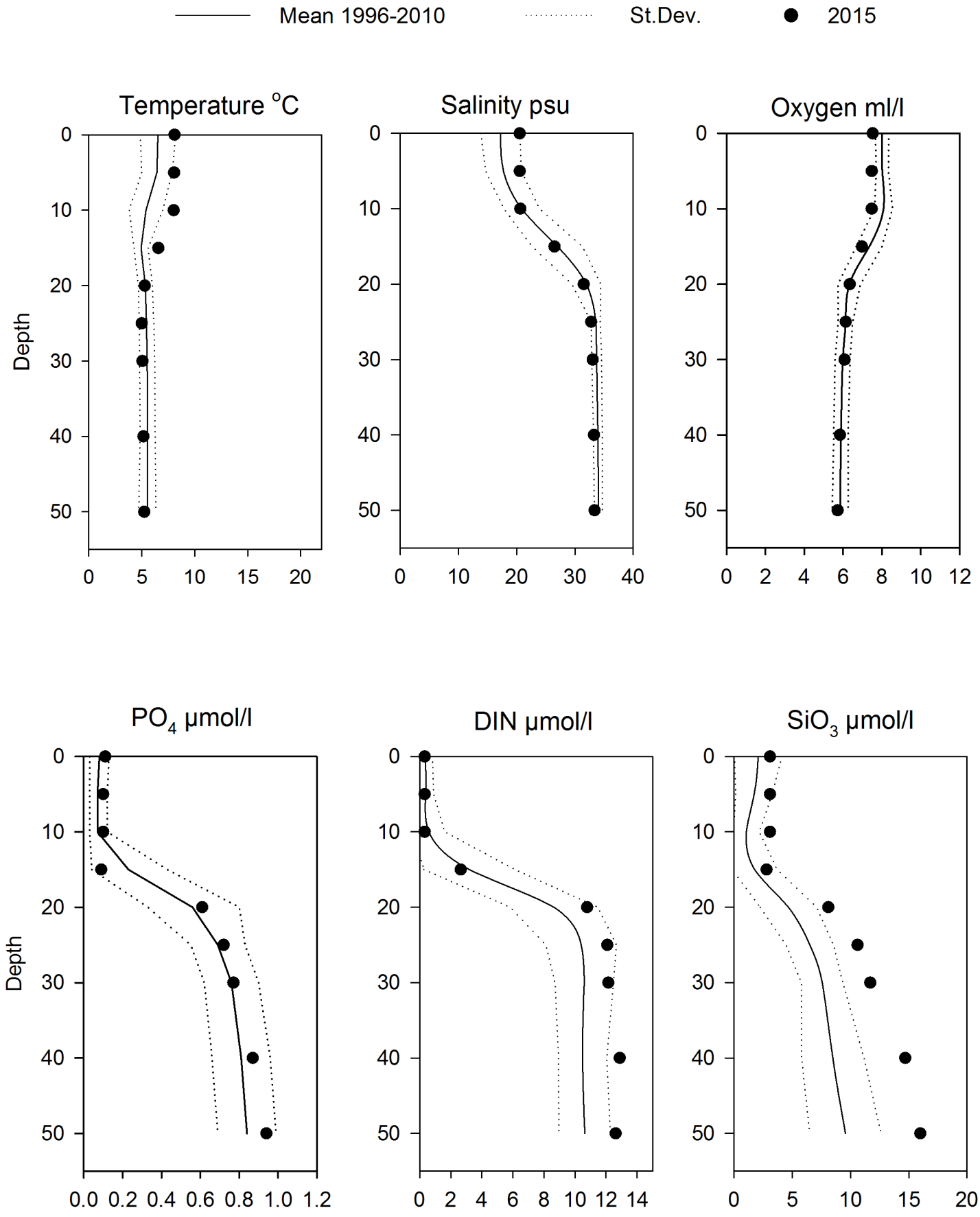
O_2 ml/l



O_2 ml/l



Vertical profiles Anholt E April

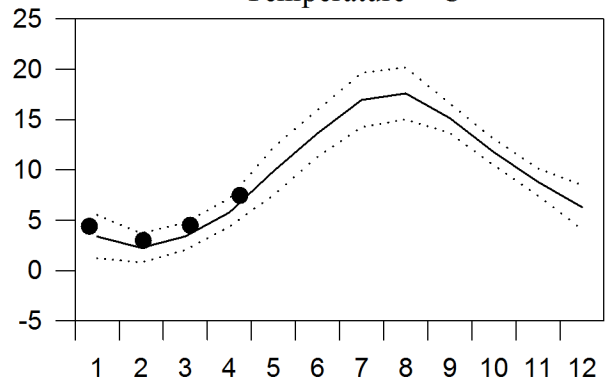


STATION W LANDSKRONA SURFACE WATER

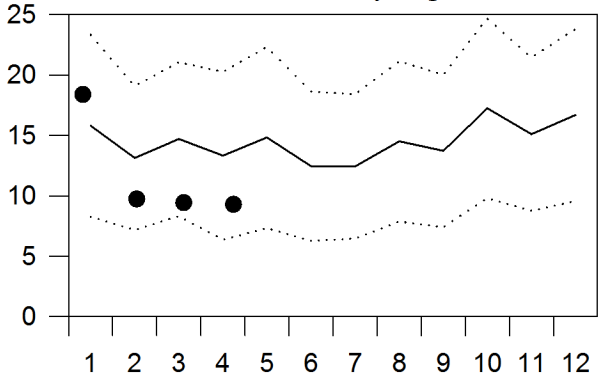
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

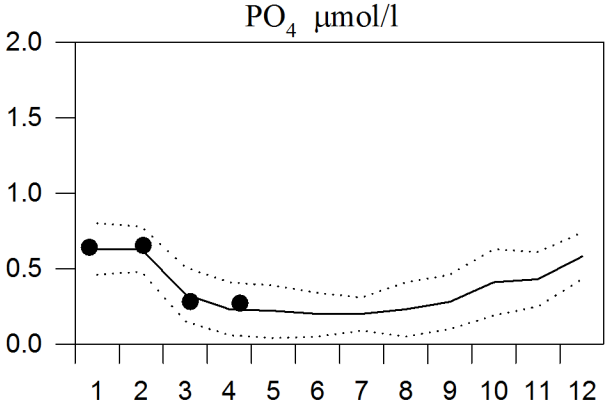
Temperature °C



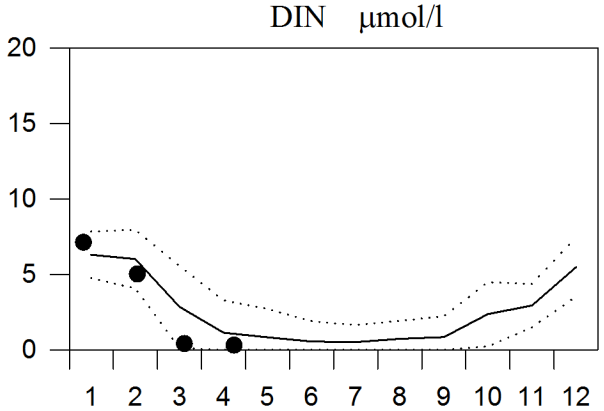
Salinity psu



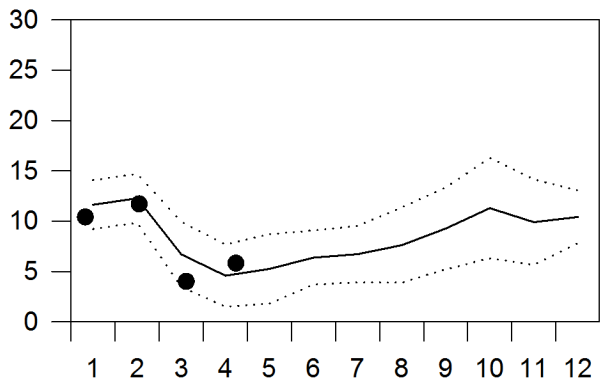
PO_4 µmol/l



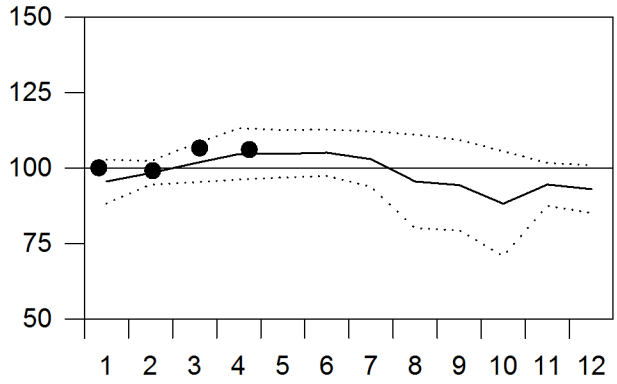
DIN µmol/l



SiO_3 µmol/l

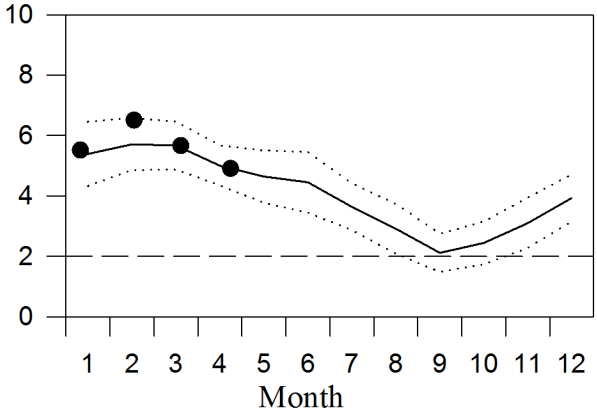


O_2 saturation %

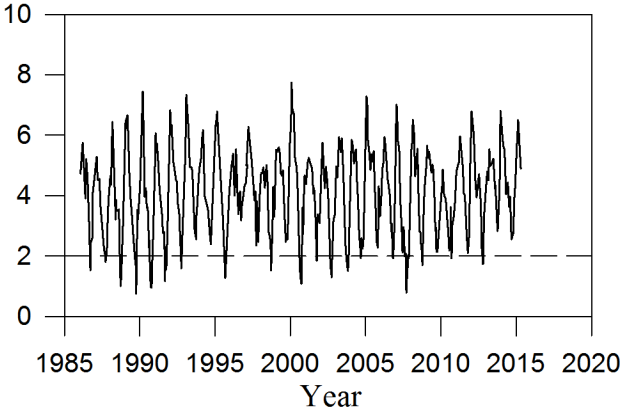


OXYGEN IN BOTTOM WATER (depth >40m)

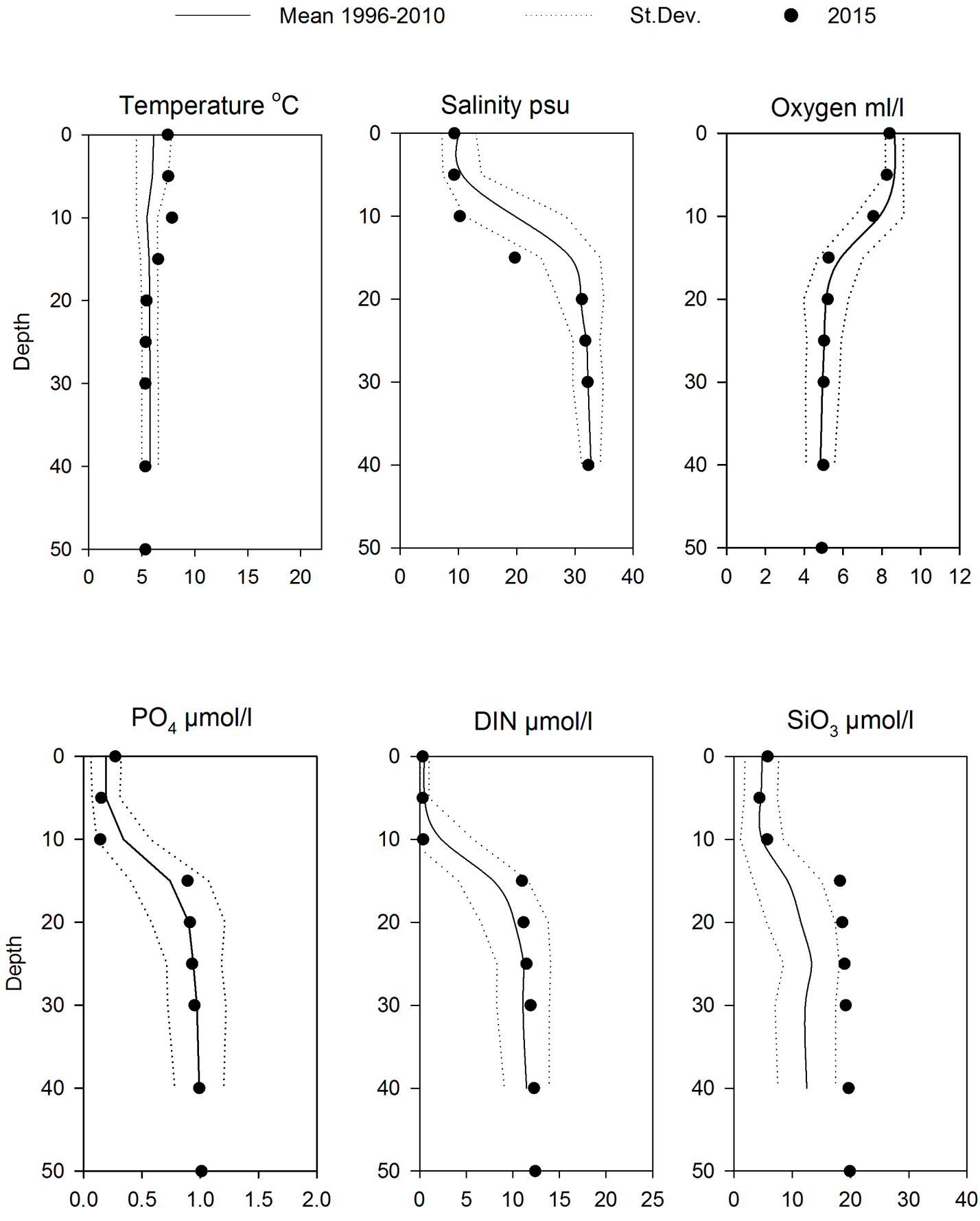
O_2 ml/l



O_2 ml/l



Vertical profiles W Landskrona April

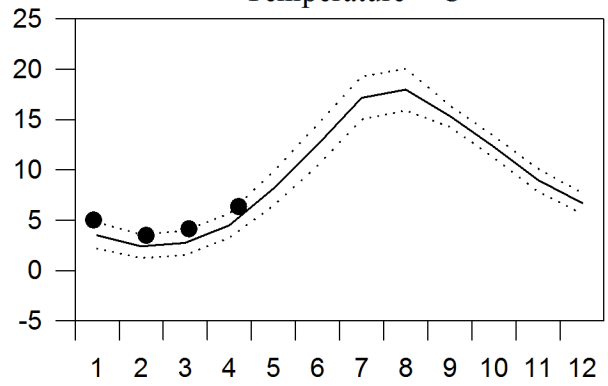


STATION BY1 SURFACE WATER

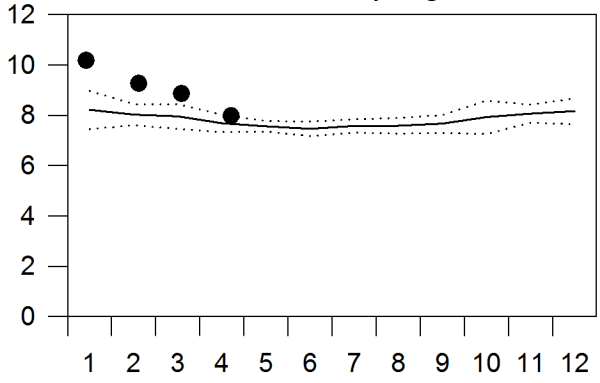
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

