

Rapport från SMHIs utsjöexpedition med R/V Aranda



Expeditionens varaktighet: 2014-10-20 - 2014-10-28
Undersökningsområde: Skagerrak, Kattegatt, Öresund och egentliga Östersjön
Uppdragsgivare: SMHI samt Havs- och Vattenmyndigheten

SAMMANFATTNING

Under expeditionen, vilken ingick i det svenska havsövervakningsprogrammet, besöktes Skagerrak, Kattegatt, Öresund och egentliga Östersjön. Denna rapport är baserad på preliminära, endast delvis kvalitetskontrollerade data.

Vattentemperaturen i ytlagret låg fortsatt något över det normala i samtliga områden. Närsalterna i ytvattnet uppvisade för årstiden i stort sett normala värden, förutom i västra och östra Gotlandsbassängen där silikathalter över det normala noterades. I västra delen av Skagerrak återfanns ett tunt skikt med mycket höga närsalthalter. I Arkonabassängen var syresituationen god medan det i Bornholmsbassängen och Hanöbukten förekom akut syrebrist (<2 ml/l) från djup överstigande 60 till 70 meter. I östra Gotlandsbassängen hade syreförhållandena åter försämrats i de centrala delarna och helt syrefria förhållanden återfanns från djup överstigande 125 meter och akut syrebrist från 70 -80 meters djup. I de södra delarna av östra Gotlandsbassängen noterades dock bottenvatten med högre syrehalt. I västra Gotlandsbassängen var syresituationen allvarlig då akut syrebrist redan förekom från djup överstigande 70 meter och svavelväte från 80 meters djup.

Nästa ordinarie expedition är planerad till vecka 46 och då kommer Skagerrak, Kattegatt, Öresund och egentliga Östersjön att besökas.

PRELIMINÄRA RESULTAT

Expeditionen genomfördes ombord det finska forskningsfartyget Aranda och startade i Helsingfors den 20:e oktober och avslutades i samma hamn den 28:e. Under expeditionens början rådde svaga till måttliga vindar i huvudsak från ost. Därefter vred vinden över till väst eller sydväst och ökade till kulingstyrka. Lufttemperaturen varierade mellan 10-13°C.

För att bättre följa syresituationen i östra Gotlandsbassängen besöktes en extra station utöver de ordinarie. En bottenmonterad rigg med registrerande syremätare sattes ut nordost om Ölands södra grund. Systemet skall registrera syrehalten på 58 meters djup, var 10:e minut, under ca 5 månader. Detta för att ge en uppfattning av hur snabbt syrehalten varierar strax ovan haloklinen.

Två forskare från Helsingfors Universitet var med ombord för att mäta N₂O i hypoxiska vatten, där denna starka växthusgas bildas genom en denitrifieringsprocess. Målet med mätningarna var att studera bildandet av N₂O efter det inflöde som skedde i februari och mars 2014 och som syresatte stora delar av djupvattnet i Östersjön, vilket låg till grund för stor utbredning av hypoxiska vatten. Vid konstant anoxiska förhållanden upphör ackumuleringen av N₂O, varför rådande förhållanden med utbredd hypoxi är intressanta att studera. Vattenprover togs också för att utvärdera en ny molekylärbiologisk metodik för planktonanalys.

Skagerrak

Termoklinen var mycket svagt utvecklad närmast kusten, medan den i de mer centrala delarna var klart markerad och återfanns på 40 till 60 meters djup. Temperaturen i det övre lagret låg något över det normala för årstiden, på ca. 13 grader. Även haloklinen var svagt utvecklad i de kustnära delarna, där salthalten i ytvattnet låg kring 33 psu, vilket är högre än normalt, medan haloklinen var tydligt markerad längre västerut, där den återfanns på 10-20 meters djup. Närsalthalterna i ytlagret hade stigit något sedan föregående mättillfälle. Fosfathalterna varierade mellan 0.10 och 0.33 µmol/l, silikat från 0.6 till 3.4 µmol/l medan koncentrationerna av oorganiskt kväve (nitrit + nitrat) varierade mellan 0.25 och 1.16 µmol/l. Samtliga värden normala för årstiden. På 15 meters djup vid stationen Å17 längst västerut återfanns ett tunt skikt av vatten med extremt höga närsalthalter, troligen härrörande från södra Nordsjön. Viss planktonaktivitet, baserat på fluorescensmätningar, förekom i de centrala delarna, medan aktiviteten var låg invid kusten. Det lägsta syrevärdet uppmättes i bottenvattnet vid stationen Släggö, i Gullmarfjordens mynning, 3 ml/l.

Kattegatt och Öresund

Termoklinen återfanns på omkring 15 meters djup, men var mycket svag. Temperaturen i ytlagret låg strax över det normala, kring 12.5 °C. Salthalten i ytvattnet var normal - ca 22 psu, i Öresund 17.5 psu. Haloklinen återfanns på 15 meters djup i Kattegatt och på 7 meter i Öresund.

Halterna av näringsämnen i ytvattnet låg inom det normala för årstiden, fosfathalten varierade mellan 0.13 och 0.18 µmol/l, nitrit + nitrat från under detektionsgränsen (< 0.10 µmol/l) till 0.17 µmol/l och silikat mellan 1.9 – 3.3 µmol/l. I Öresund låg halterna generellt högre, fosfat 0.42 µmol/l och silikat på 11 µmol/l.

Fluorescensmätningar visade på viss planktonaktivitet, i ytlagret, i hela området.

I Kattegatt och Öresund var syrgashalterna i djupvattnet normala och varierade mellan 2.8 och 4.1 ml/l, lägst i Öresund.

Egentliga Östersjön

Vattentemperaturen i ytlagret var över det normala i hela området, 11.4 -14.3°C och termoklinen återfanns på ca. 30 meters djup. Salthalten i ytvattnet var normal i större delen av området, mellan 6.5 och 7.9 psu. I östra Gotlandsbassängen var ytsalthalten dock klart under det normala, ca 6.6 psu.

Haloklinen återfanns på omkring 60 till 70 meters djup i västra och östra Gotlandsbassängen, medan den låg grundare i de södra delarna, på djup mellan 35 och 50 meter.

Samtliga närsalter uppvisade normala halter för årstiden i ytlagret, silikat varierade mellan 7 – 12 $\mu\text{mol/l}$, fosfathalterna låg i intervallet 0.15 – 0.30 $\mu\text{mol/l}$, medan halterna av oorganiskt kväve (nitrit + nitrat) låg i intervallet från under detektionsgränsen till 0.6 $\mu\text{mol/l}$, högst i västra Gotlandsbassängen.

Effekterna av inflödet genom Öresund på $\sim 25 \text{ km}^3$, vilket ägde rum under mitten av augusti, syntes fortfarande i de södra delarna. Dessutom skedde det under september och oktober ett par smärre inflöden på $\sim 20 \text{ km}^3$ respektive 8 km^3 genom Öresund. Arkonabassängen var väl syresatt, medan akut syrebrist förekom i Bornholmsbassängen och Hanöbukten från 60-70 meters djup.

I de norra och centrala delarna av östra Gotlandsbassängen noterades akut syrebrist från 70 - 80 meters djup och svavelväte vid djup överstigande 125 - 135 meter. I de södra delarna av bassängen (vid BY10 samt BY9 W) återfanns ett syreminimum (ca 1 ml/l) på 90 till 100 meters djup, medan syrehalten vid botten, på 143 respektive 124 meter, låg på 2 ml/l. Vid station BCSIII-10 i sydost förekom ett syreminimum på 0.6 ml/l vid 80 meters djup, medan det vid botten på 90 meter uppmättes en halt av 2.4 ml/l. I västra Gotlandsbassängen var syresituationen allvarlig då akut syrebrist förekom från djup överstigande 70 meter och svavelväte från 80-90 meters djup.

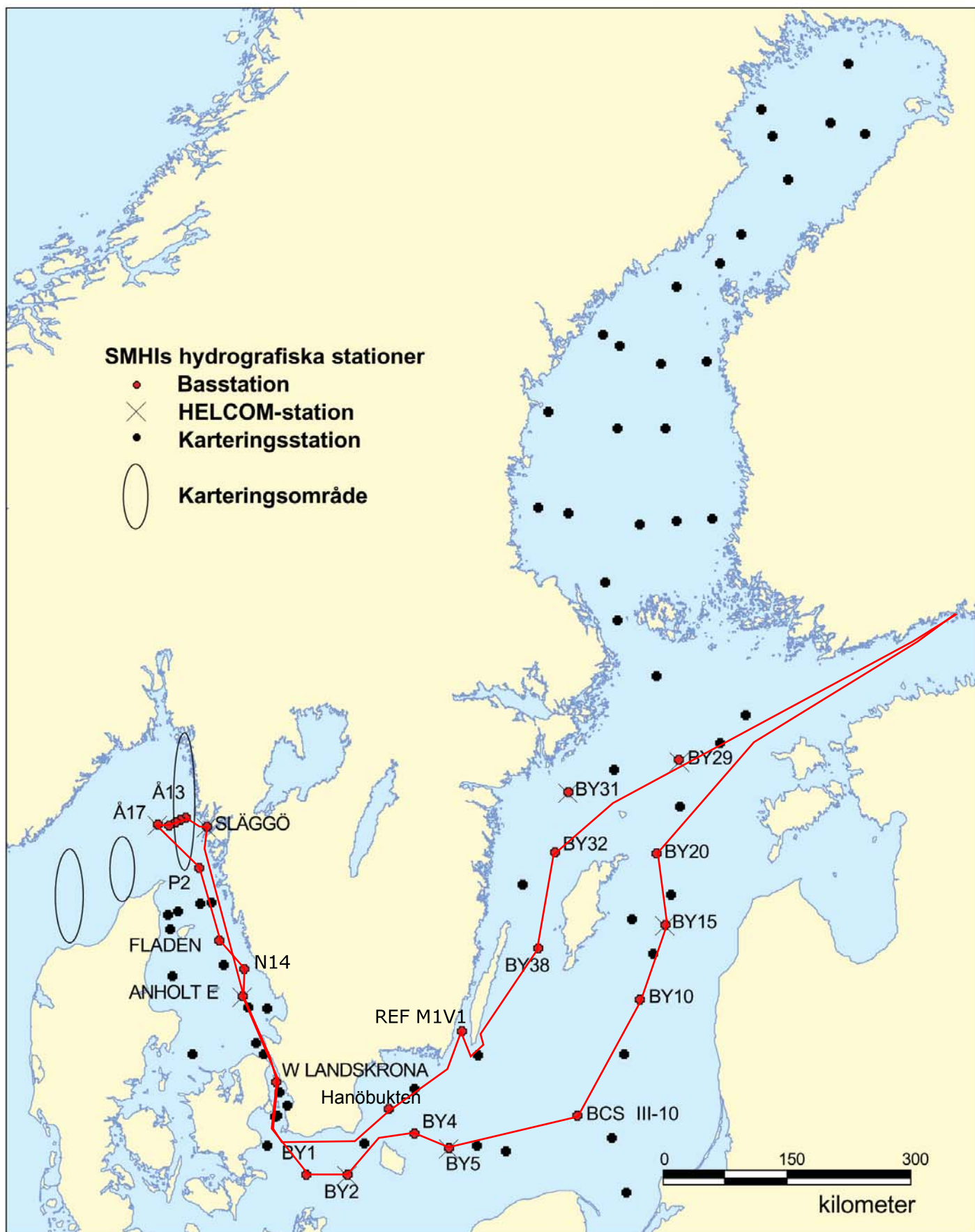
DELTAGARE

Namn		Från
Lars Andersson	Expeditionsledare	SMHI
Kristin Andreasson	Kvalitetsansvarig	SMHI
Daniel Bergman-Sjöstrand		SMHI
Örjan Bäck		SMHI
Sofia Carlsson	(Lysekil – Helsingfors)	SMHI
Martin Hansson	(Helsingfors – Lysekil)	SMHI
Mikael Krysell	(Lysekil – Helsingfors)	SMHI
Vivi Månsson		SMHI
Susanna Hietanen		Helsingfors Universitet
Petra Tallberg		Helsingfors Universitet

BILAGOR

- Färdkarta
- Tabell över stationer, antal parametrar och provtagningsdjup
- Karta över syrehalter i bottenvattnet
- Vertikalprofiler för basstationer
- Månadsmedelvärdesplottar för ytvatten

TRACKCHART
Country: Sweden
Ship: R/V ARANDA
Date: 20141020-20141028
Series: 0720-0746



Date: 2014-10-27
Time: 14:05

Ser no	Stat code	P r o j	Station-----	Lat-----	Lon-----	Date yyyymmdd	Time hhmm utc	Bottom depth m	Secchi depth m	Wind di ve	Air temp C	Air pres hPa	WCSI elec t aoe hd	C PPCPZT Hrhhoo ml y P t m o t P N N N N N N N A 3 u n l s i	No de	T e a l h y g	P o 2 S 4	O H 5 P P	P T 6 N N	N N 7 N N	N T 8 N N	A S h o l i k o m n a	H L u i o u n g	L P 0 O O C C	P T 0 O O C C	
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0721	BPEX21BAS	BY15	GOTLANDSDJ	N5720	E2003	20141021	1030	239	11	08 3	10.0	1004	2740	x -xxxx--	19	x x	x x	x x	x x	x x	x x	x x	- x	- -	- -	- x
0722	BPEX21EXT	BY15	GOTLANDSDJ	N5720	E2003	20141021	1215	239	11	08 3	10.0	1004	2740	x -----	5	x x	- x	x x	x x	x x	x x	- x	- -	- -	- x	
0723	BPEX13BAS	BY10		N5638	E1935	20141021	1730	144		12 9	10.3	1003	9990	x --x----	15	x x	- x	x x	x x	x x	x x	- x	- -	- -	- x	
0724	BPSE00BAS	BY9W		N5607.20	E1901.00	20141021	2240	125		11 12	10.8	1002	9990	x -----	14	x x	- x	- -	- -	- -	- -	- -	- -	- -	- x	
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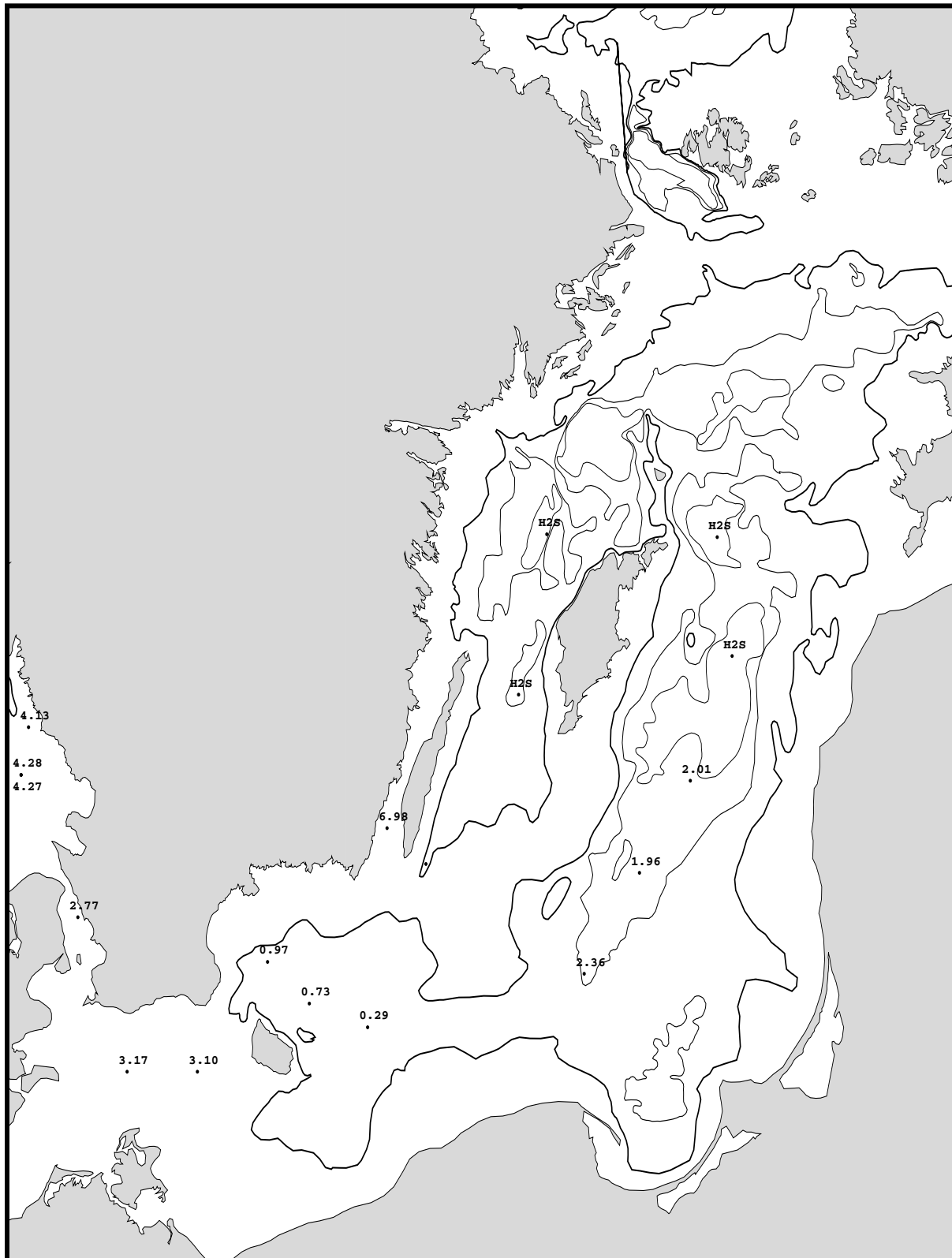
Bottom water oxygen concentration (ml/l)