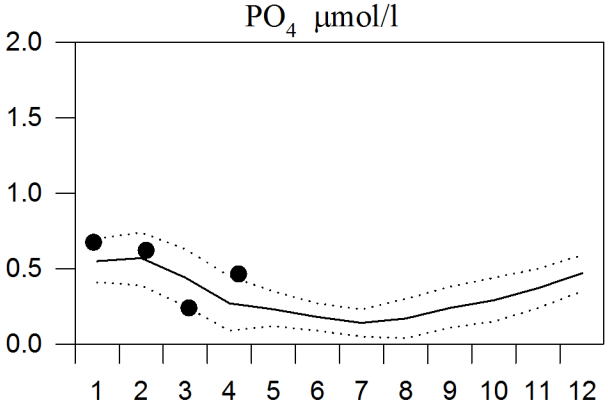
Temperature °C



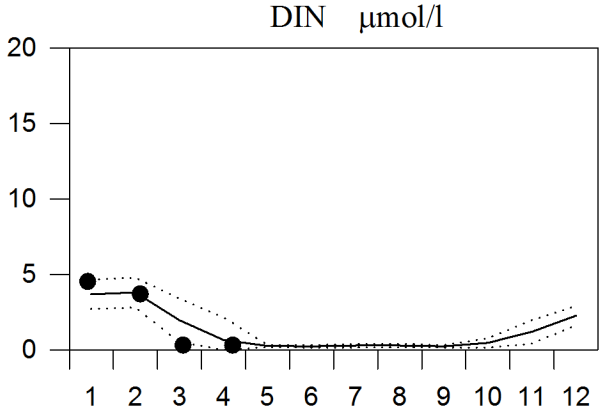
Salinity psu



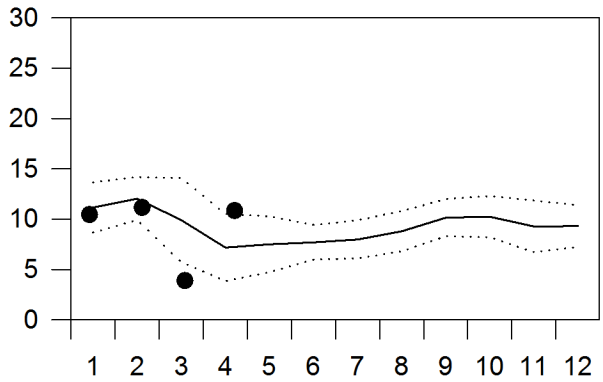
PO_4 µmol/l



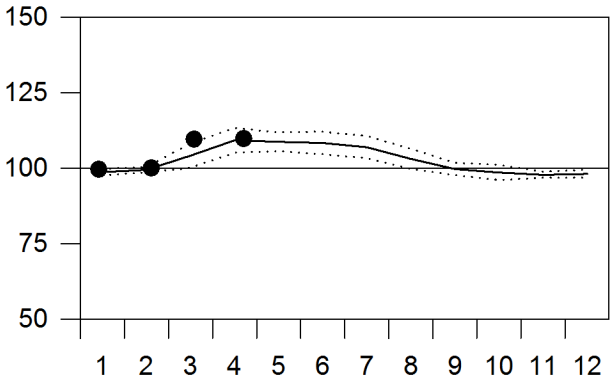
DIN µmol/l



SiO_3 µmol/l

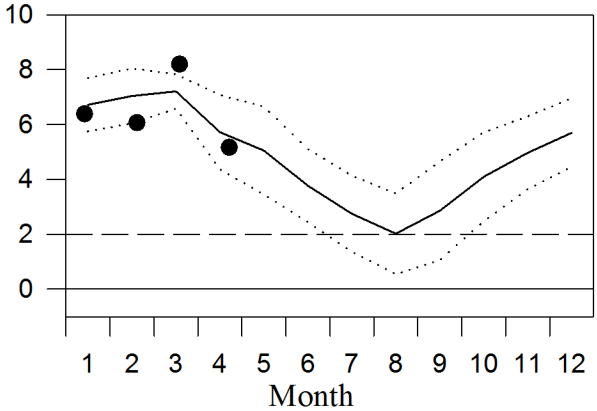


O_2 saturation %

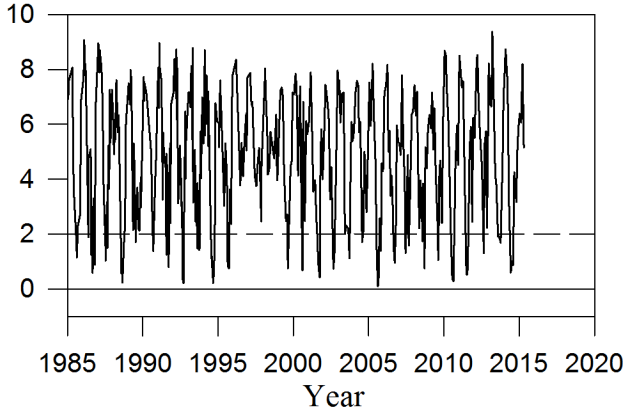


OXYGEN IN BOTTOM WATER (depth >40m)

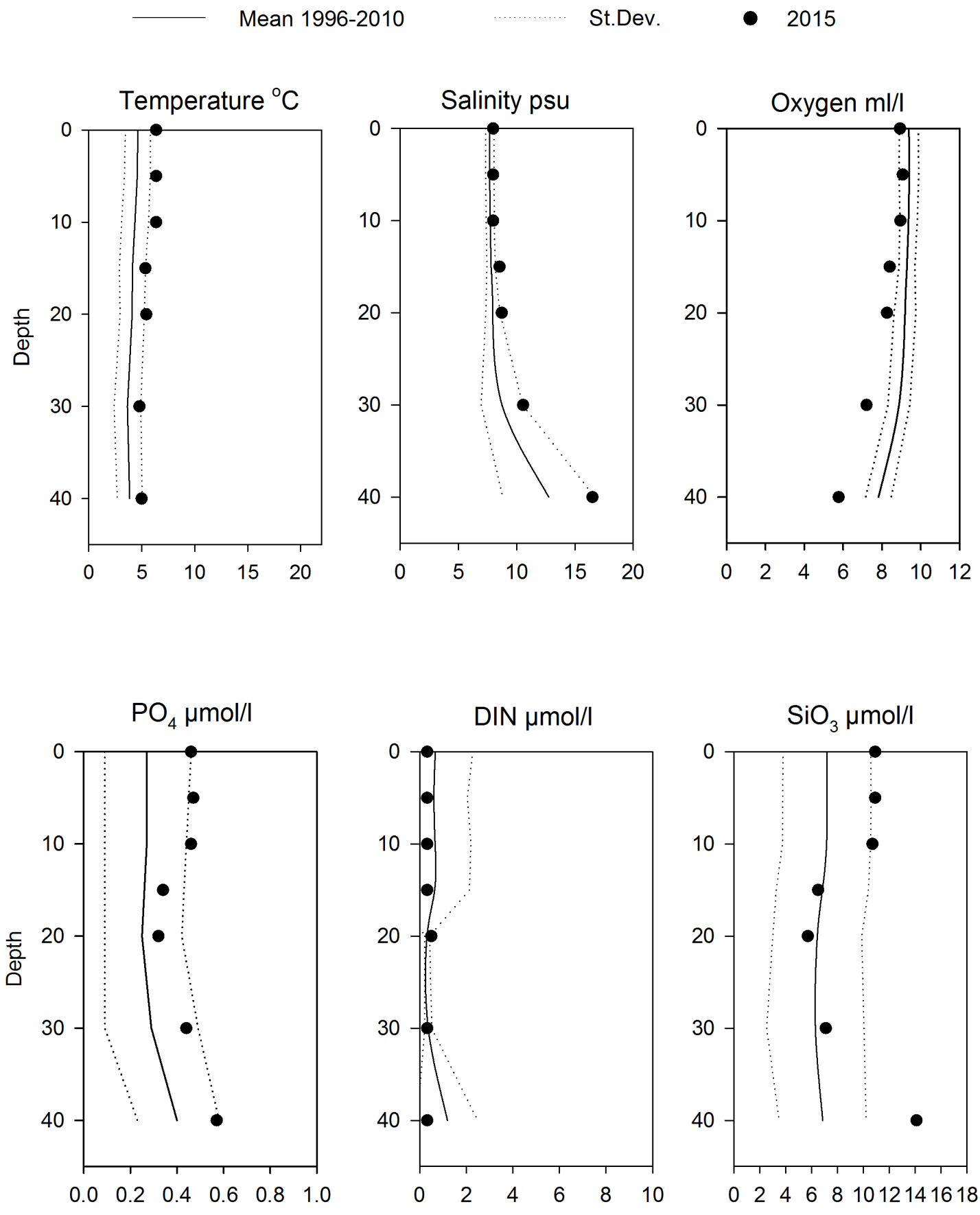
O_2 ml/l



O_2 ml/l



Vertical profiles BY1 April

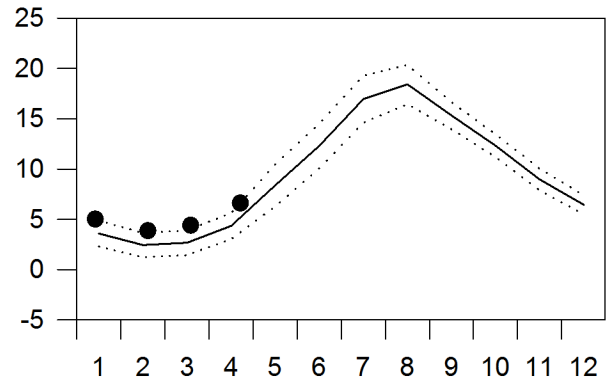


STATION BY2 SURFACE WATER

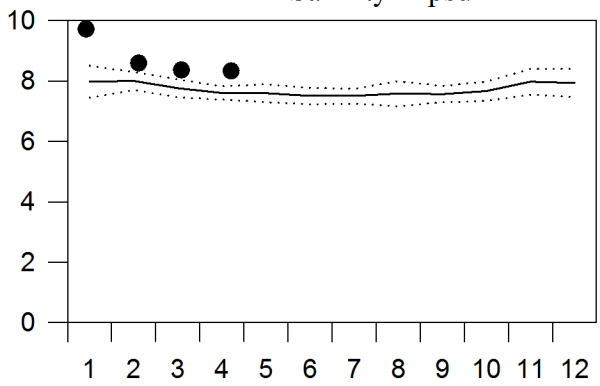
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

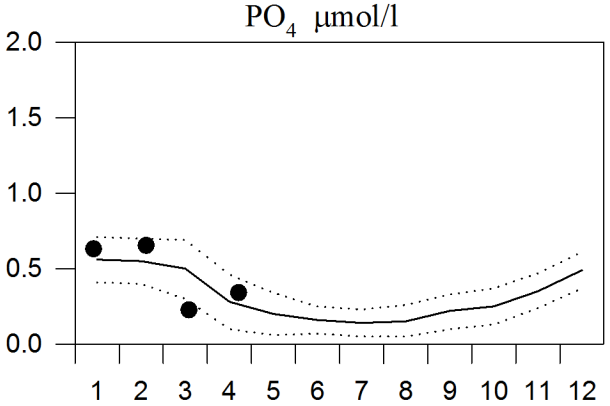
Temperature °C



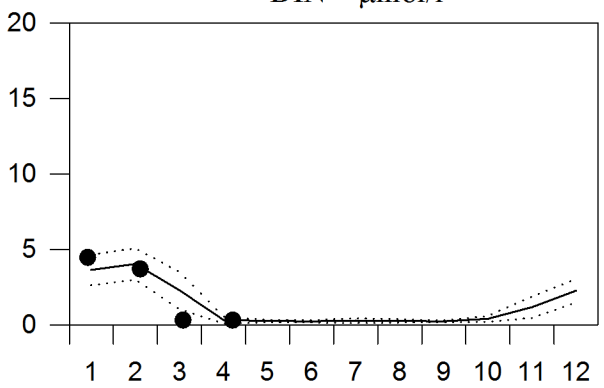
Salinity psu



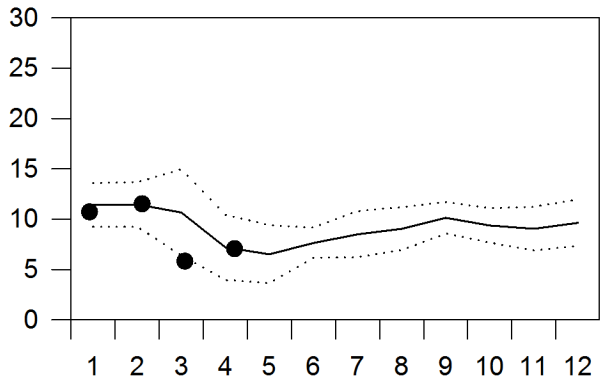
PO_4 µmol/l



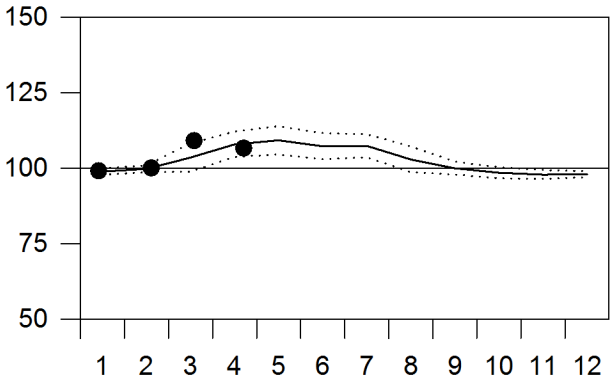
DIN µmol/l



SiO_3 µmol/l

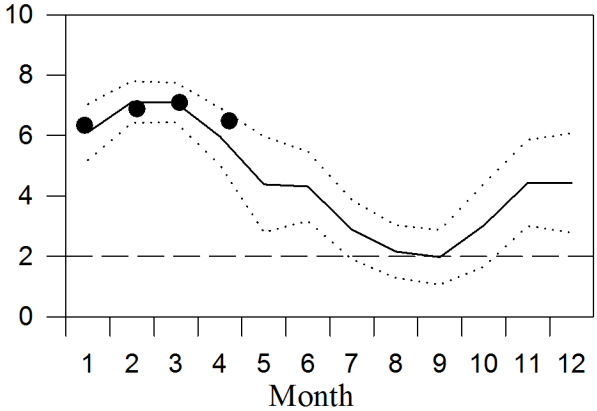


O_2 saturation %

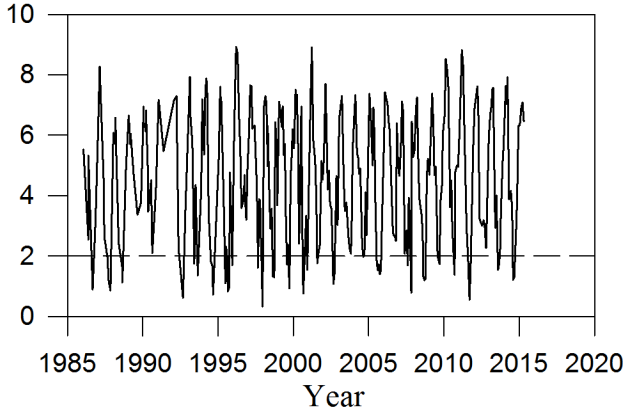


OXYGEN IN BOTTOM WATER (depth >40m)

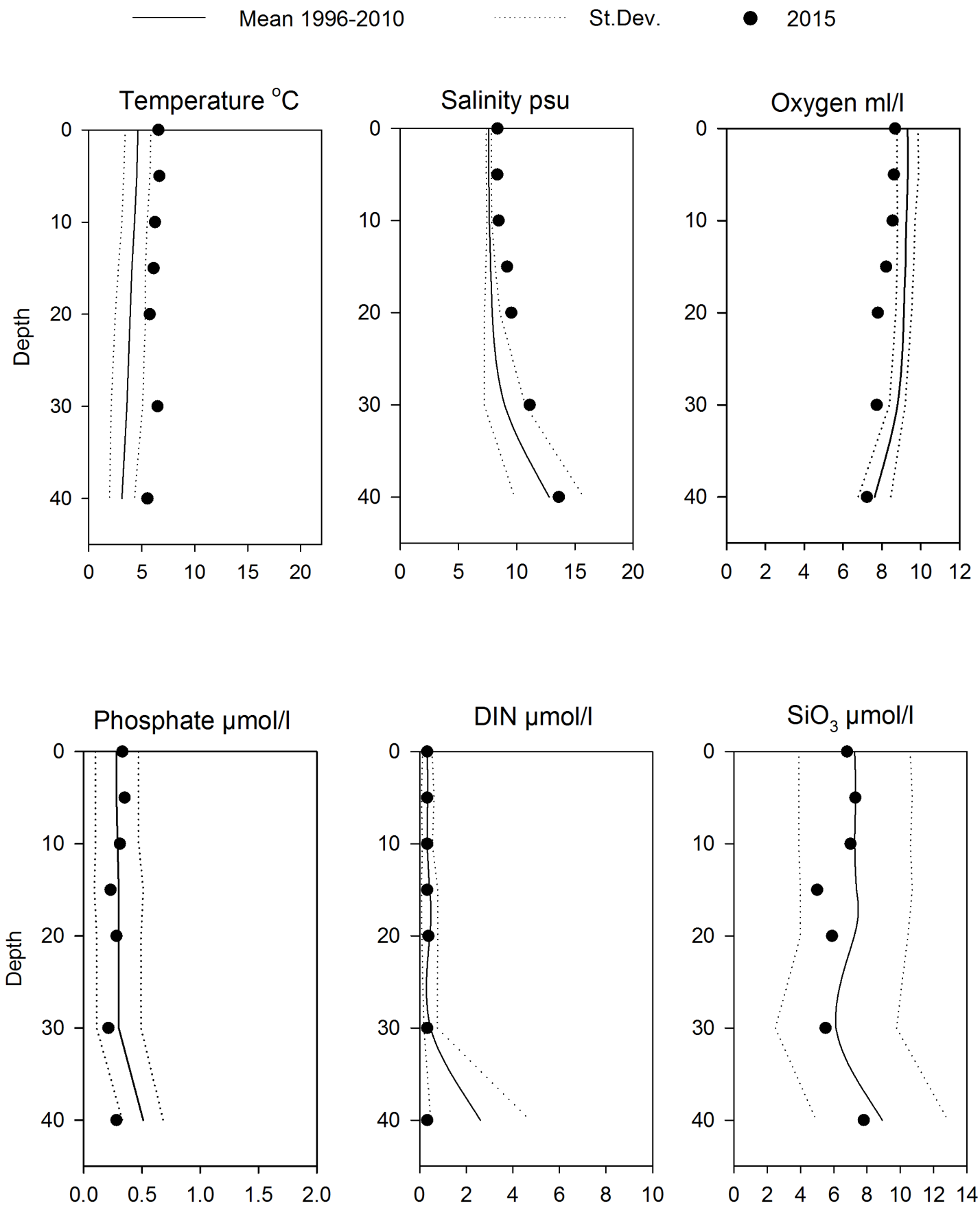
O_2 ml/l



O_2 ml/l



Vertical profiles BY2 April

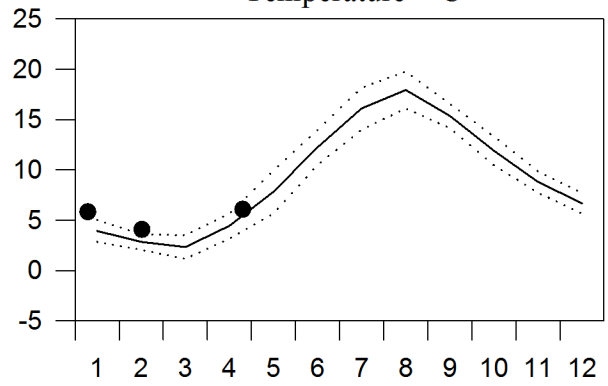


STATION HANÖBUKTEN SURFACE WATER

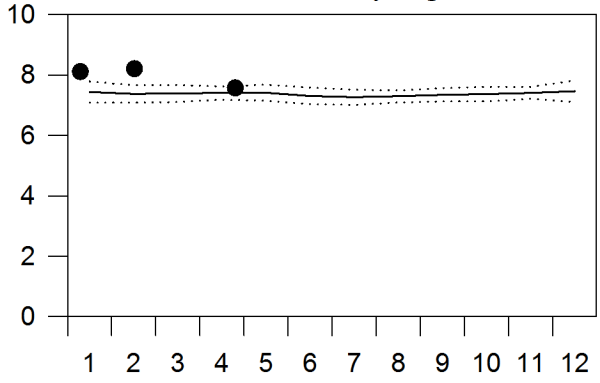
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

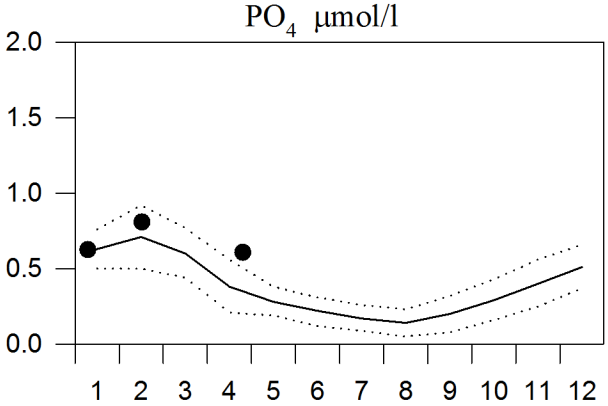
Temperature °C



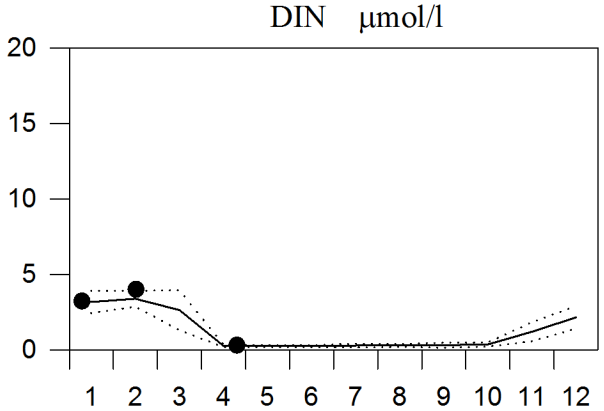
Salinity psu



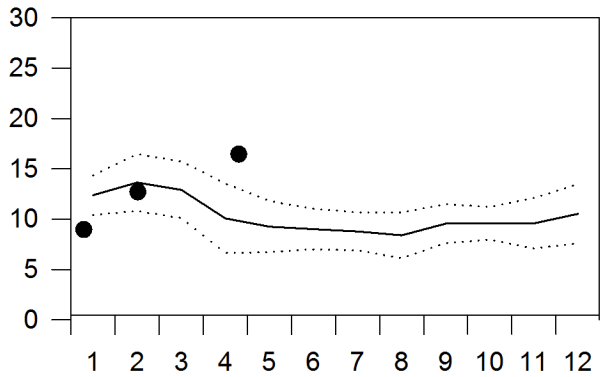
PO_4 µmol/l



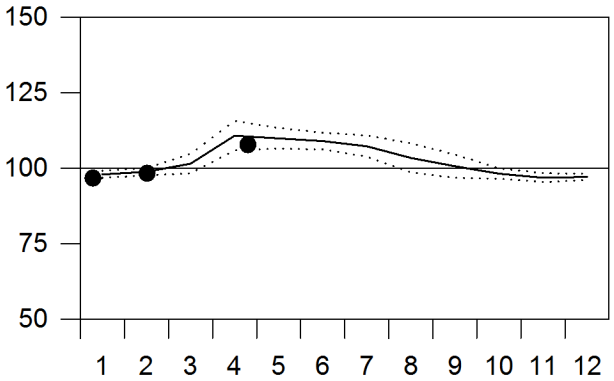
DIN µmol/l



SiO_3 µmol/l

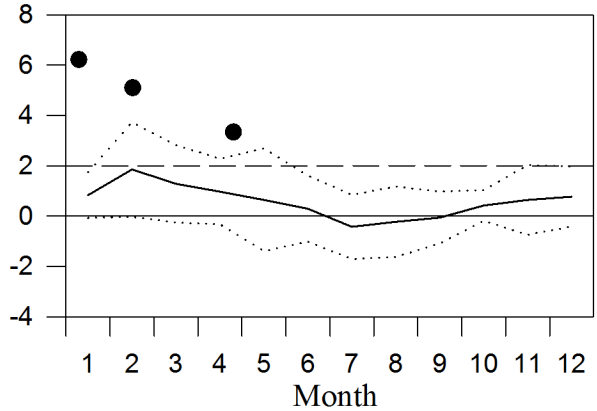


O_2 saturation %

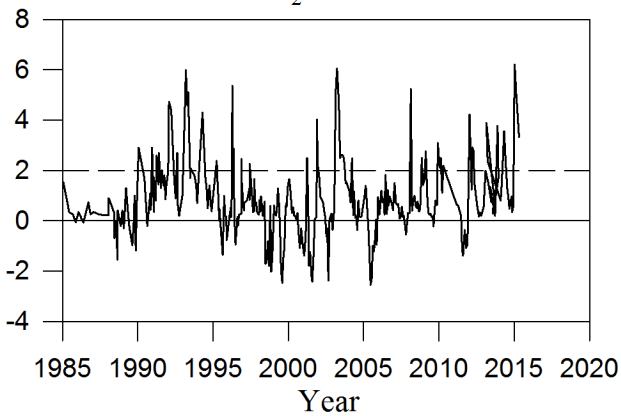


OXYGEN IN BOTTOM WATER (depth > 70m)

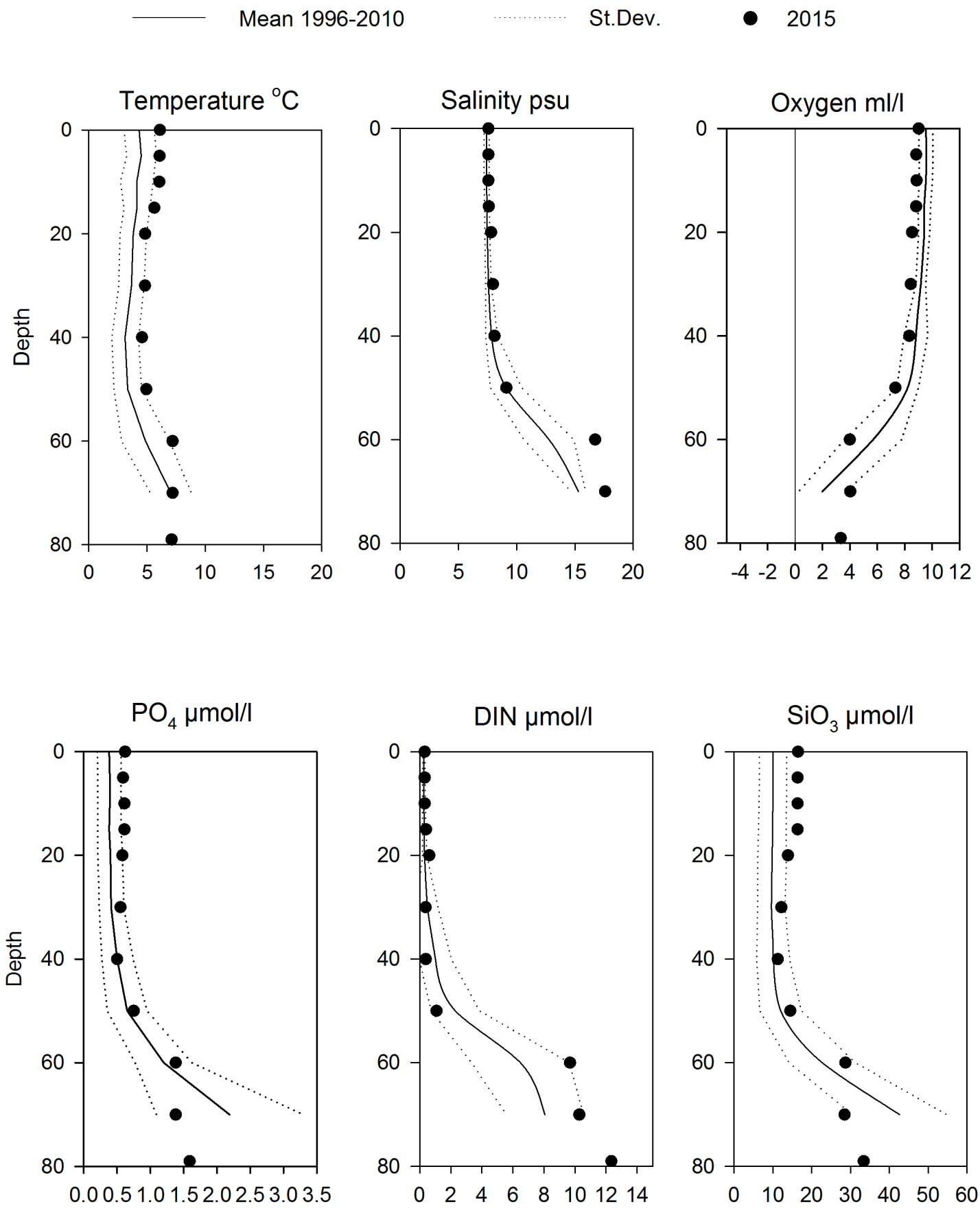
O_2 ml/l



O_2 ml/l

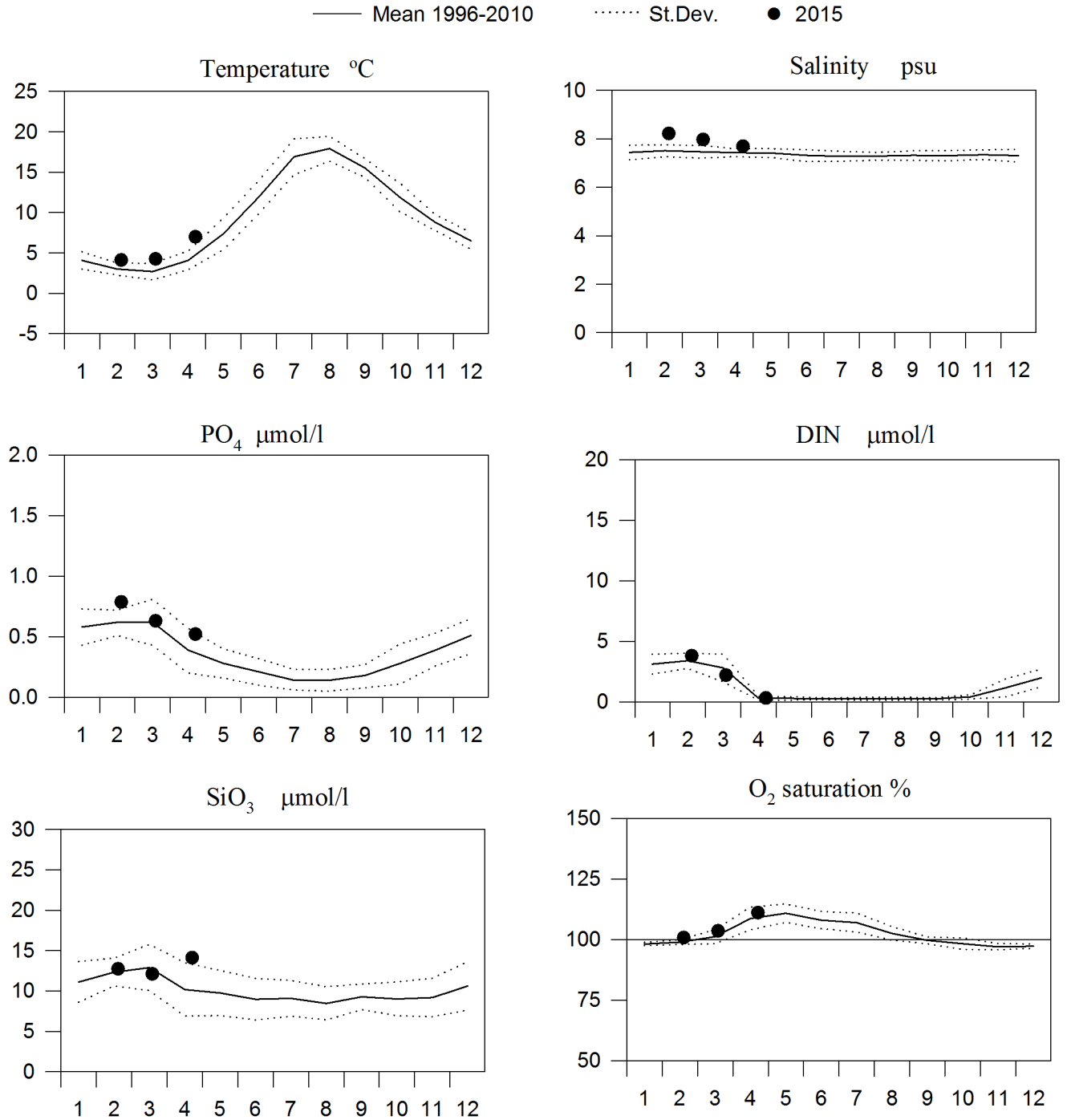


Vertical profiles Hanöbukten April

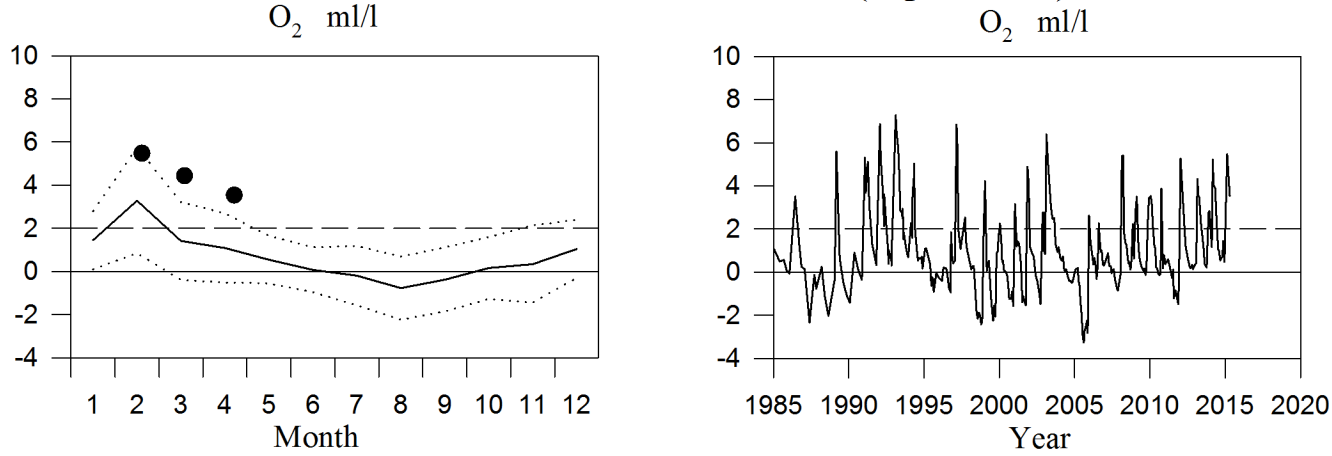


STATION BY4 SURFACE WATER

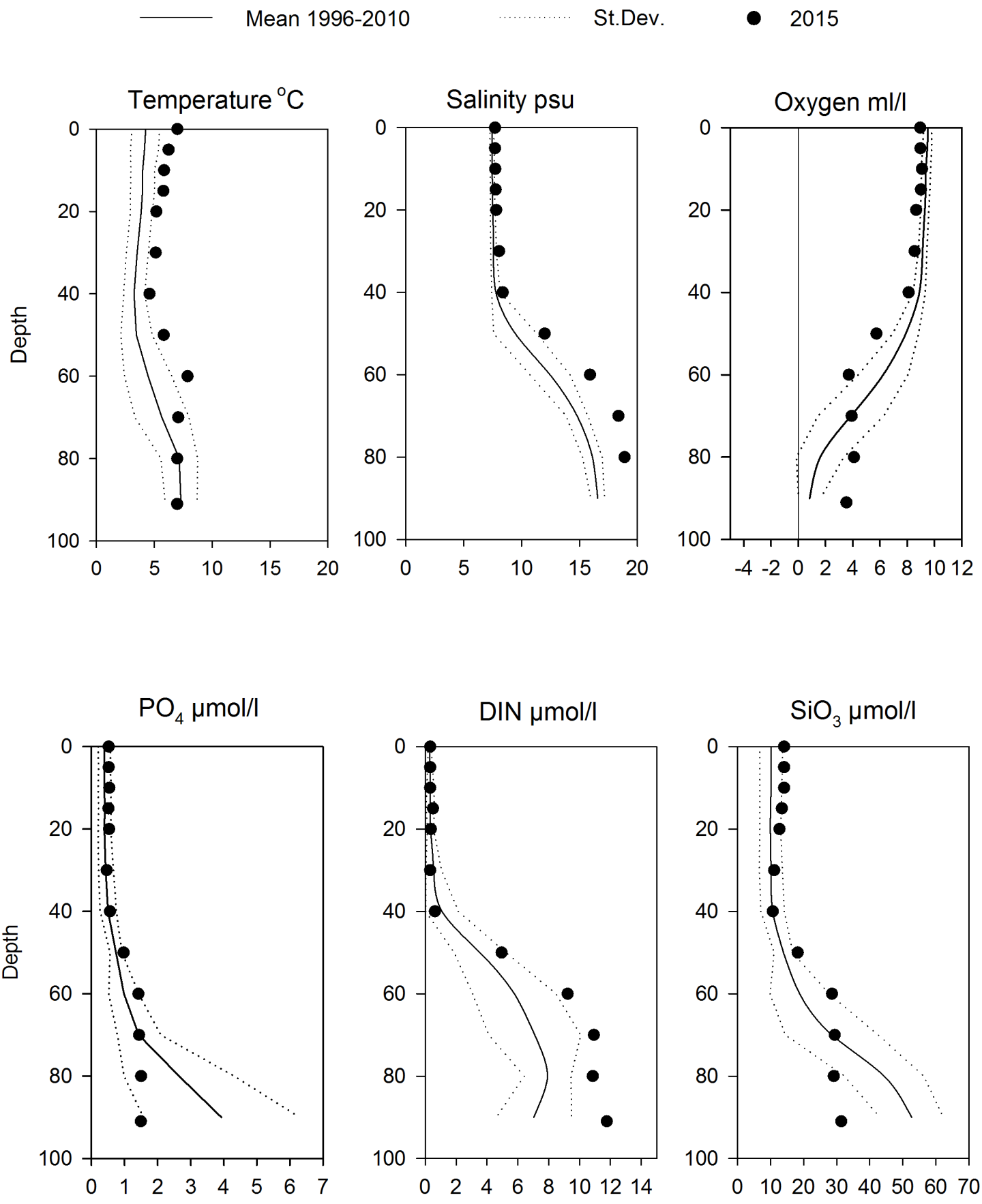
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >80m)