Country: Finland

Ship : Aranda

Date : 20141021-20141027

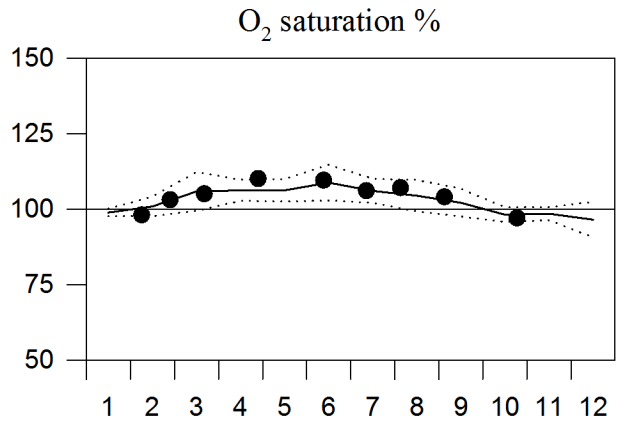
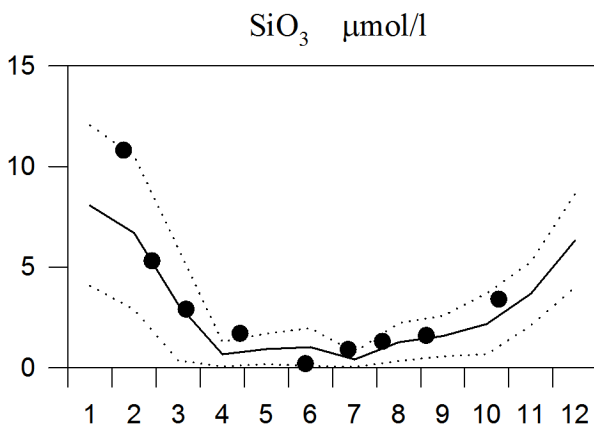
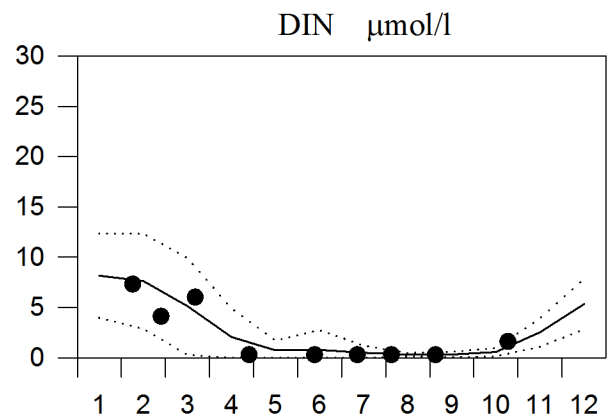
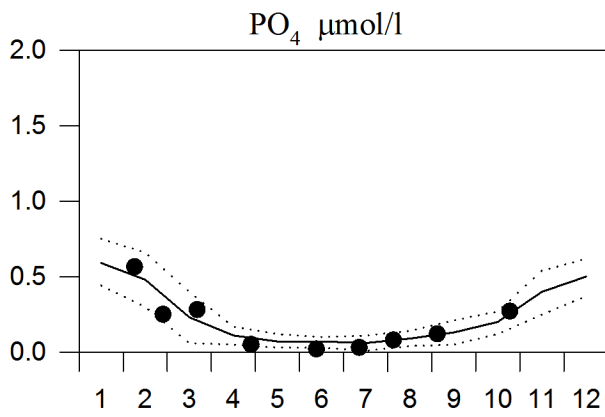
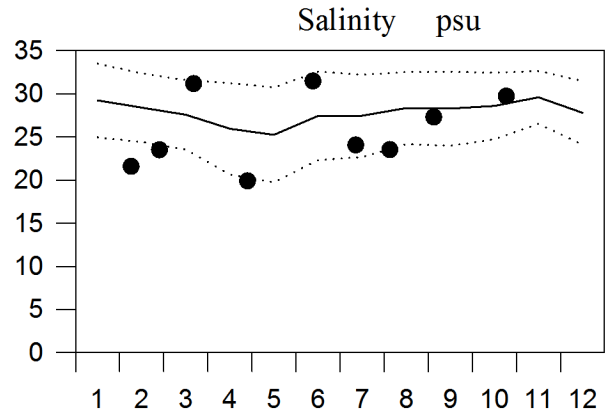
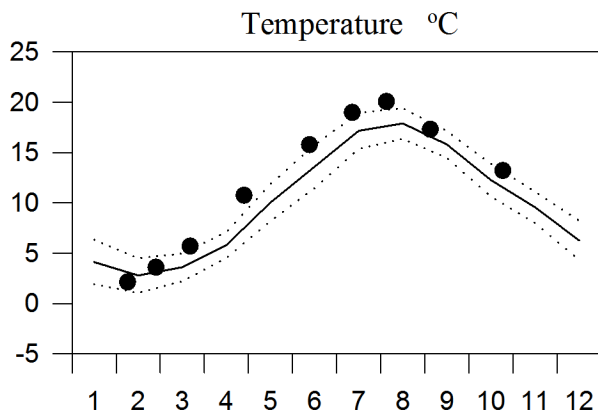
Series : 0720-0746



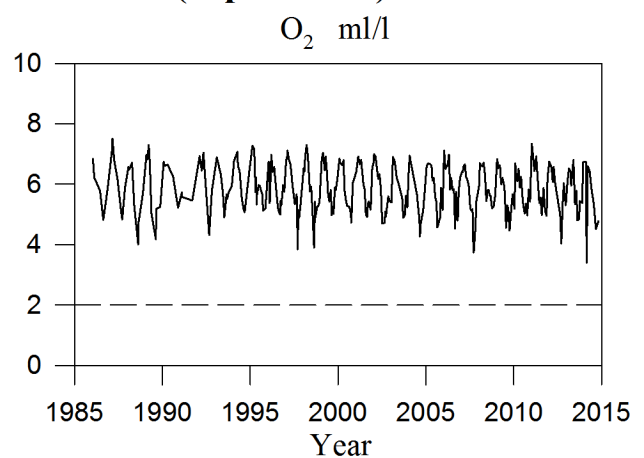
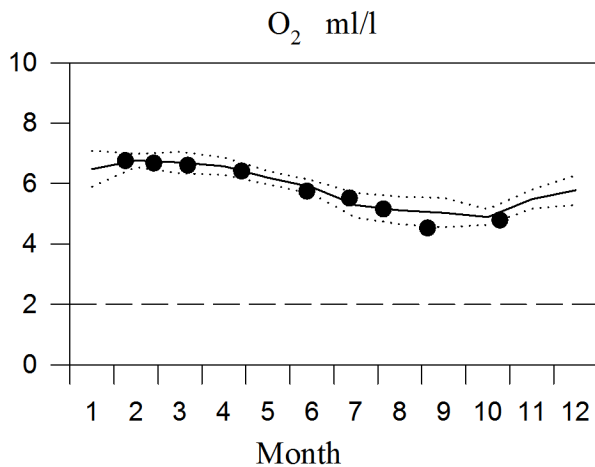
STATION P2 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2014

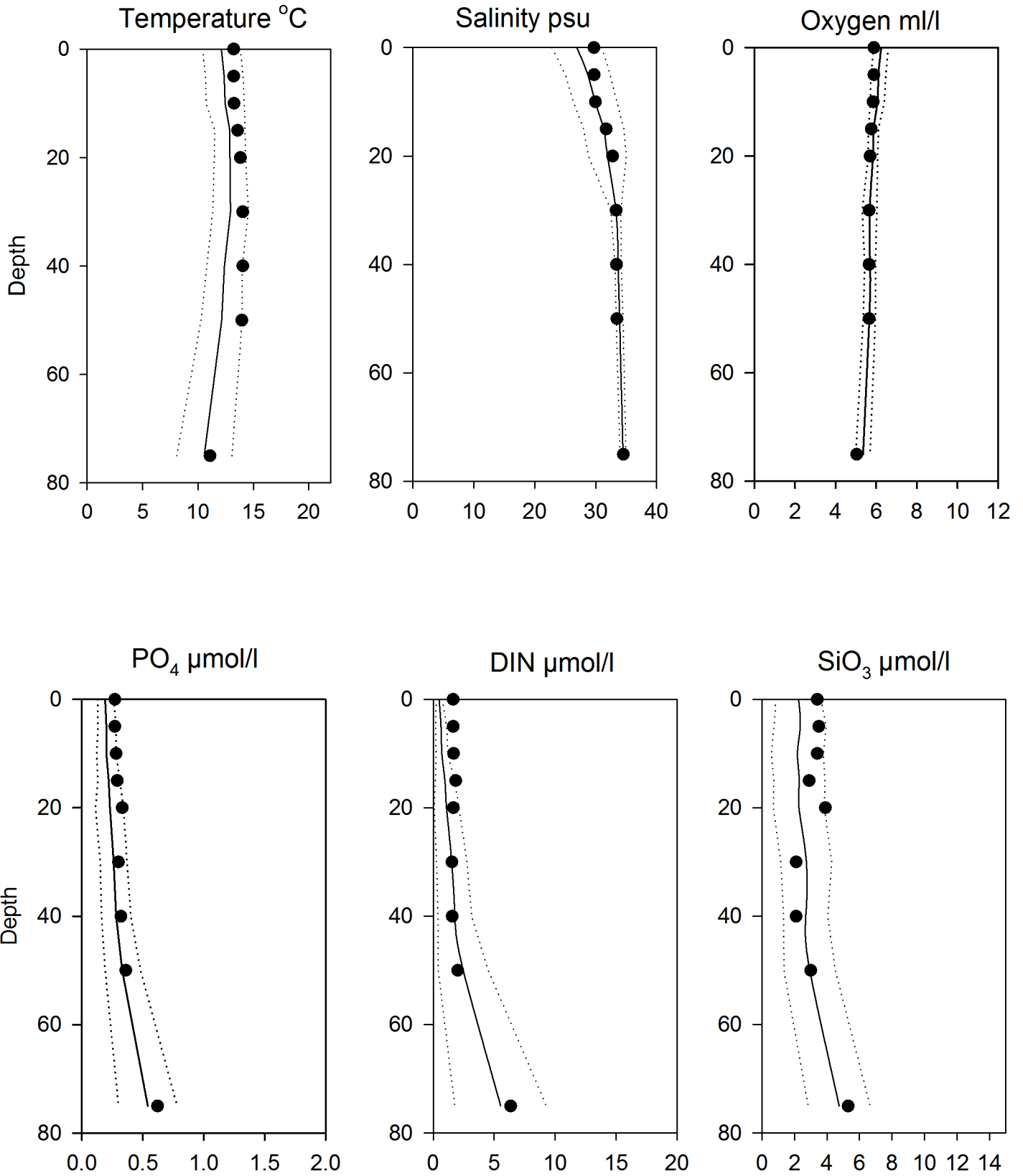


OXYGEN IN BOTTOM WATER (depth >75m)