Vertical profiles BY4 April

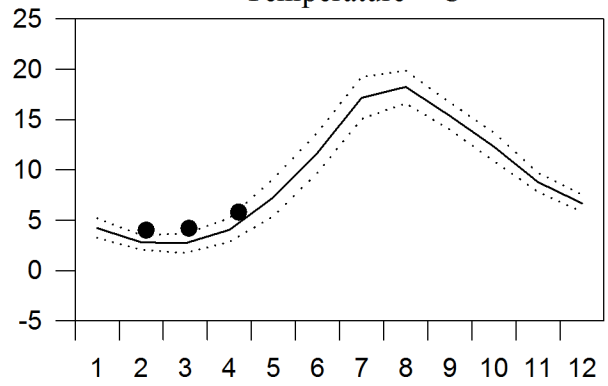


STATION BY5 SURFACE WATER

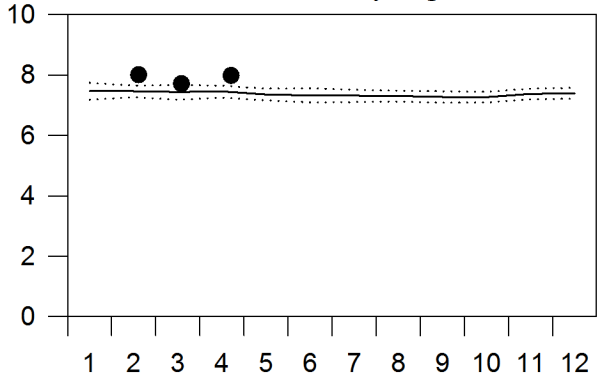
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

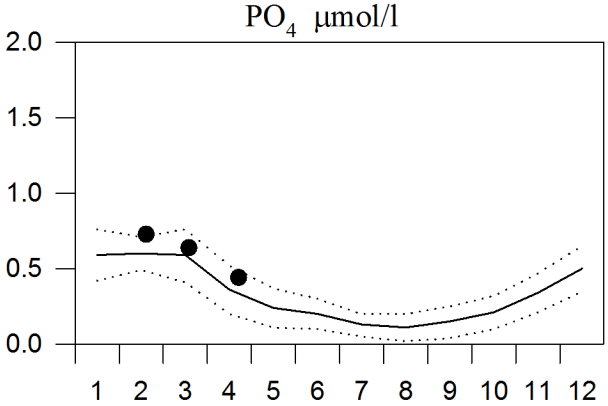
Temperature °C



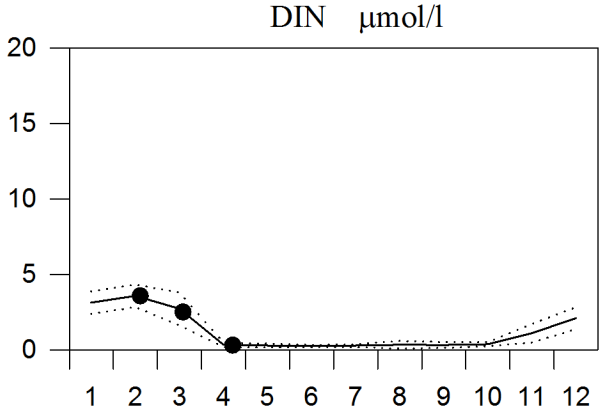
Salinity psu



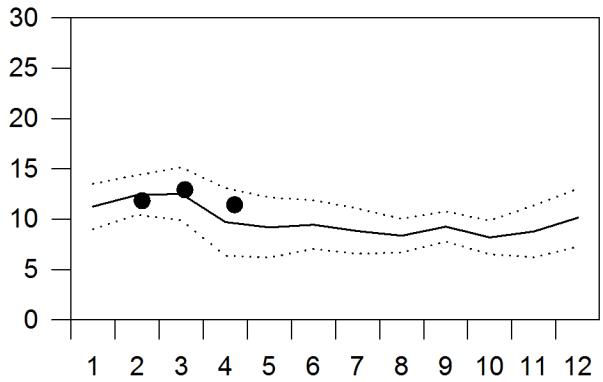
PO_4 µmol/l



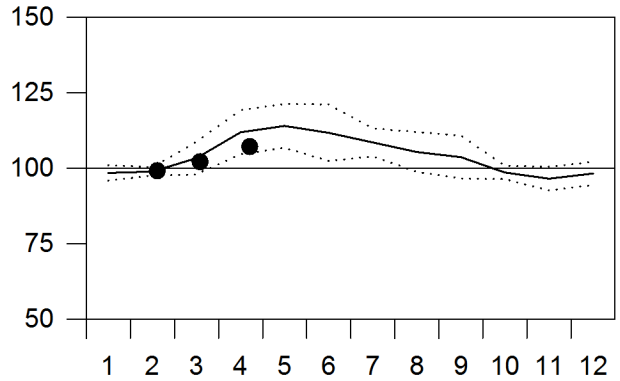
DIN µmol/l



SiO_3 µmol/l

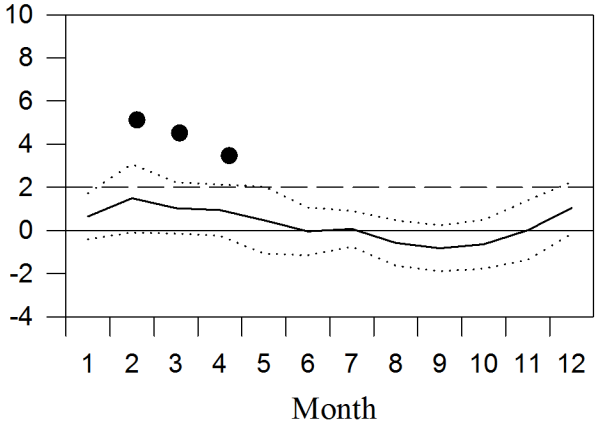


O_2 saturation %

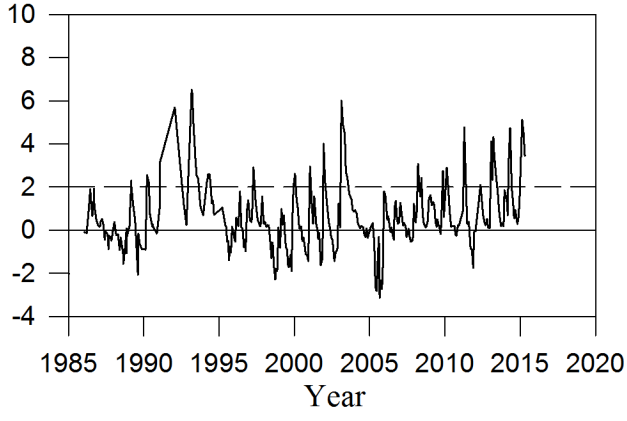


OXYGEN IN BOTTOM WATER (depth >80m)

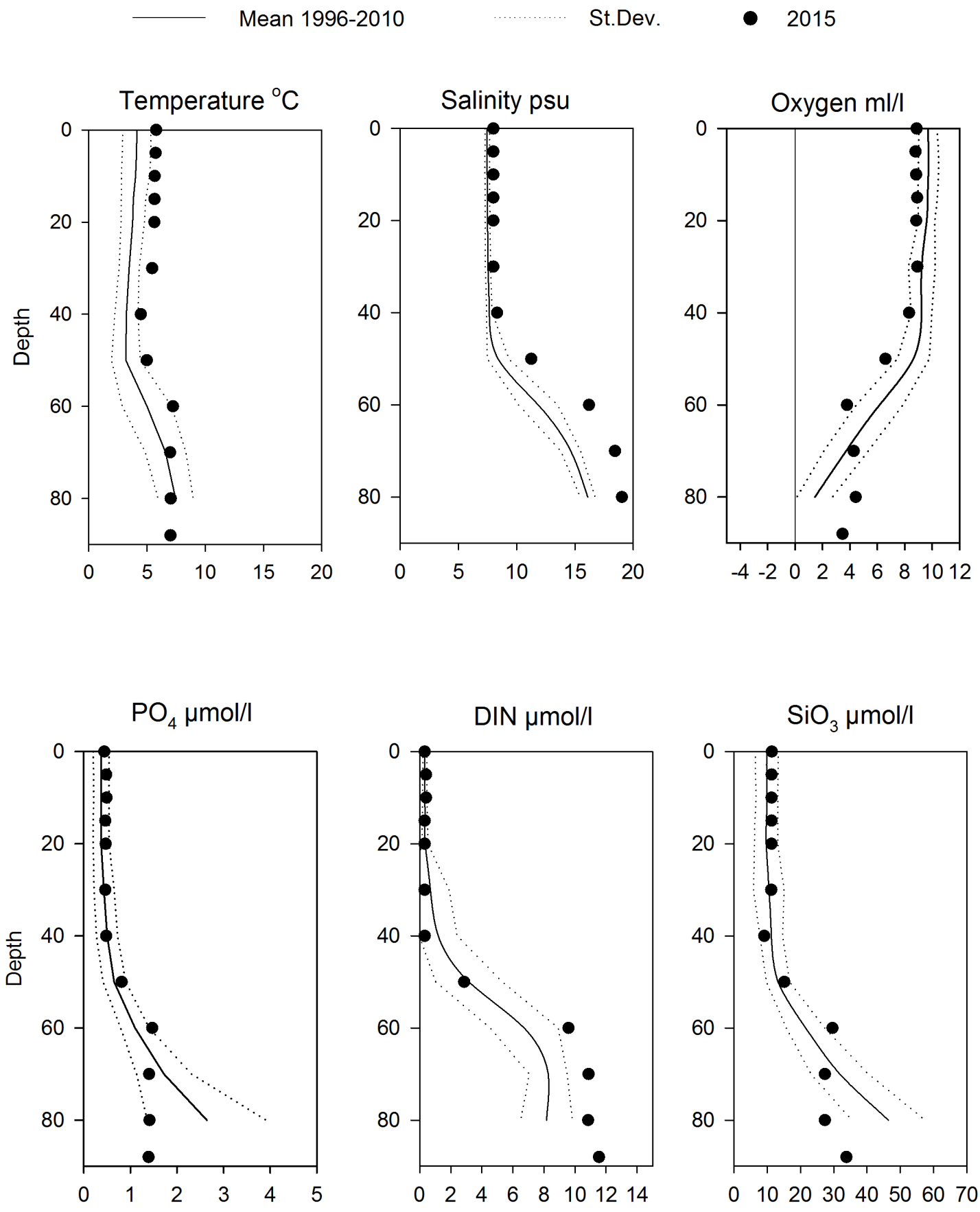
O_2 ml/l



O_2 ml/l



Vertical profiles BY5 April

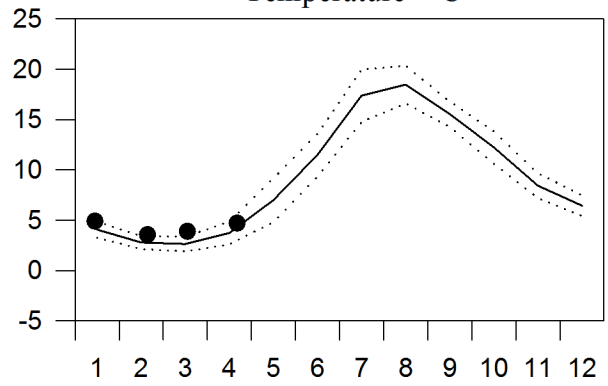


STATION BCS III-10 SURFACE WATER

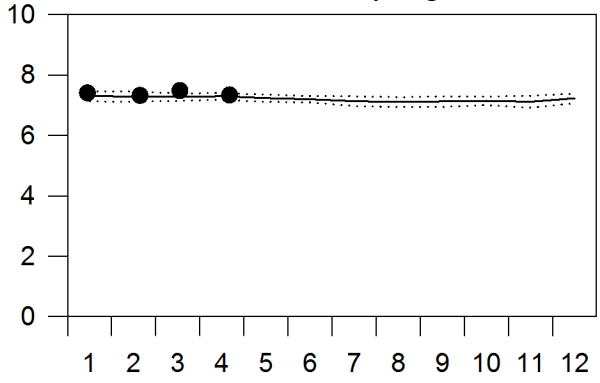
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

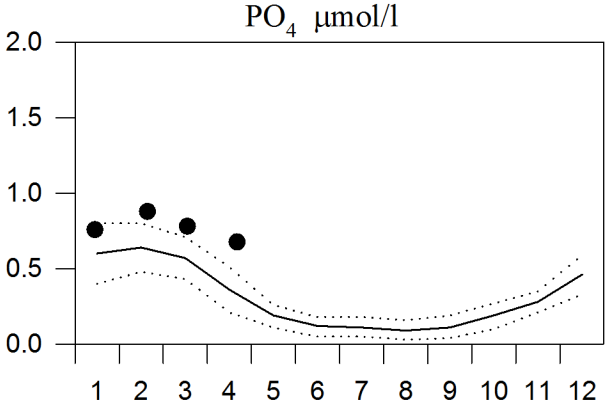
Temperature °C



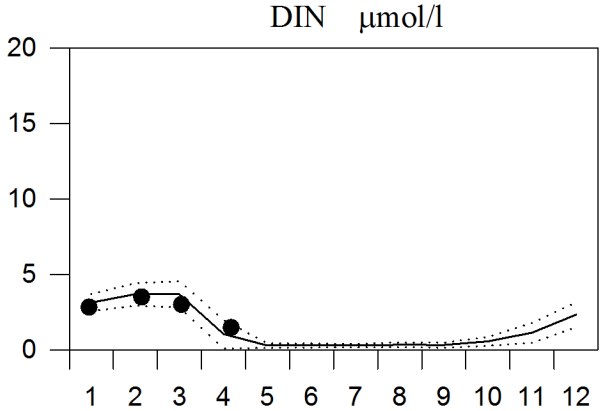
Salinity psu



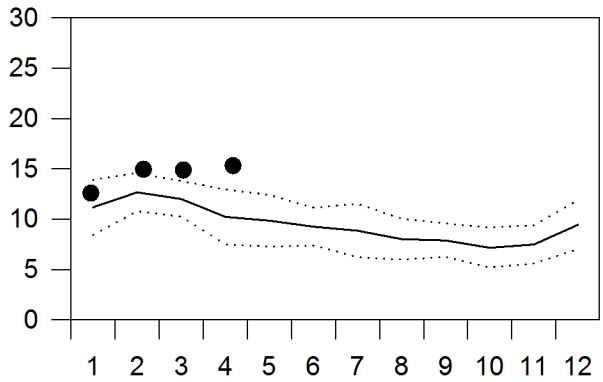
PO_4 µmol/l



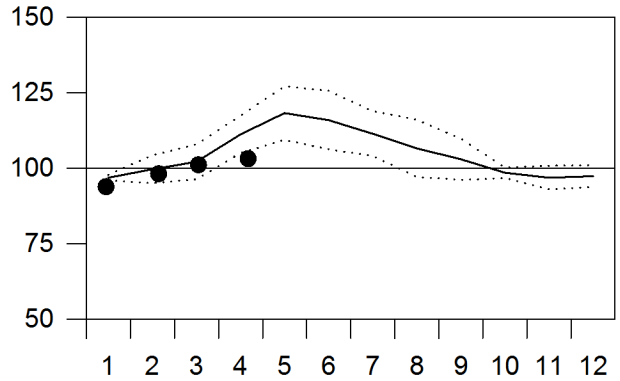
DIN µmol/l



SiO_3 µmol/l

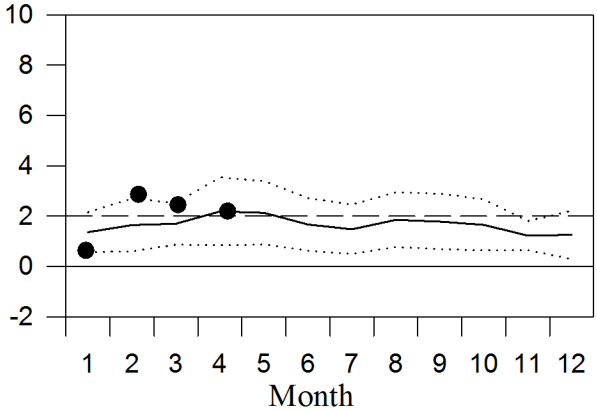


O_2 saturation %

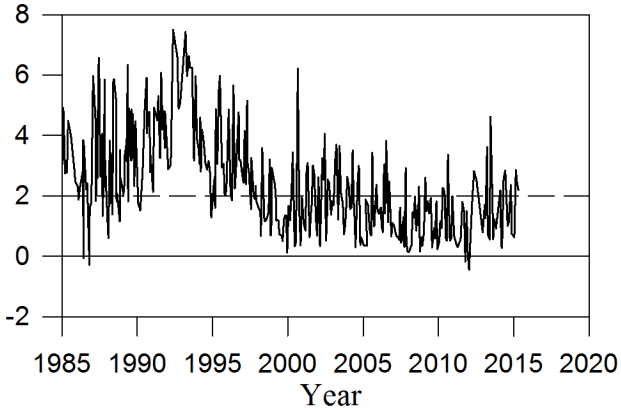


OXYGEN IN BOTTOM WATER (depth > 80m)

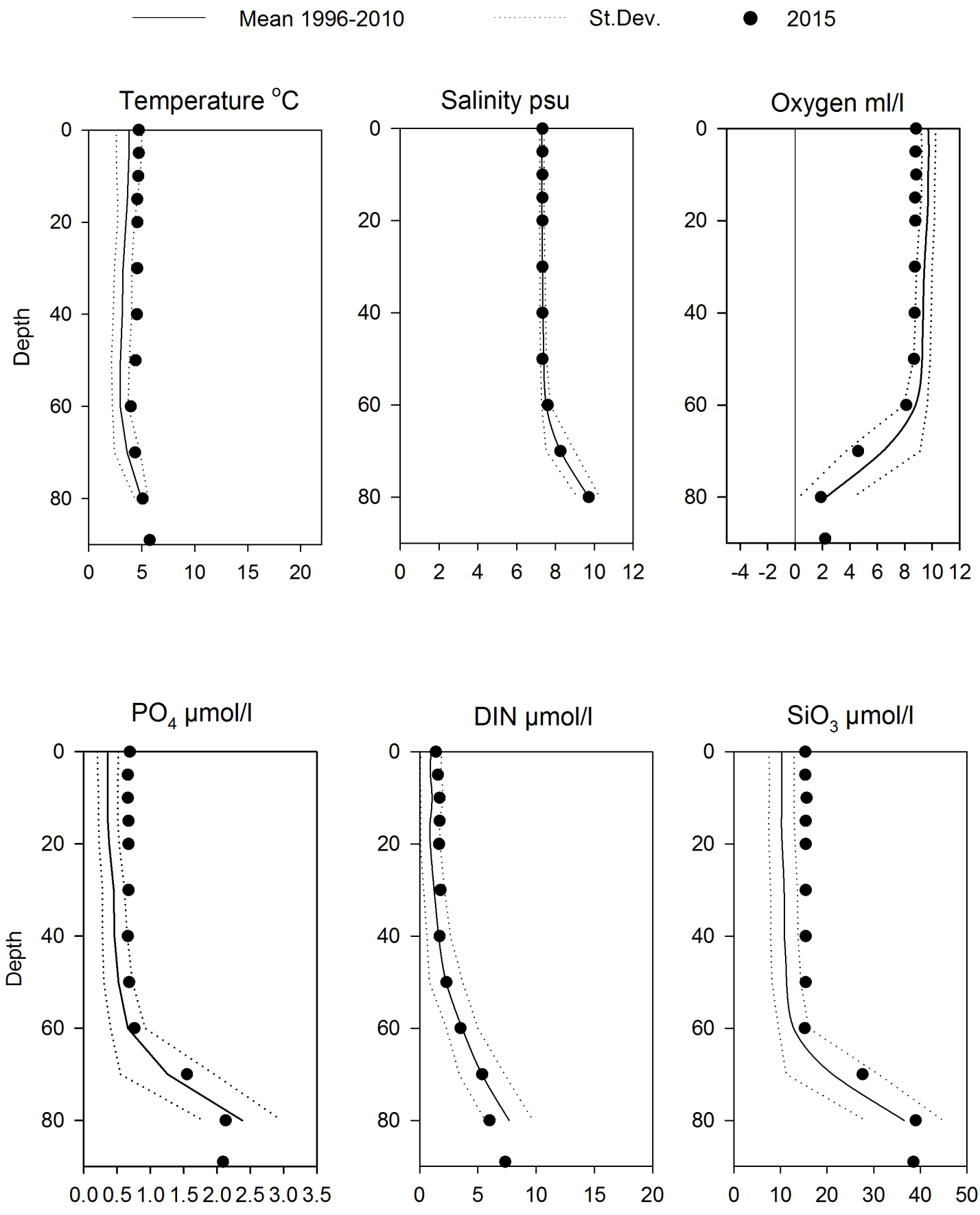
O_2 ml/l



O_2 ml/l

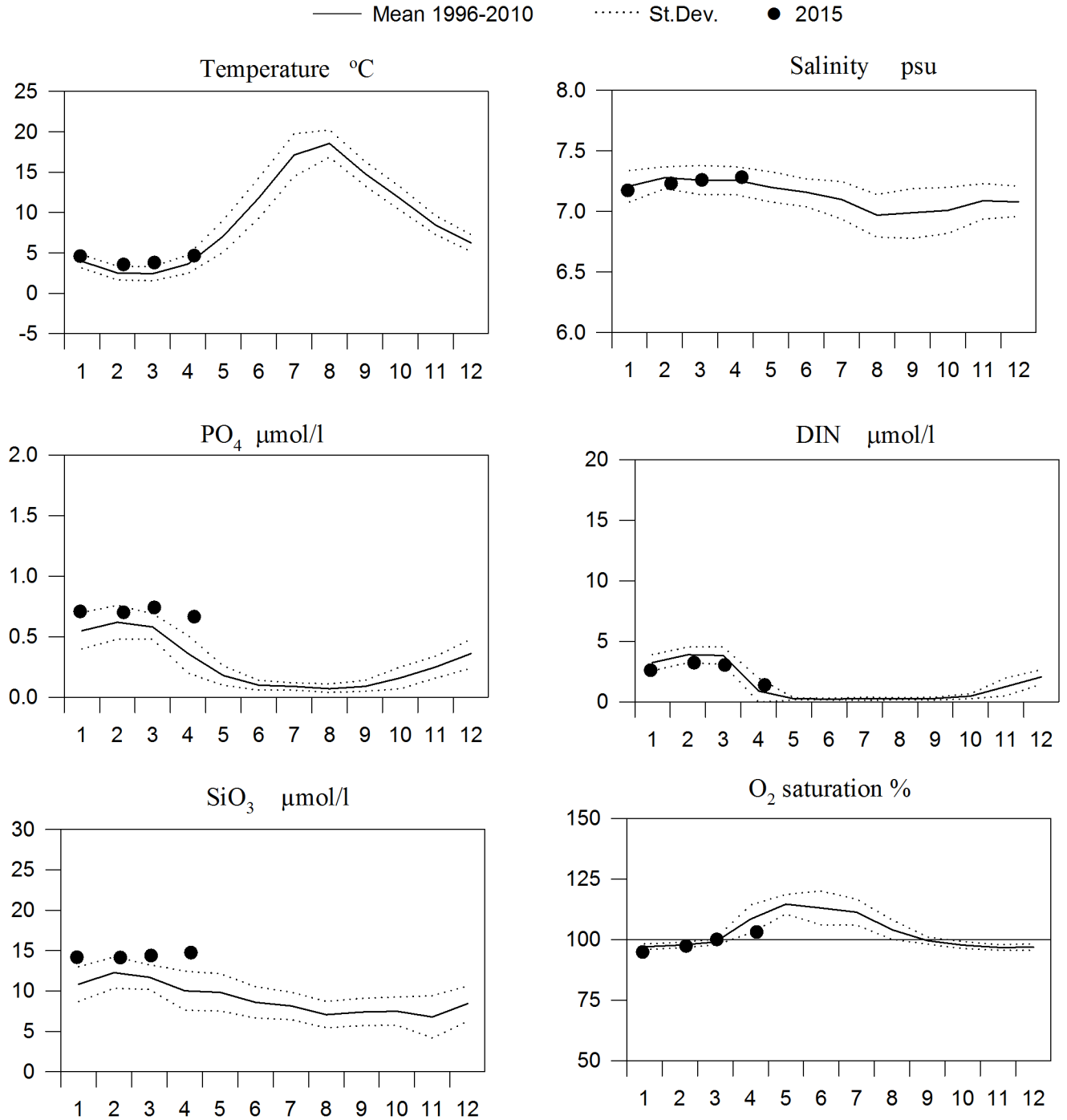


Vertical profiles BCS III-10 April

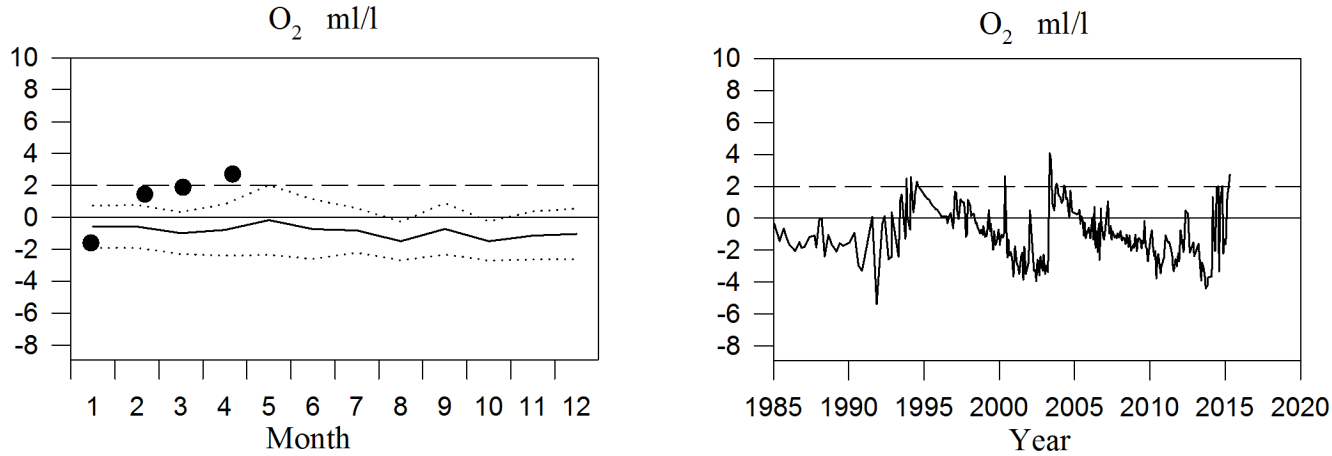


STATION BY10 SURFACE WATER

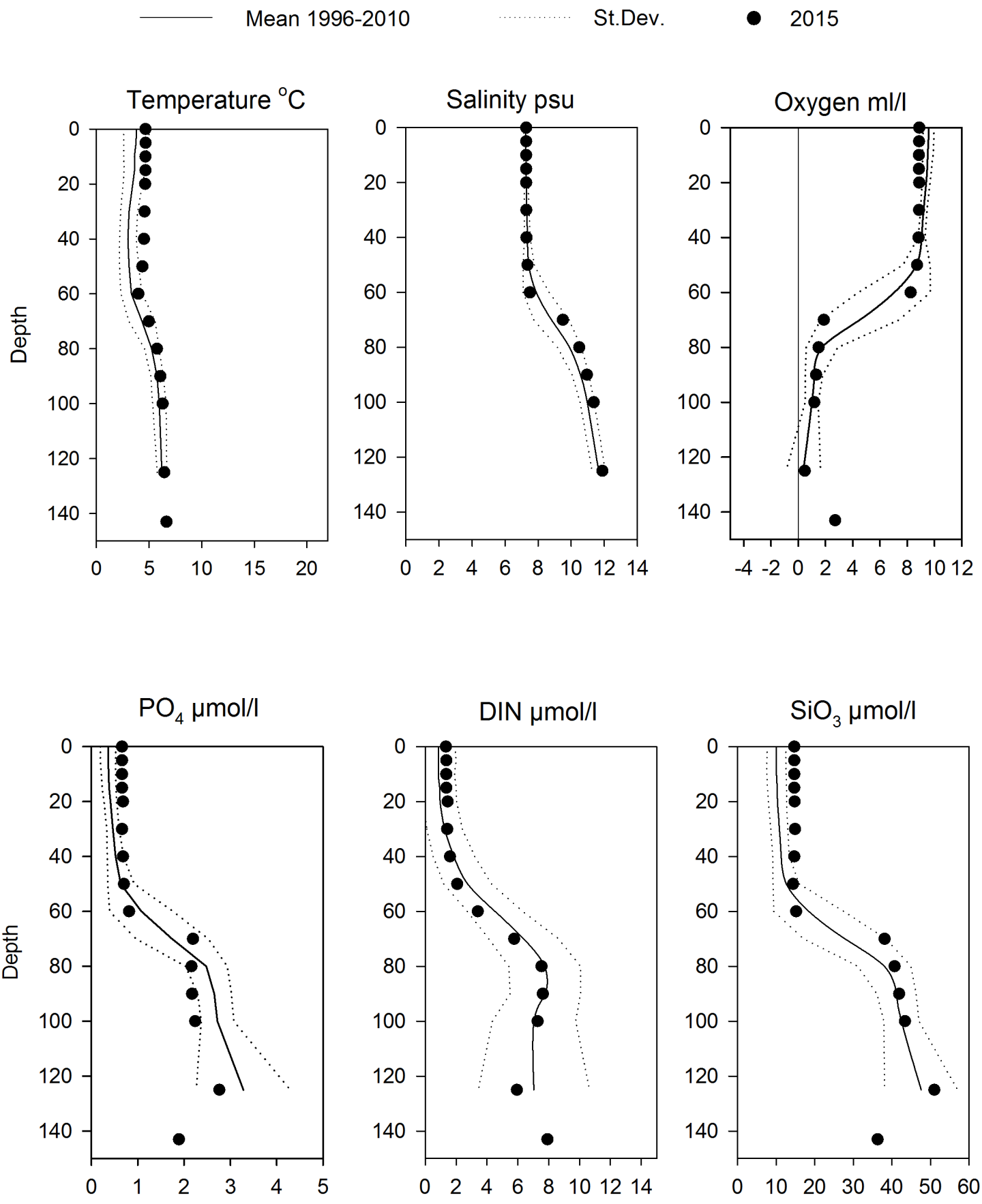
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >125m)



Vertical profiles BY10 April

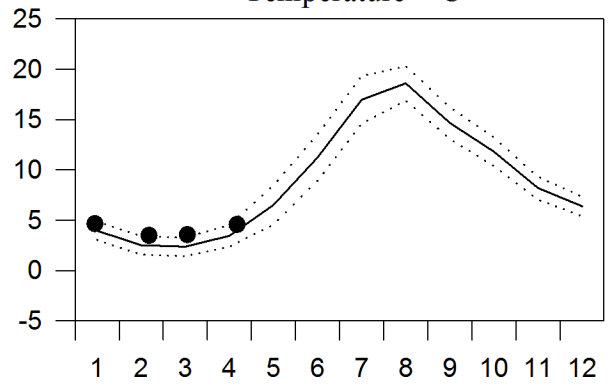


STATION BY15 SURFACE WATER

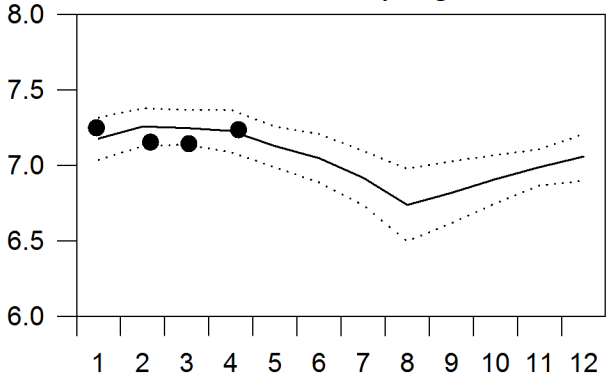
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

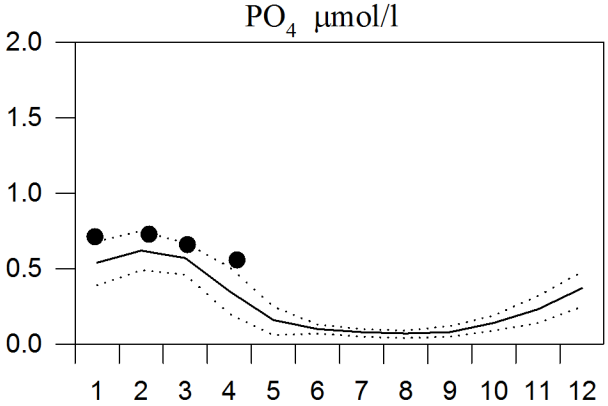
Temperature °C



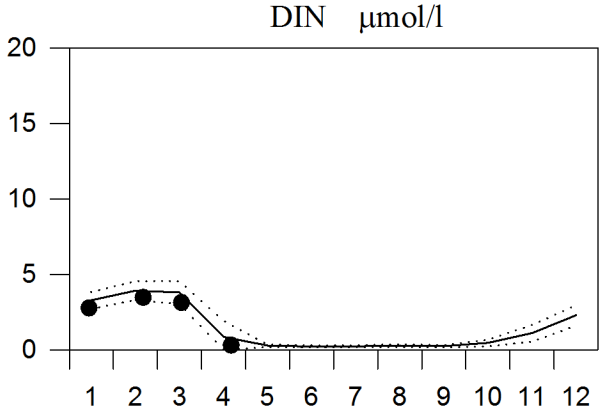
Salinity psu



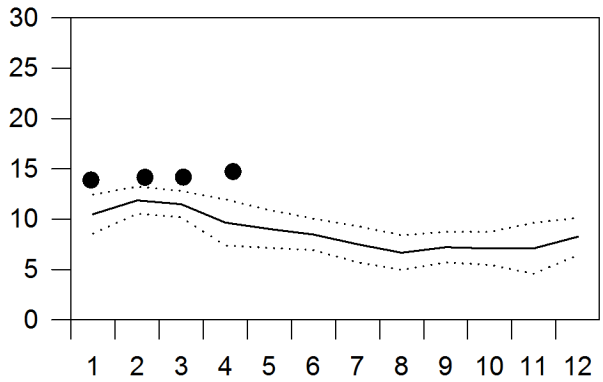
PO_4 µmol/l



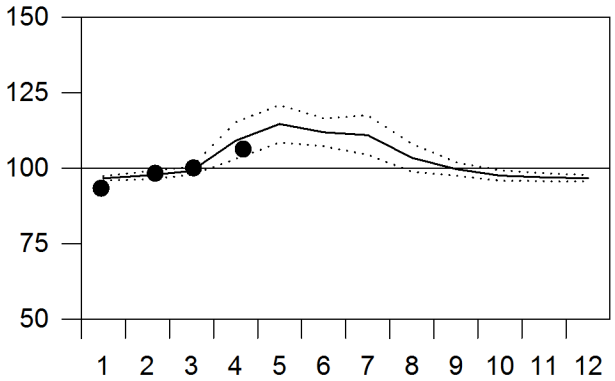
DIN µmol/l



SiO_3 µmol/l

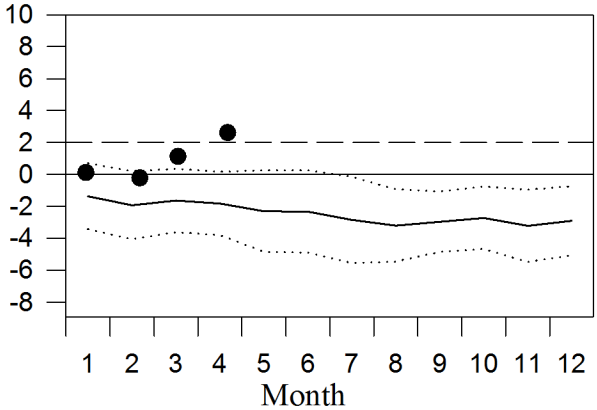


O_2 saturation %

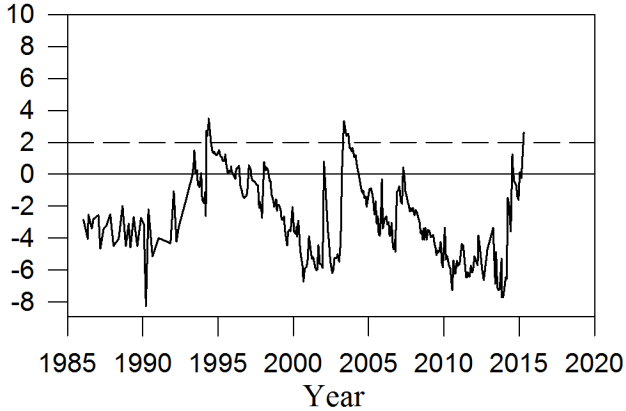


OXYGEN IN BOTTOM WATER (depth >225m)