Vertical profiles P2 October

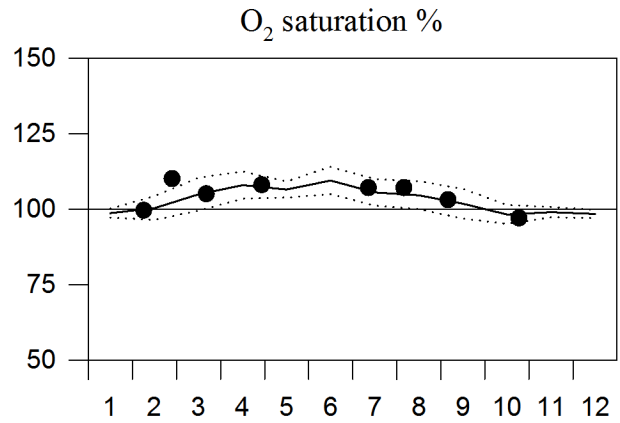
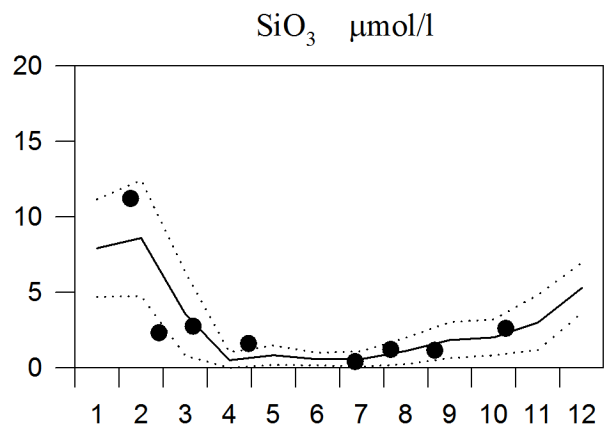
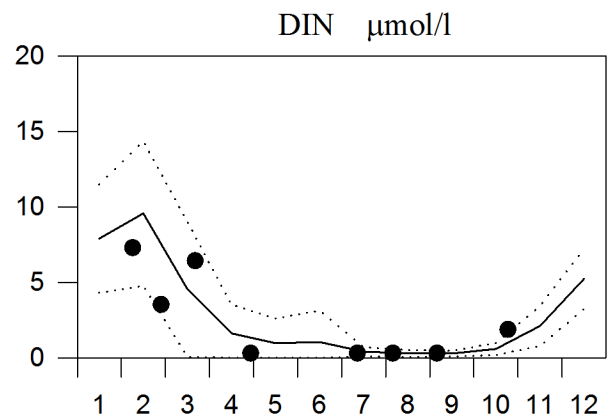
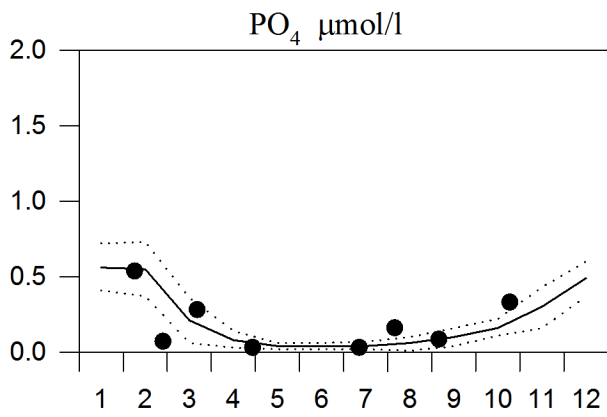
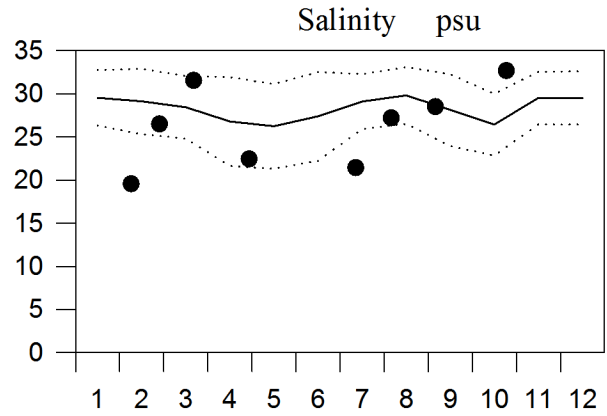
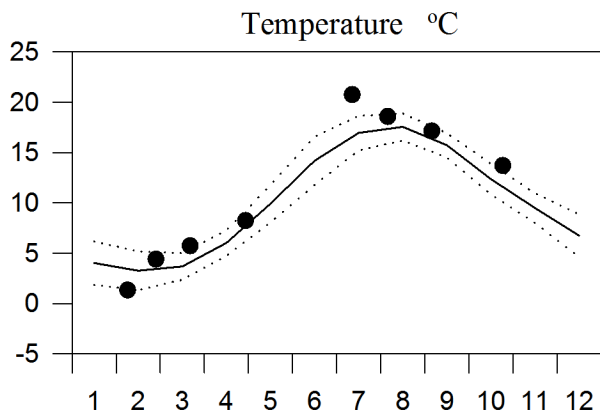
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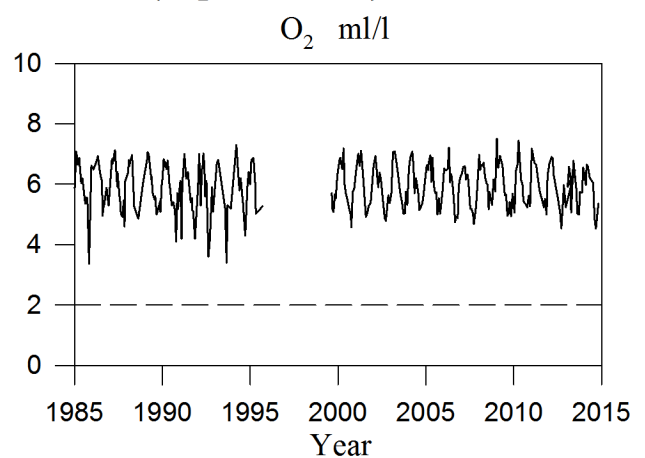
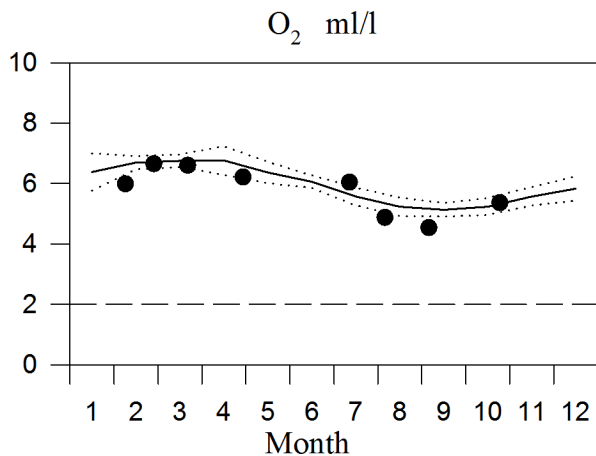
STATION Å13 SURFACE WATER

Annual Cycles

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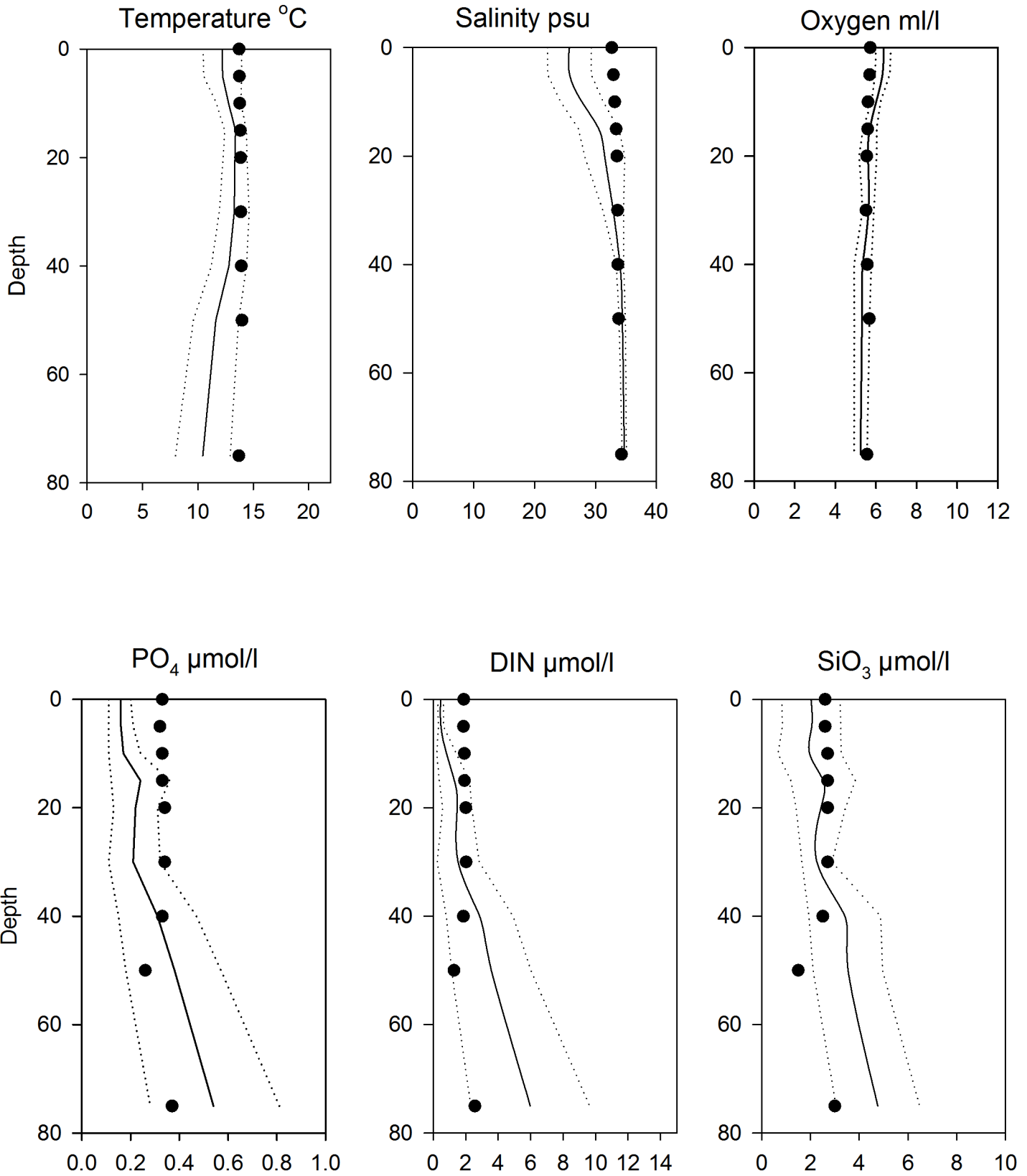


OXYGEN IN BOTTOM WATER (depth >=75m)



Vertical profiles Å13 October

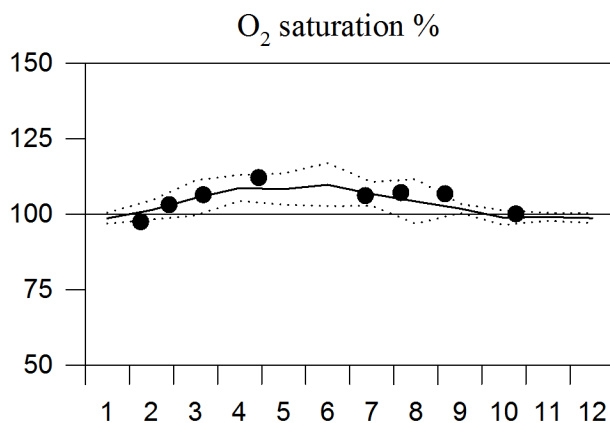
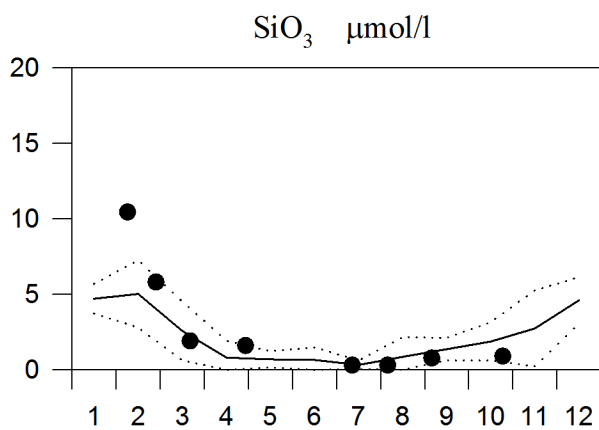
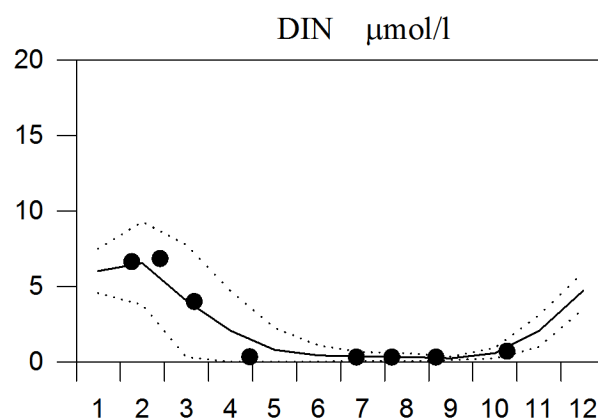
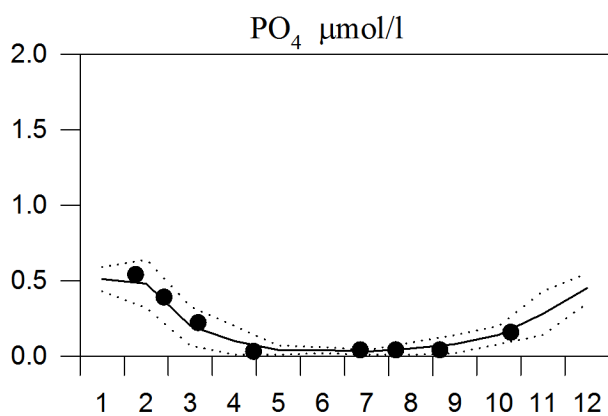
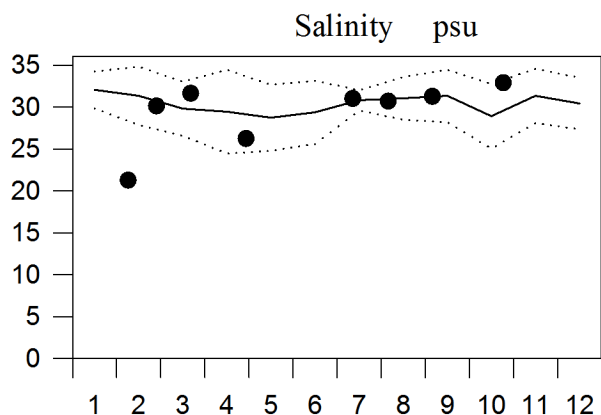
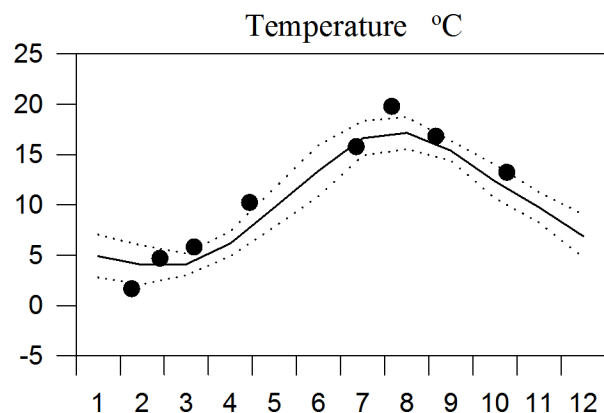
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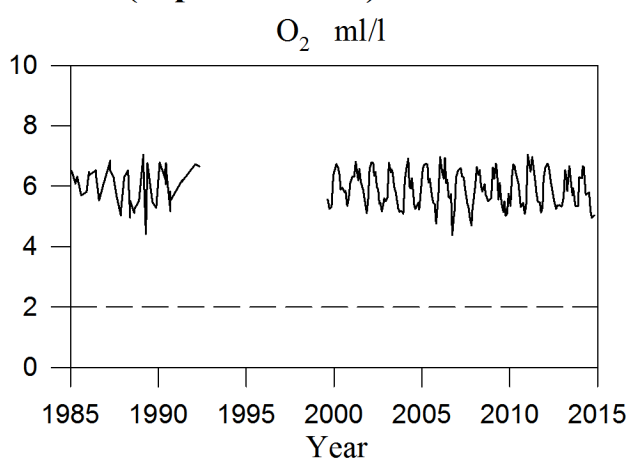
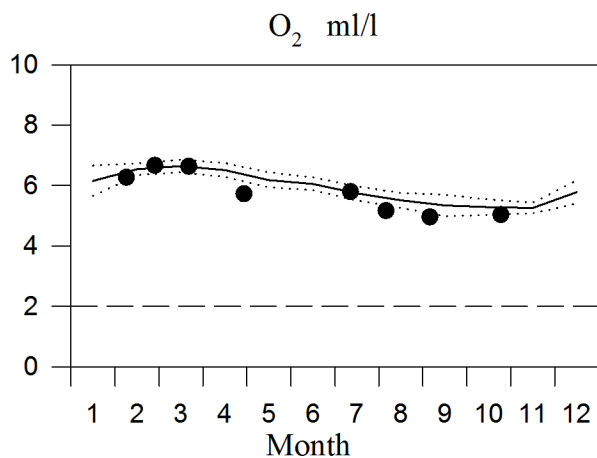
STATION Å15 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2014