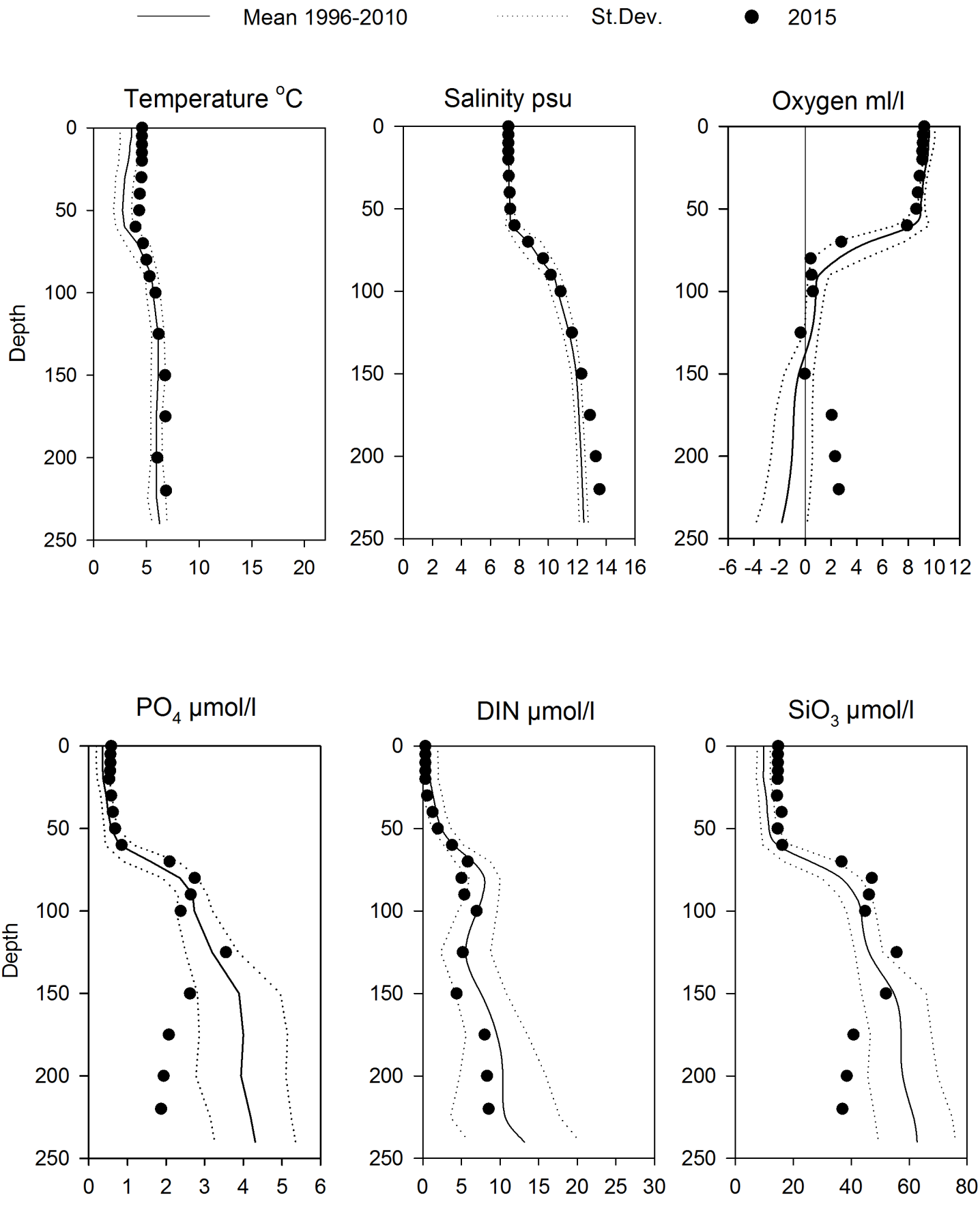
O_2 ml/l



O_2 ml/l



Vertical profiles BY15 April

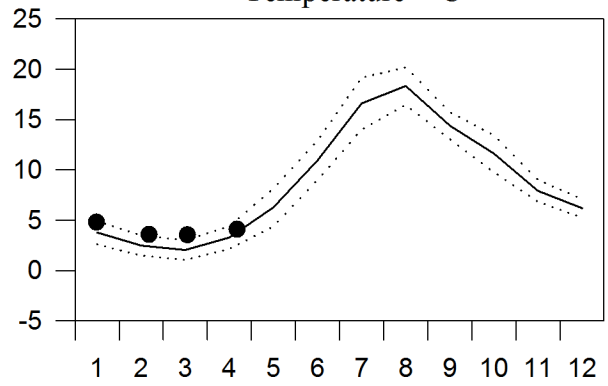


STATION BY20 SURFACE WATER

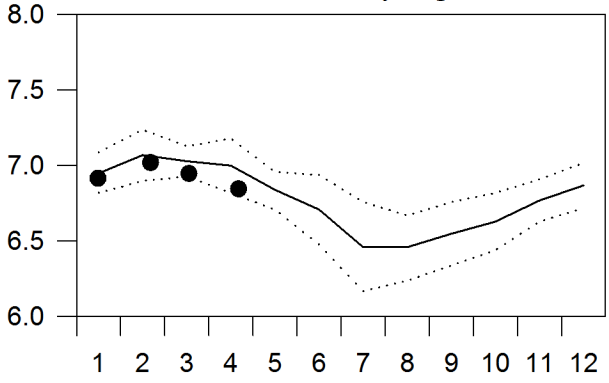
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

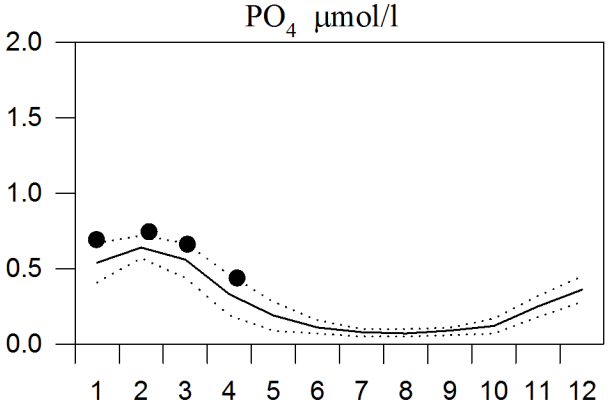
Temperature °C



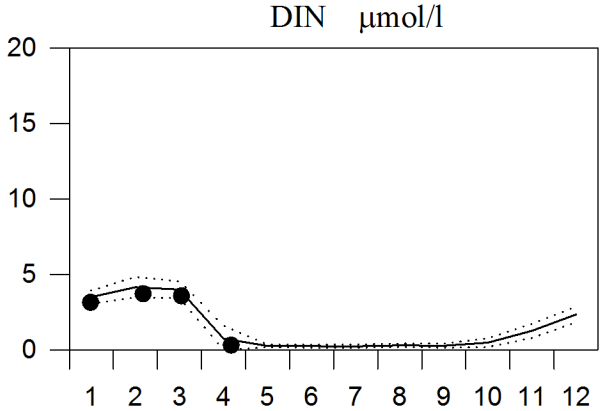
Salinity psu



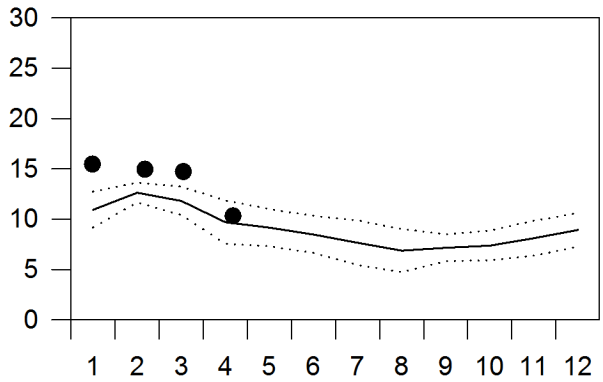
PO_4 µmol/l



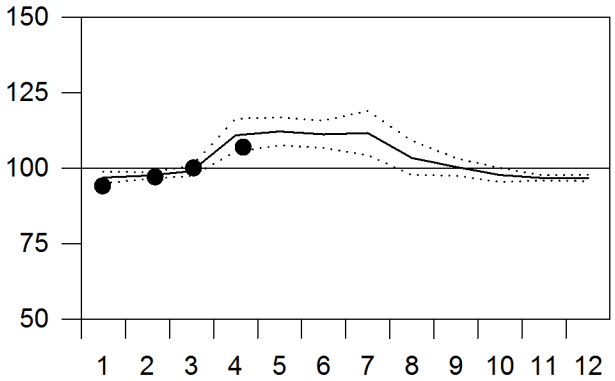
DIN µmol/l



SiO_3 µmol/l

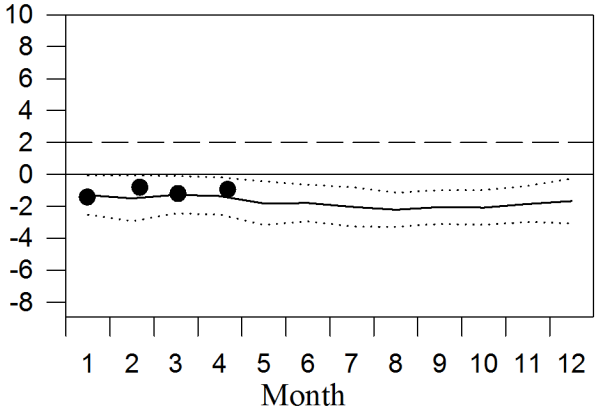


O_2 saturation %

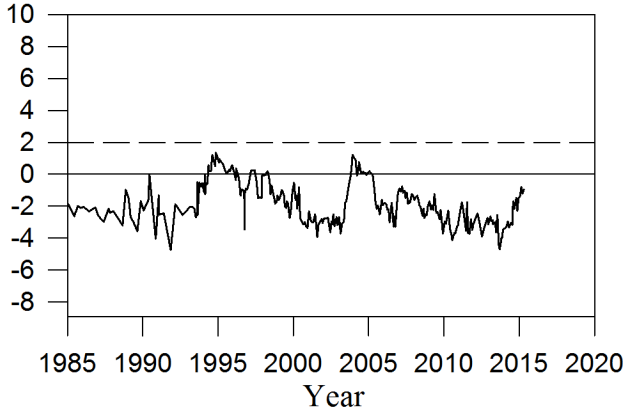


OXYGEN IN BOTTOM WATER (depth >175m)

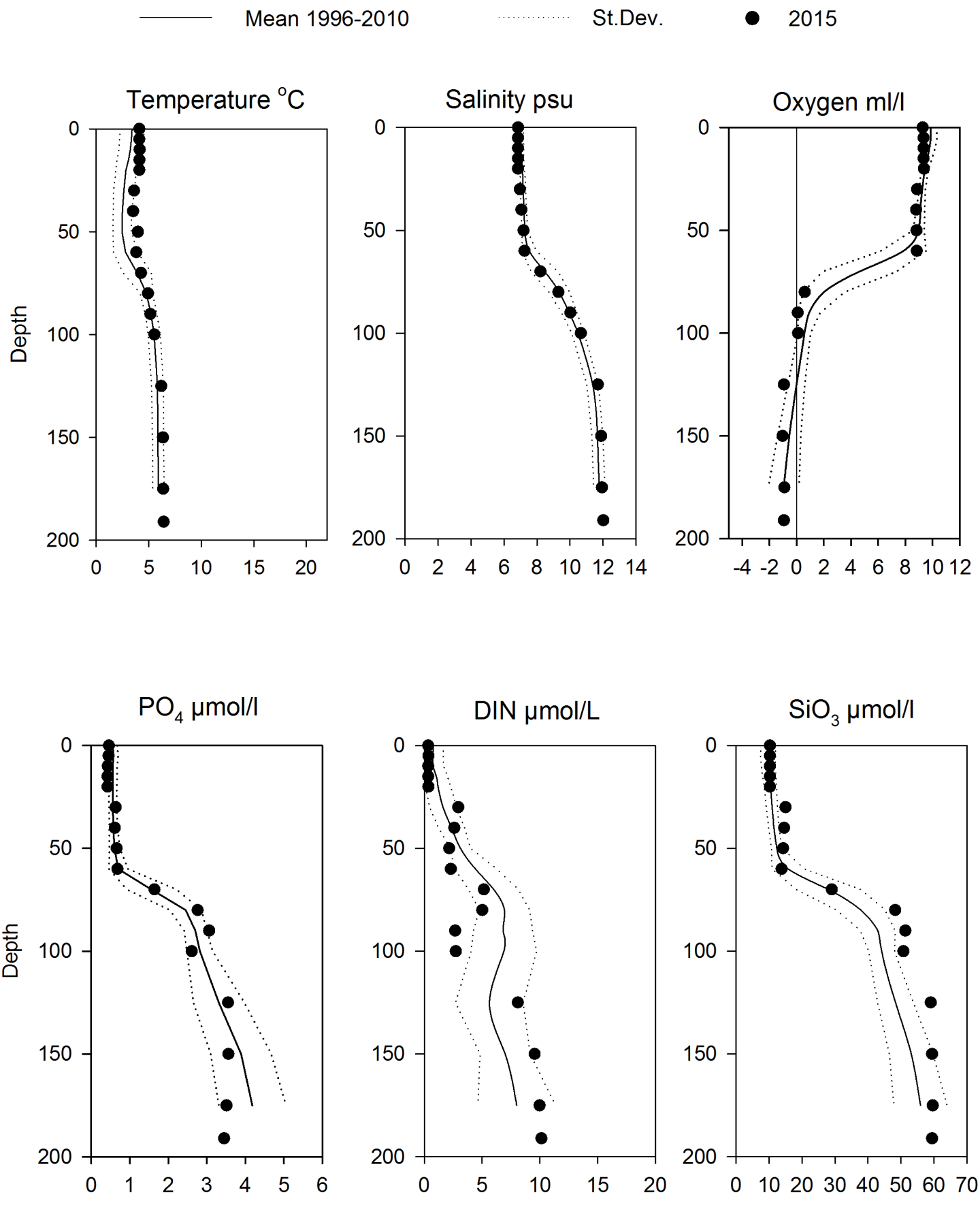
O_2 ml/l



O_2 ml/l



Vertical profiles BY20 April

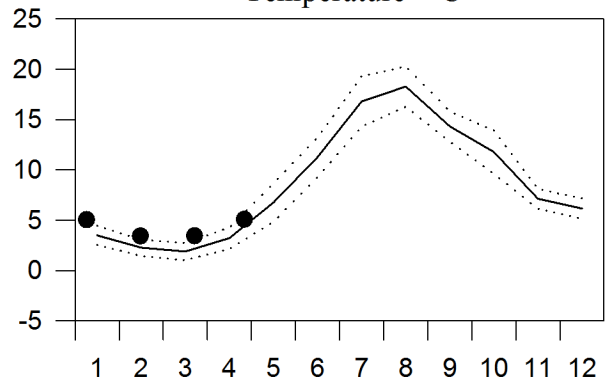


STATION BY32 SURFACE WATER

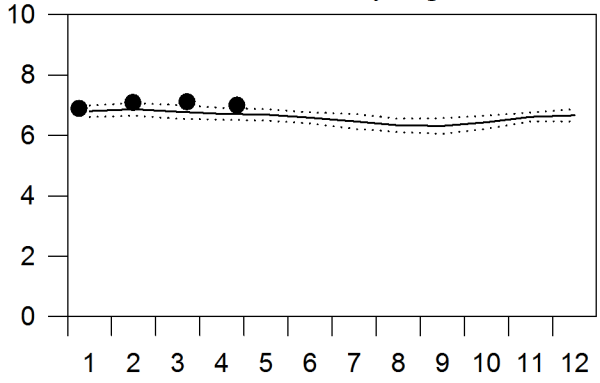
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