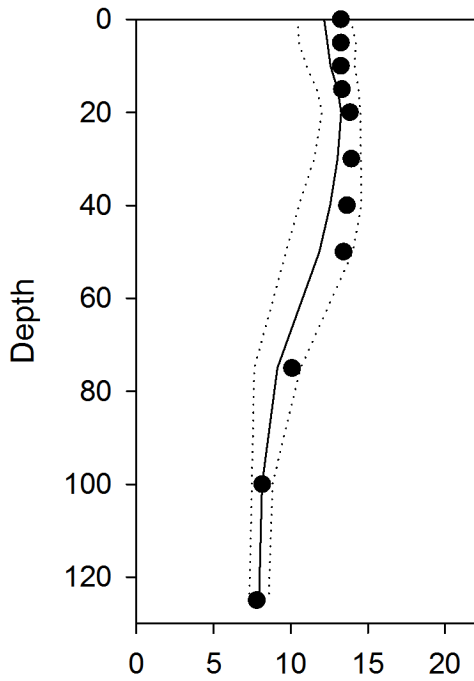
OXYGEN IN BOTTOM WATER (depth >=125m)



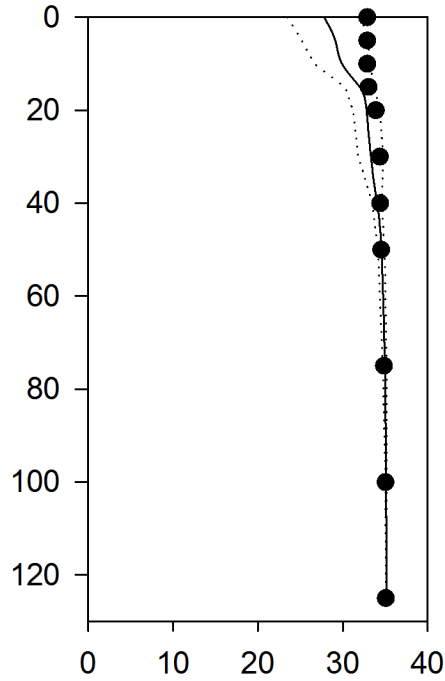
Vertical profiles Å15 October

— Mean 1996-2010 St.Dev. ● 2014

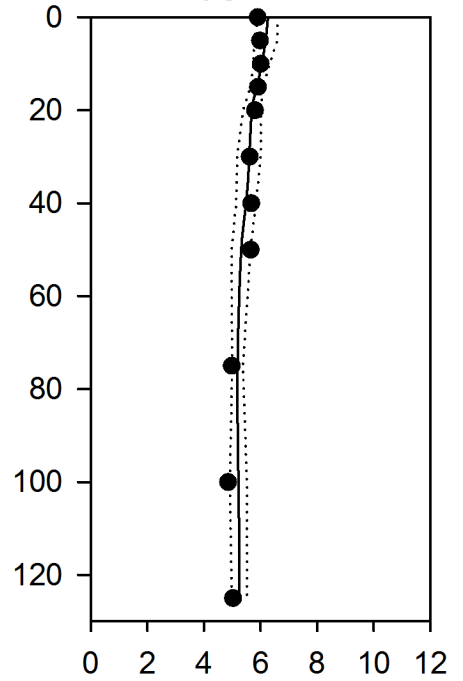
Temperature °C



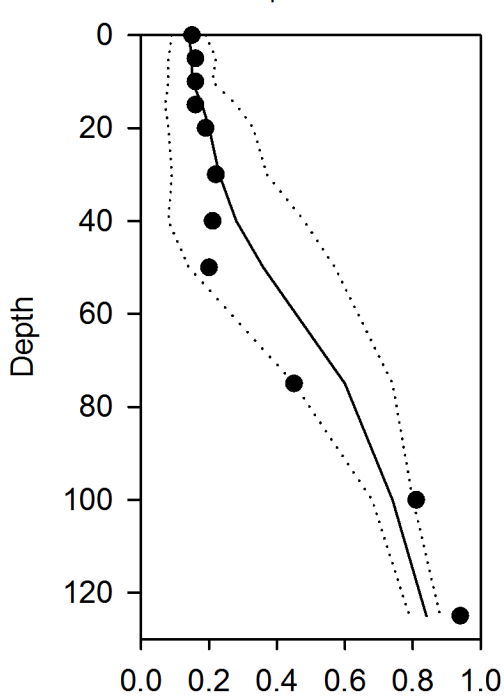
Salinity psu



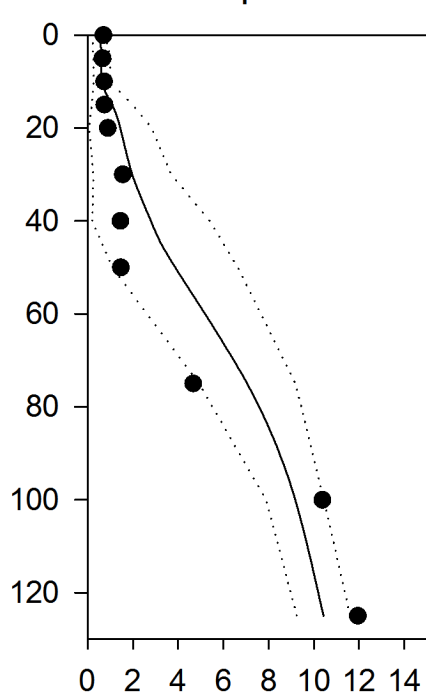
Oxygen ml/l



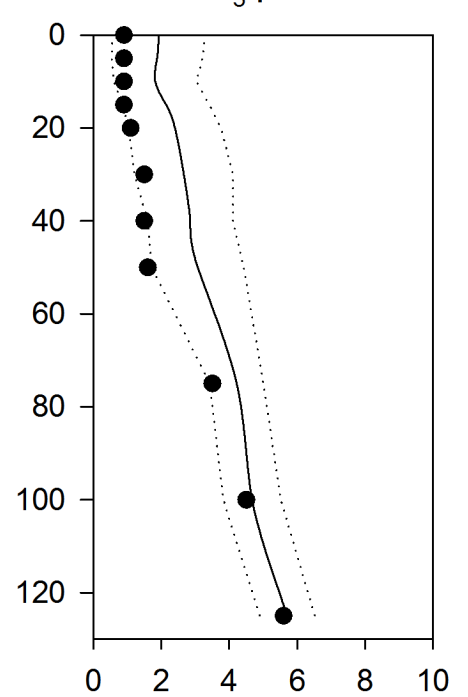
PO₄ µmol/l



DIN µmol/l



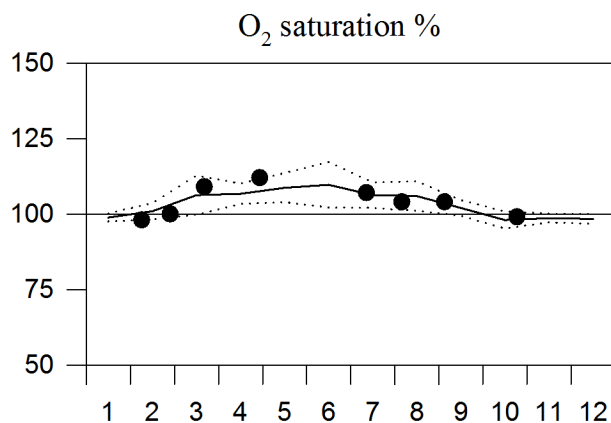
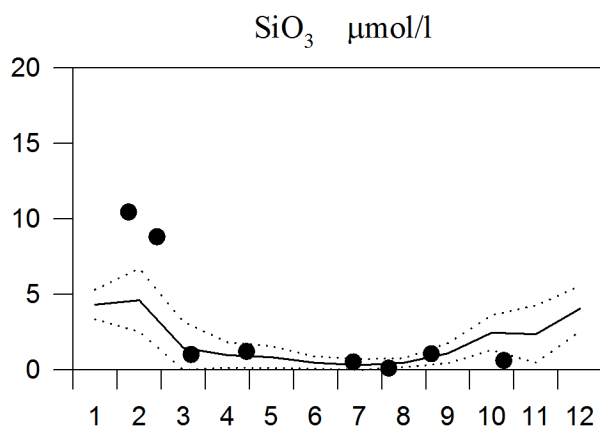
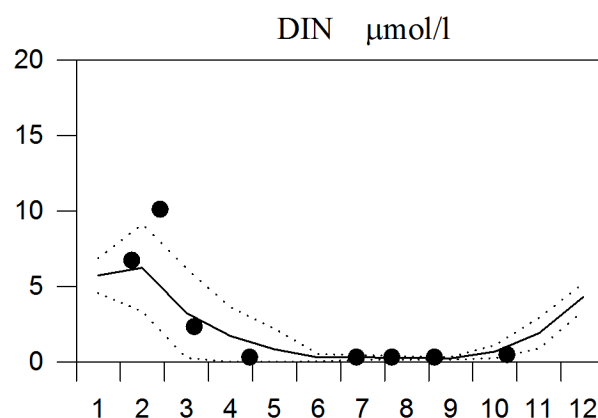
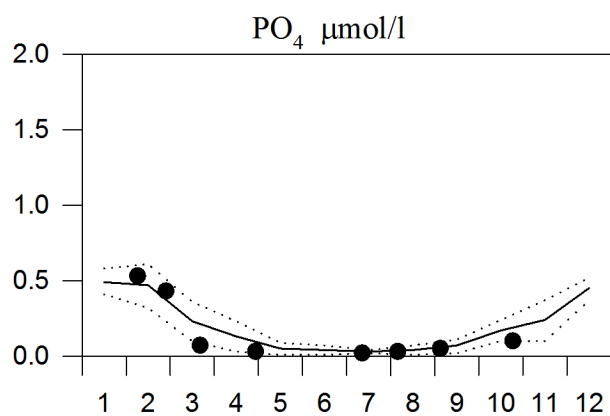
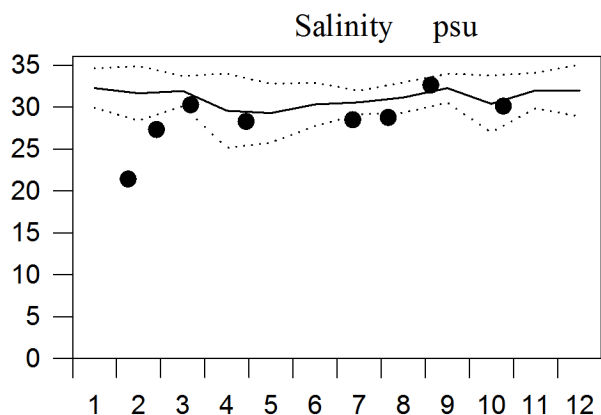
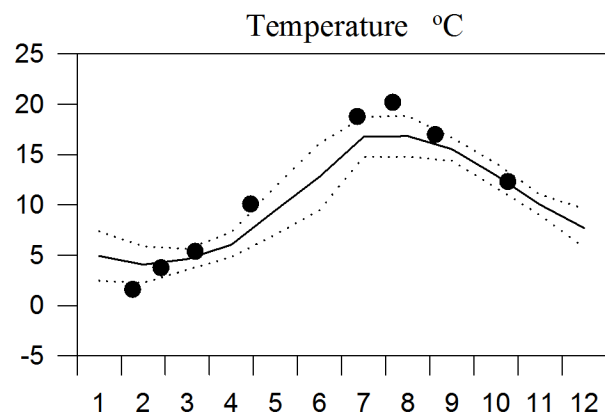
SiO₃ µmol/l



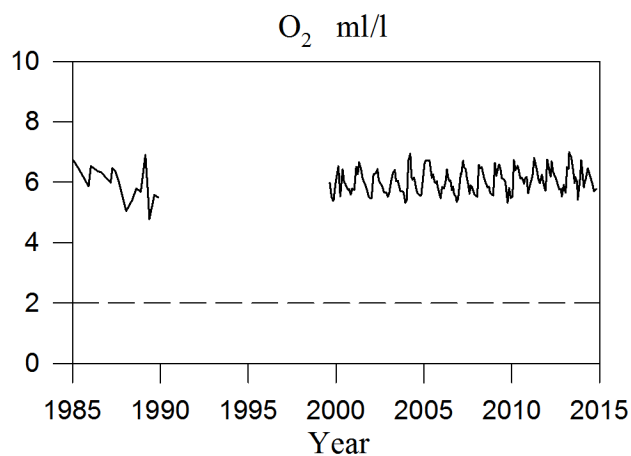
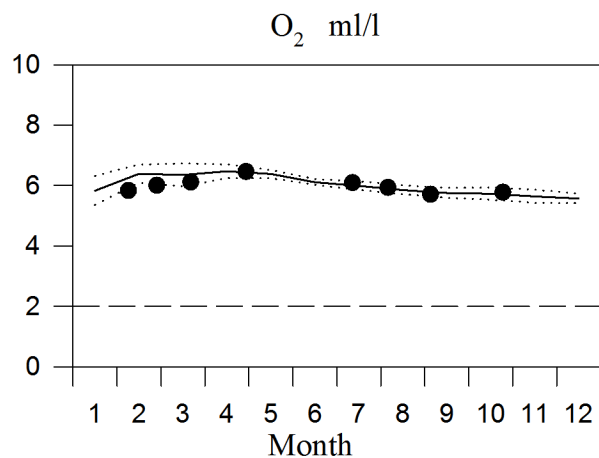
STATION Å17 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2014



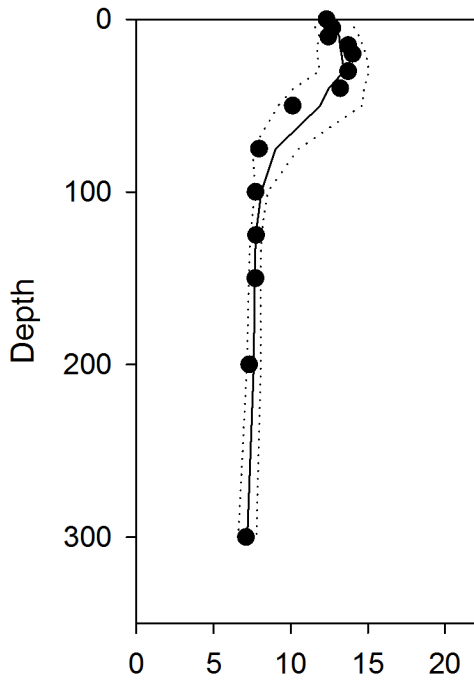
OXYGEN IN BOTTOM WATER (depth = 300m)