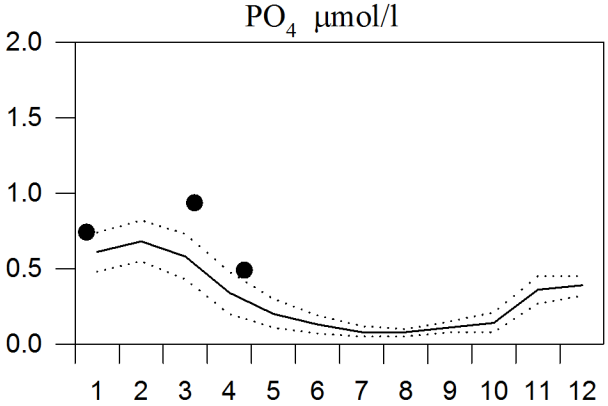
Temperature °C



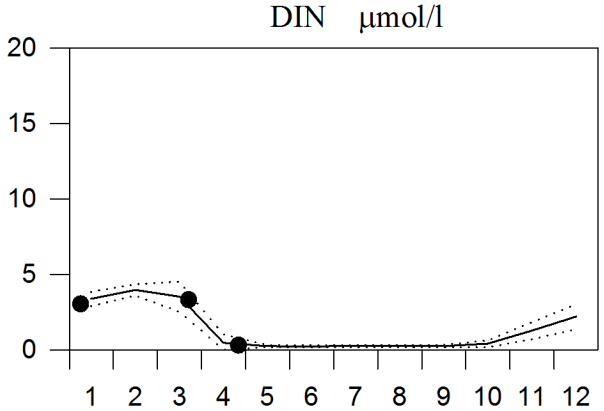
Salinity psu



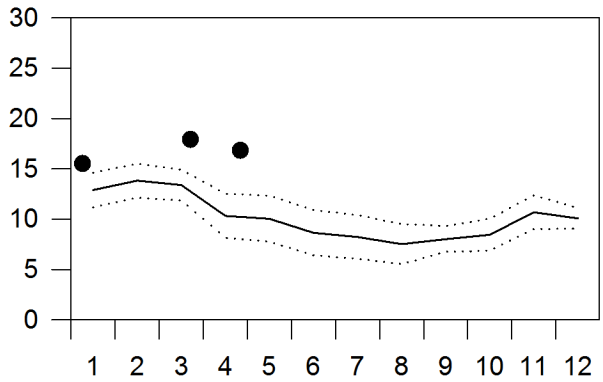
PO_4 µmol/l



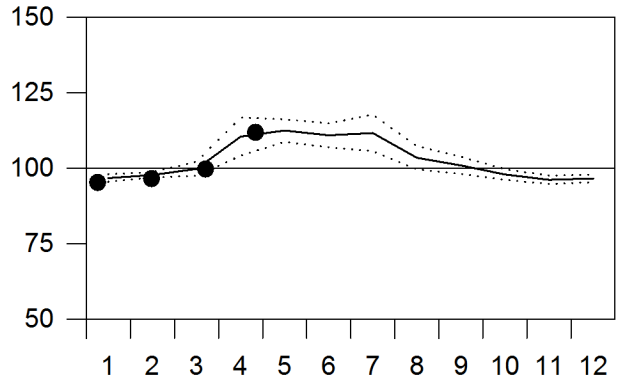
DIN µmol/l



SiO_3 µmol/l

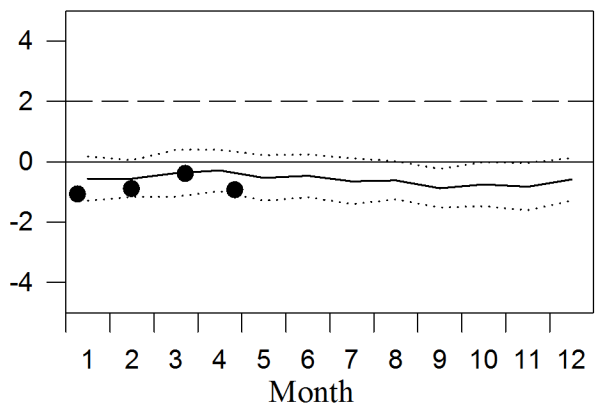


O_2 saturation %

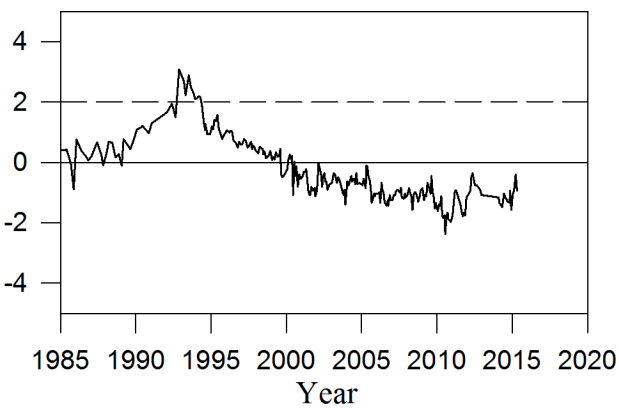


OXYGEN IN BOTTOM WATER (depth > 175m)

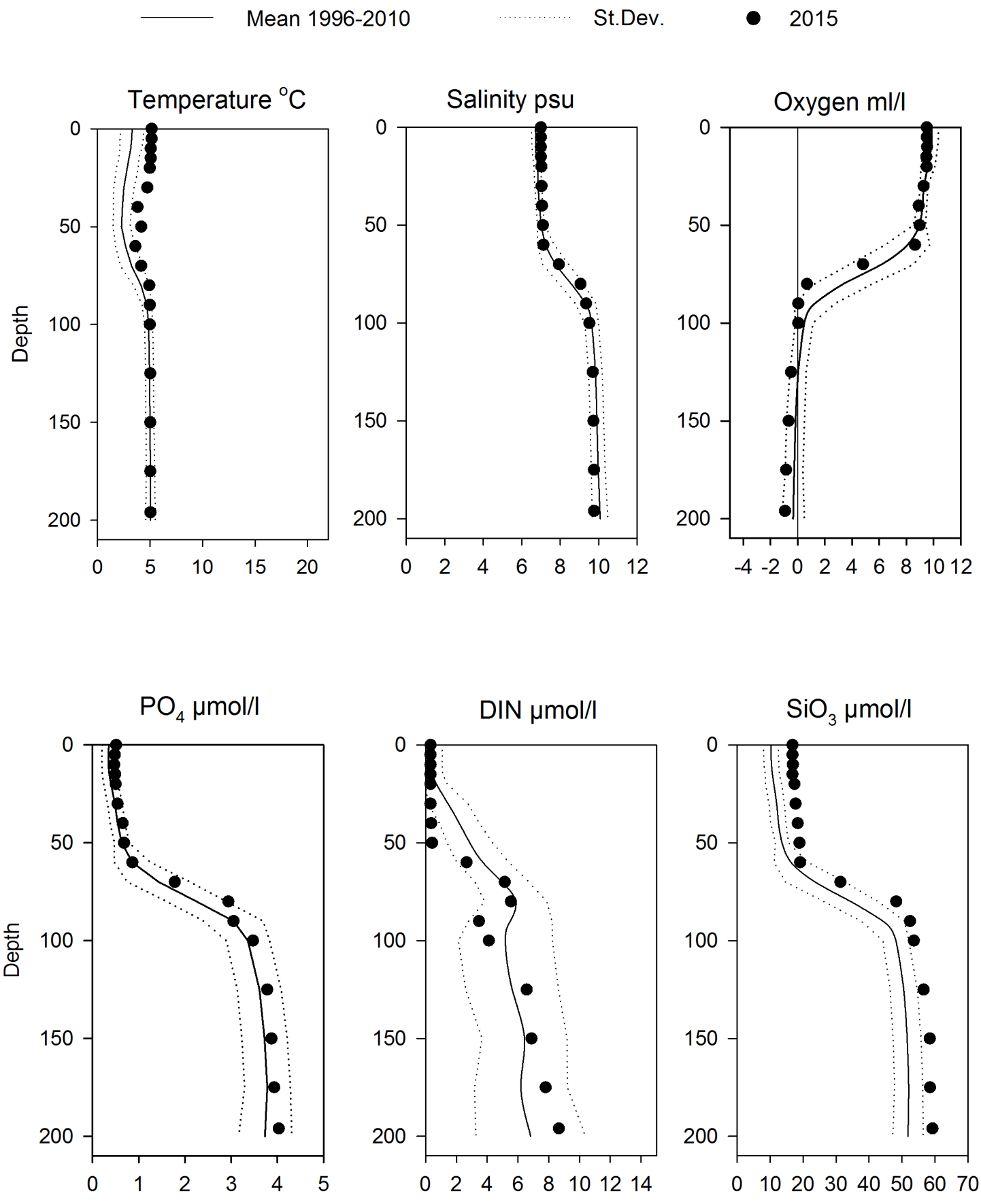
O_2 ml/l



O_2 ml/l



Vertical profiles BY32 April

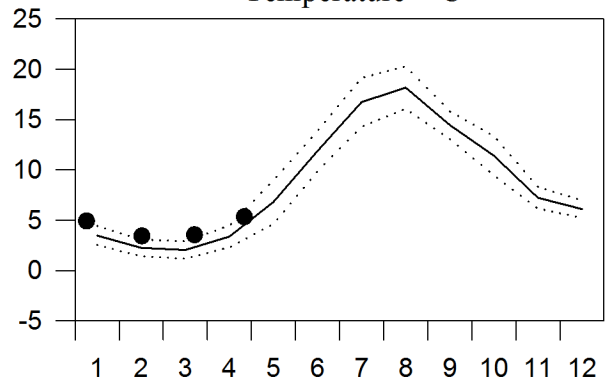


STATION BY38 SURFACE WATER

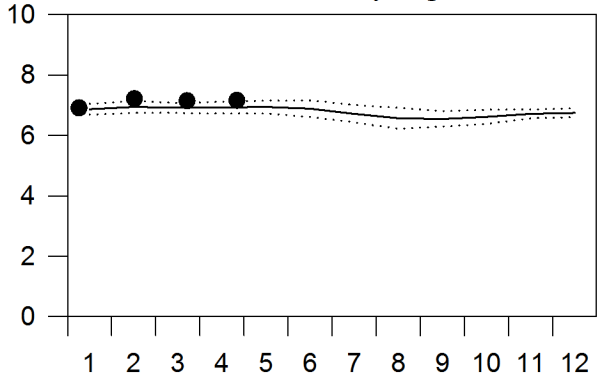
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

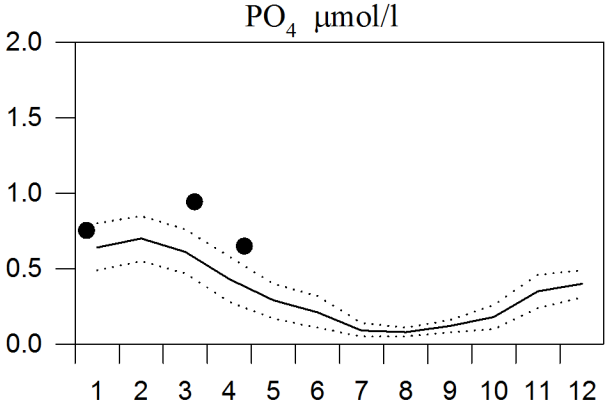
Temperature °C



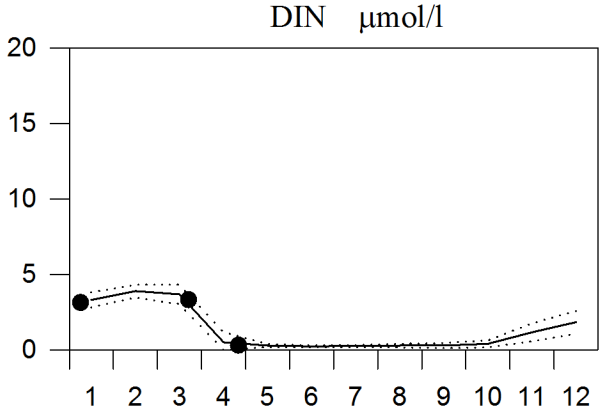
Salinity psu



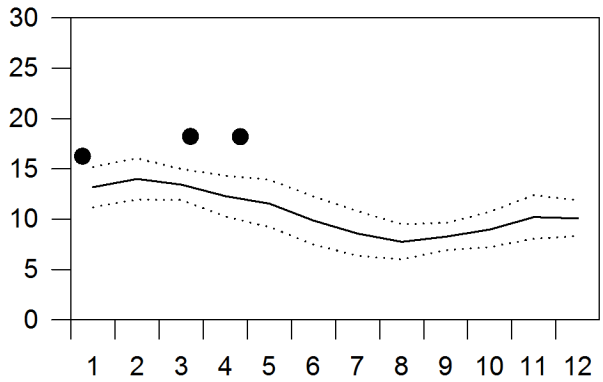
PO_4 µmol/l



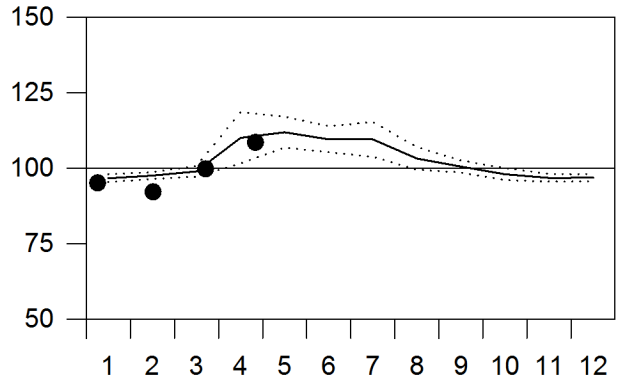
DIN µmol/l



SiO_3 µmol/l

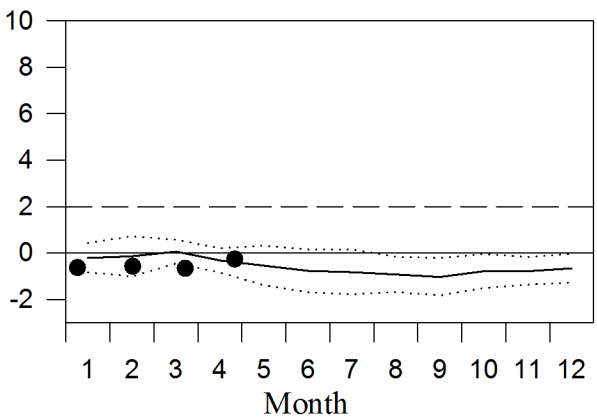


O_2 saturation %

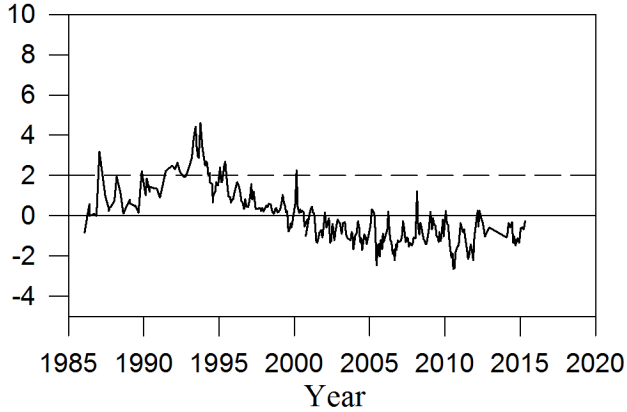


OXYGEN IN BOTTOM WATER (> 100m)

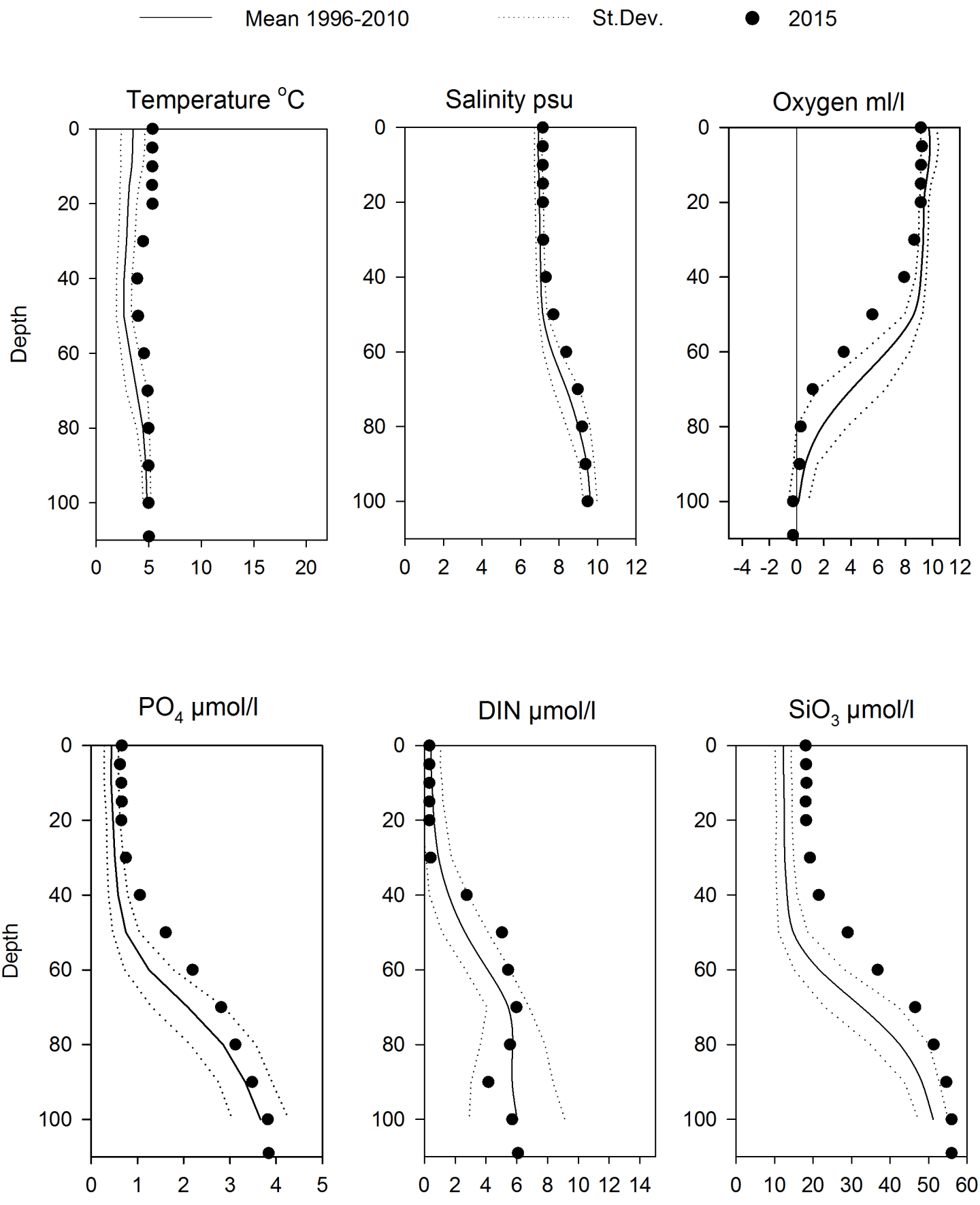
O_2 ml/l



O_2 ml/l



Vertical profiles BY38 April

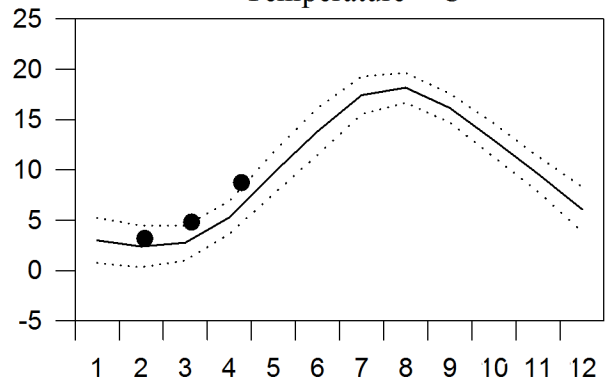


STATION SLÄGGÖ SURFACE WATER

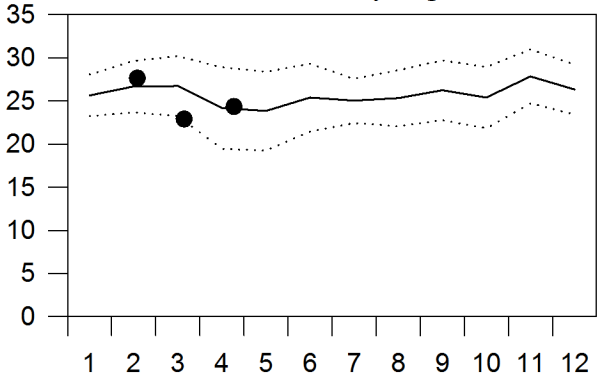
Annual Cycles

Mean 1996-2010 ····· St.Dev. ● 2015

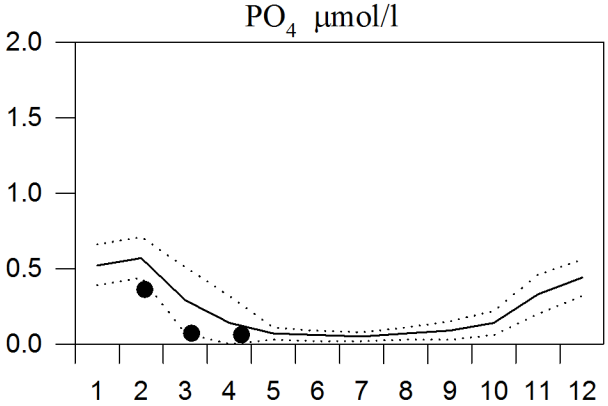
Temperature °C



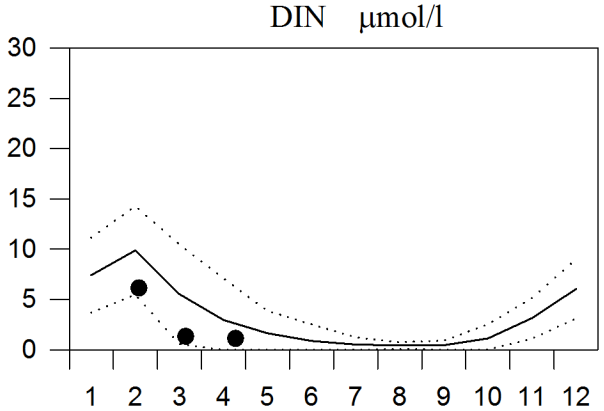
Salinity psu



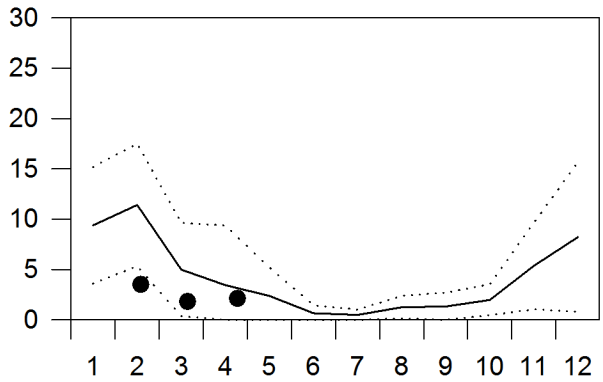
PO_4 µmol/l



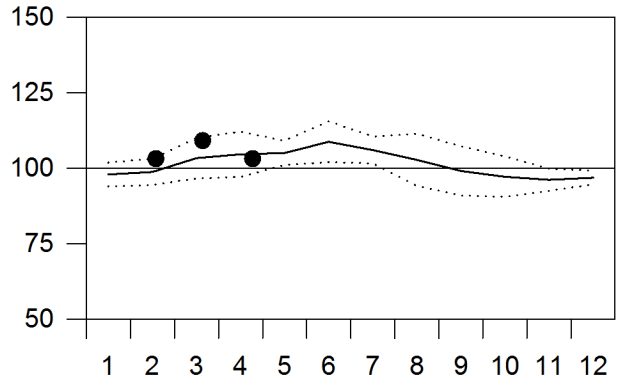
DIN µmol/l



SiO_3 µmol/l

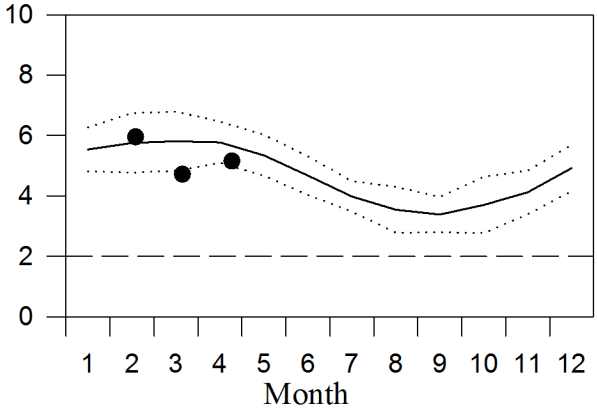


O_2 saturation %

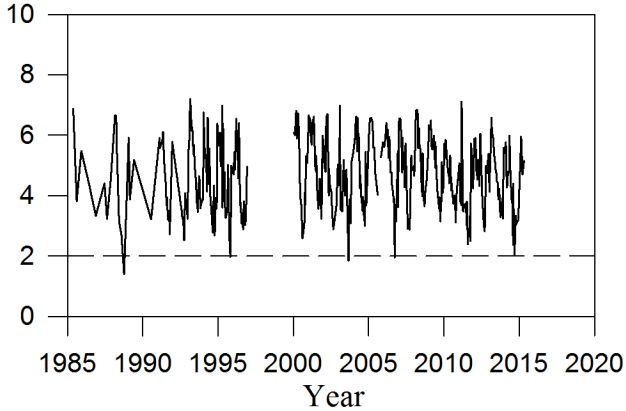


OXYGEN IN BOTTOM WATER (depth >50m)

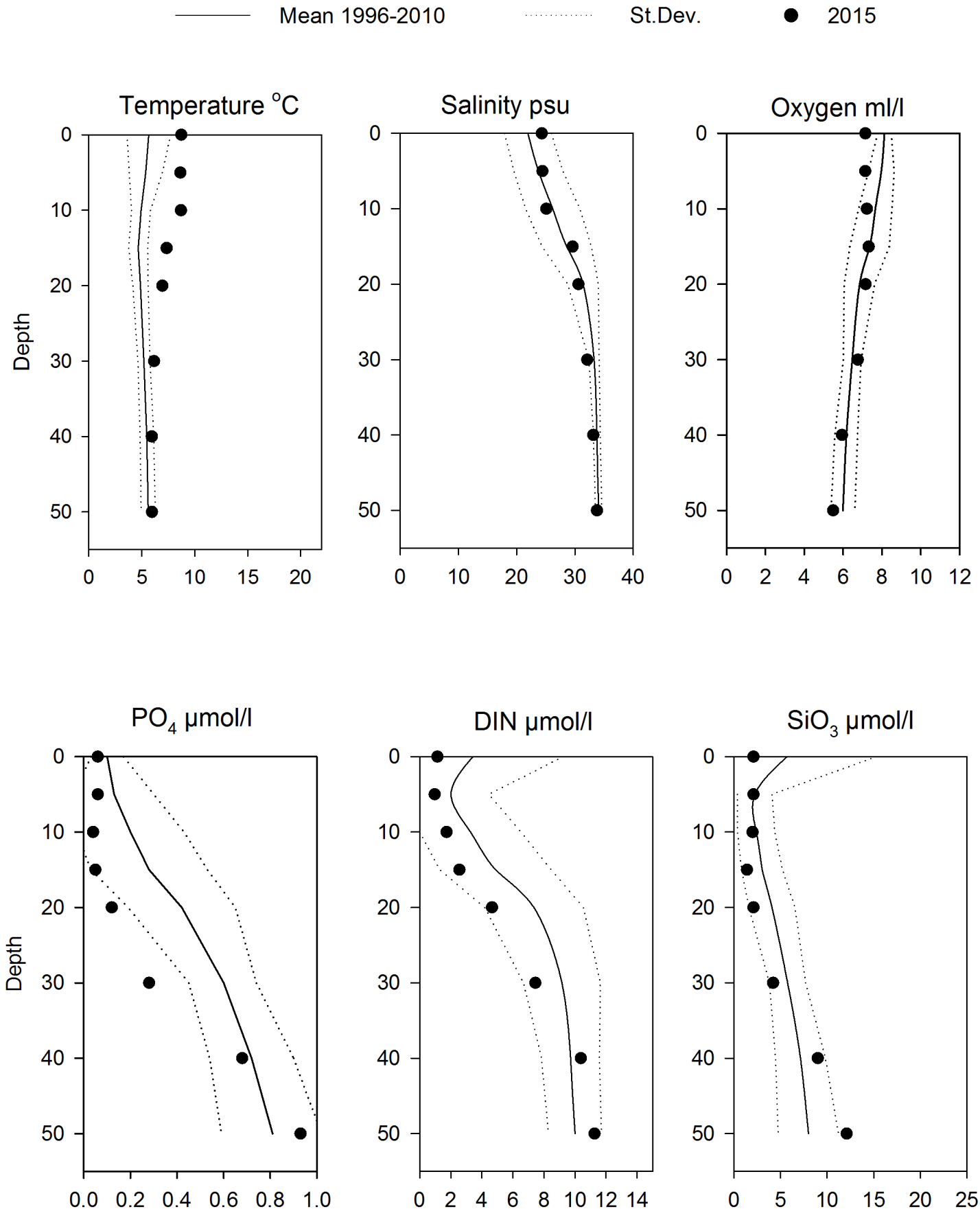
O_2 ml/l



O_2 ml/l

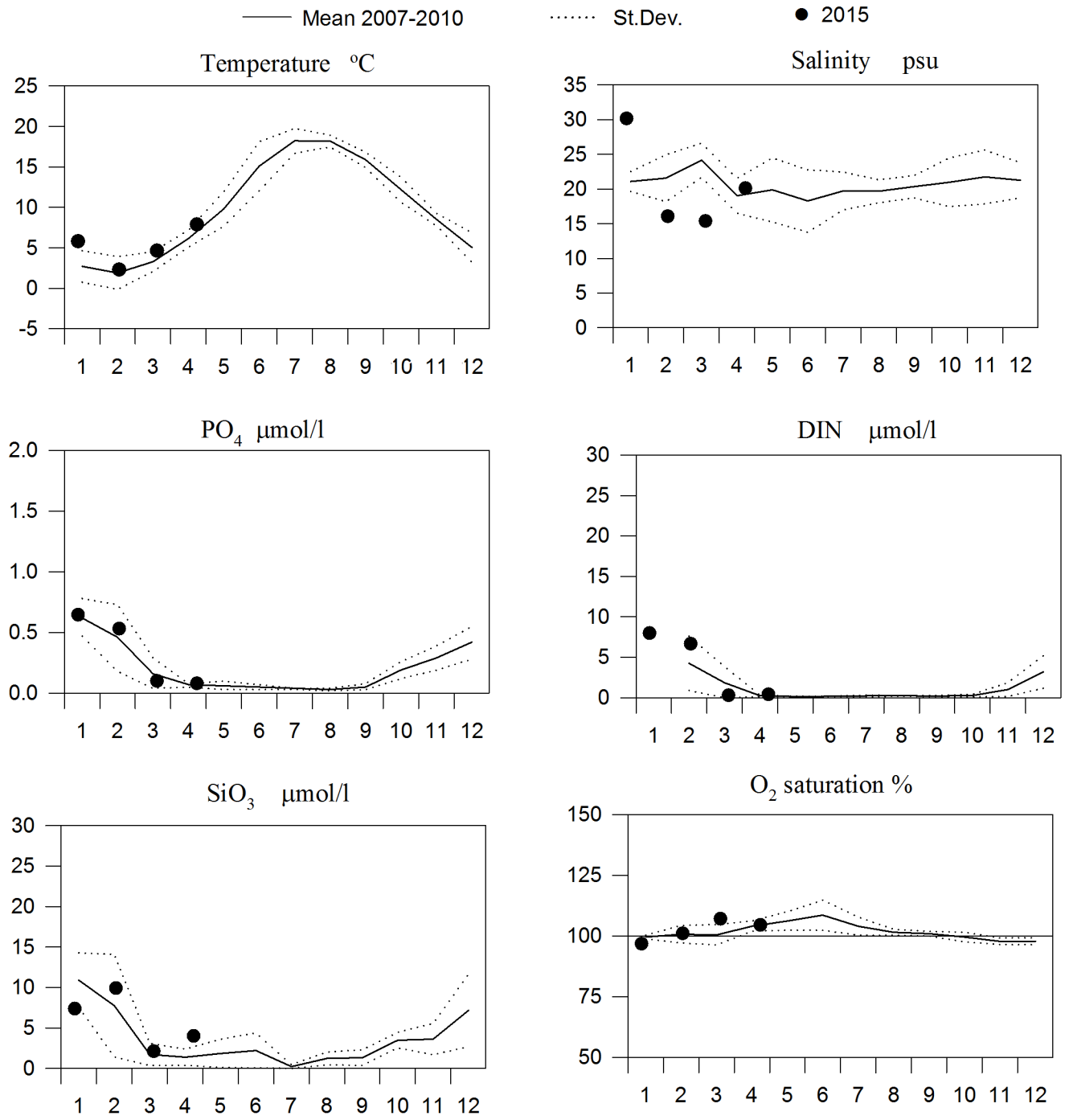


Vertical profiles Släggö April

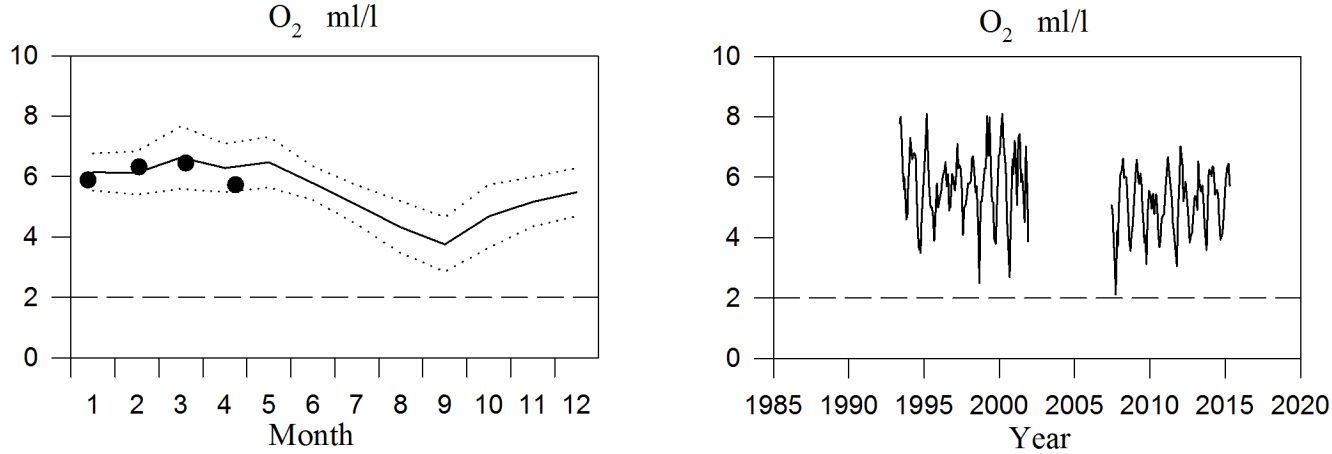


STATION N14 Falkenberg SURFACE WATER

Annual Cycles



OXYGEN IN BOTTOM WATER (depth > 25m)



Vertical profiles N14 Falkenberg April