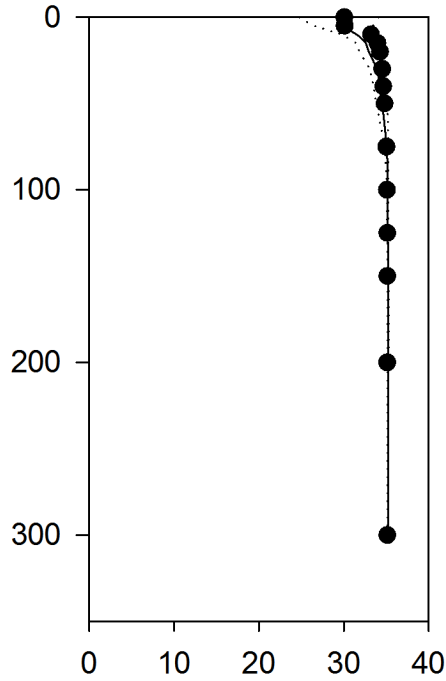
Vertical profiles Å17 October

— Mean 1996-2010 St.Dev. ● 2014

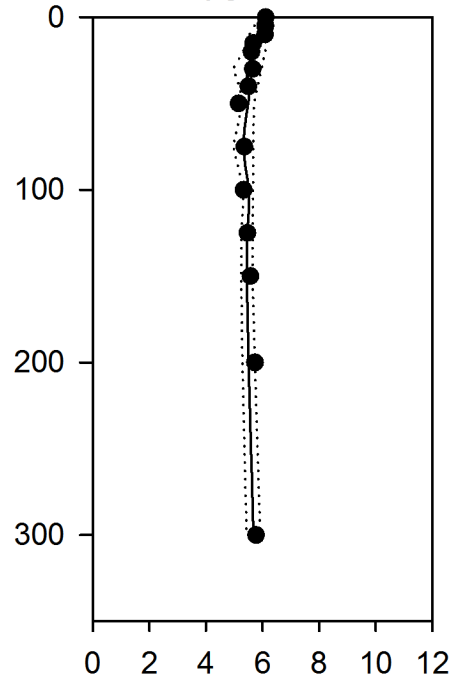
Temperature °C



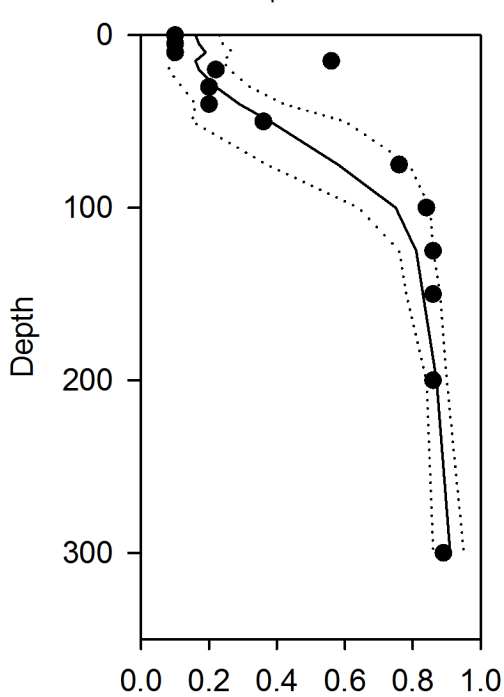
Salinity psu



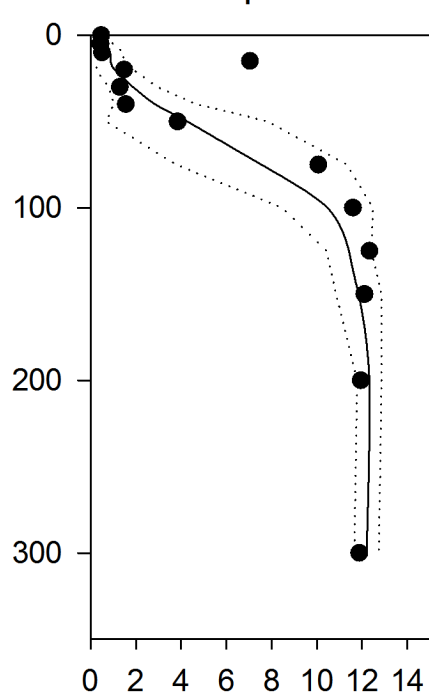
Oxygen ml/l



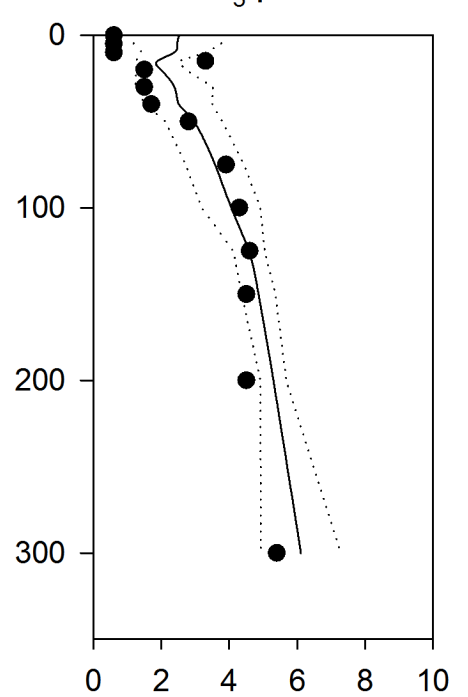
PO₄ µmol/l



DIN µmol/l



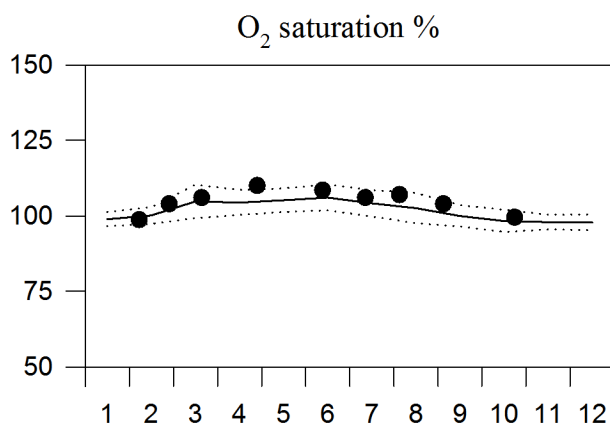
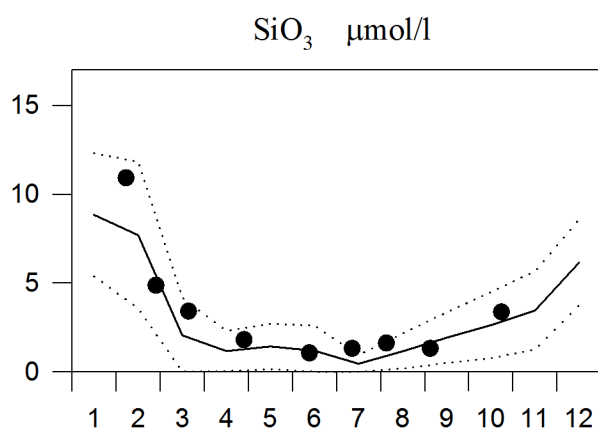
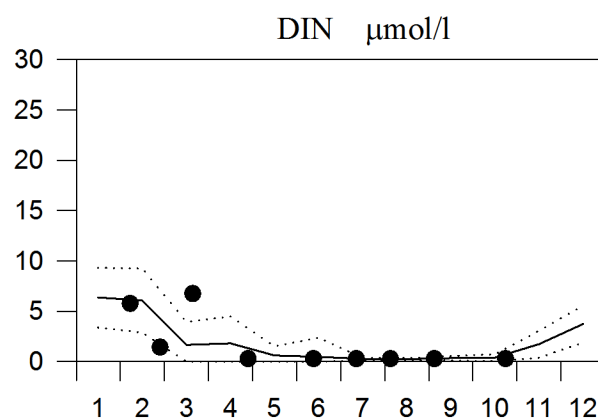
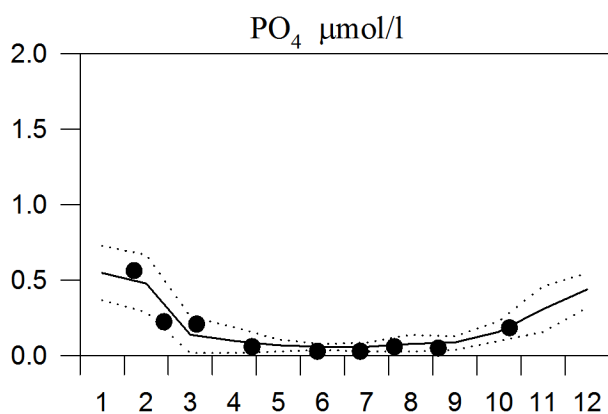
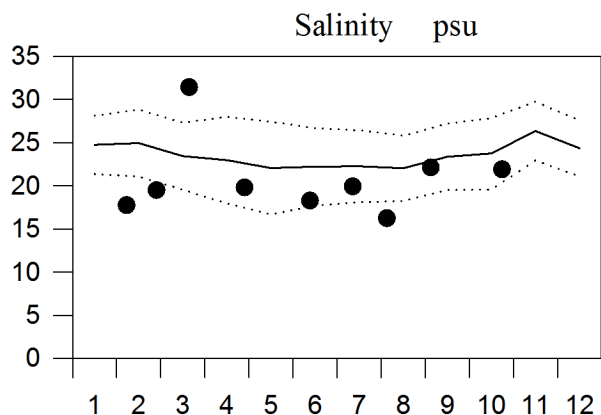
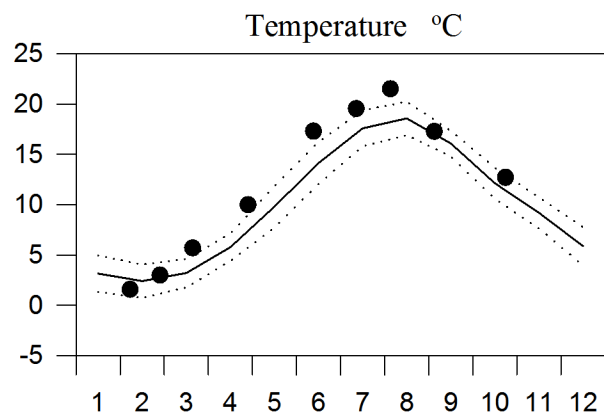
SiO₃ µmol/l



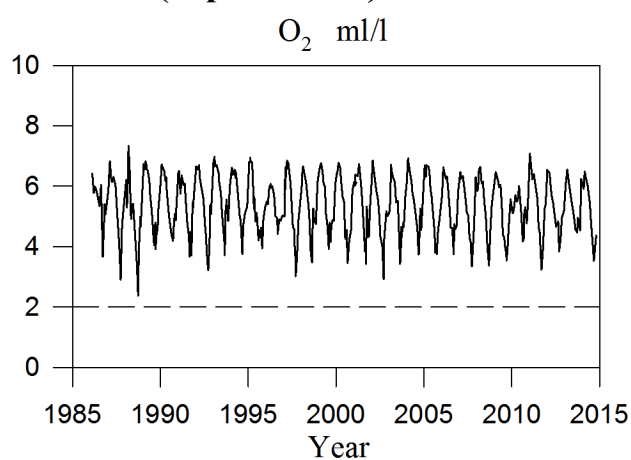
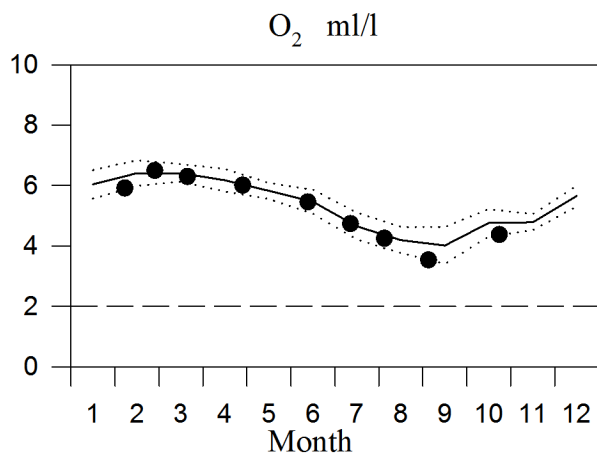
STATION FLADEN SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2014

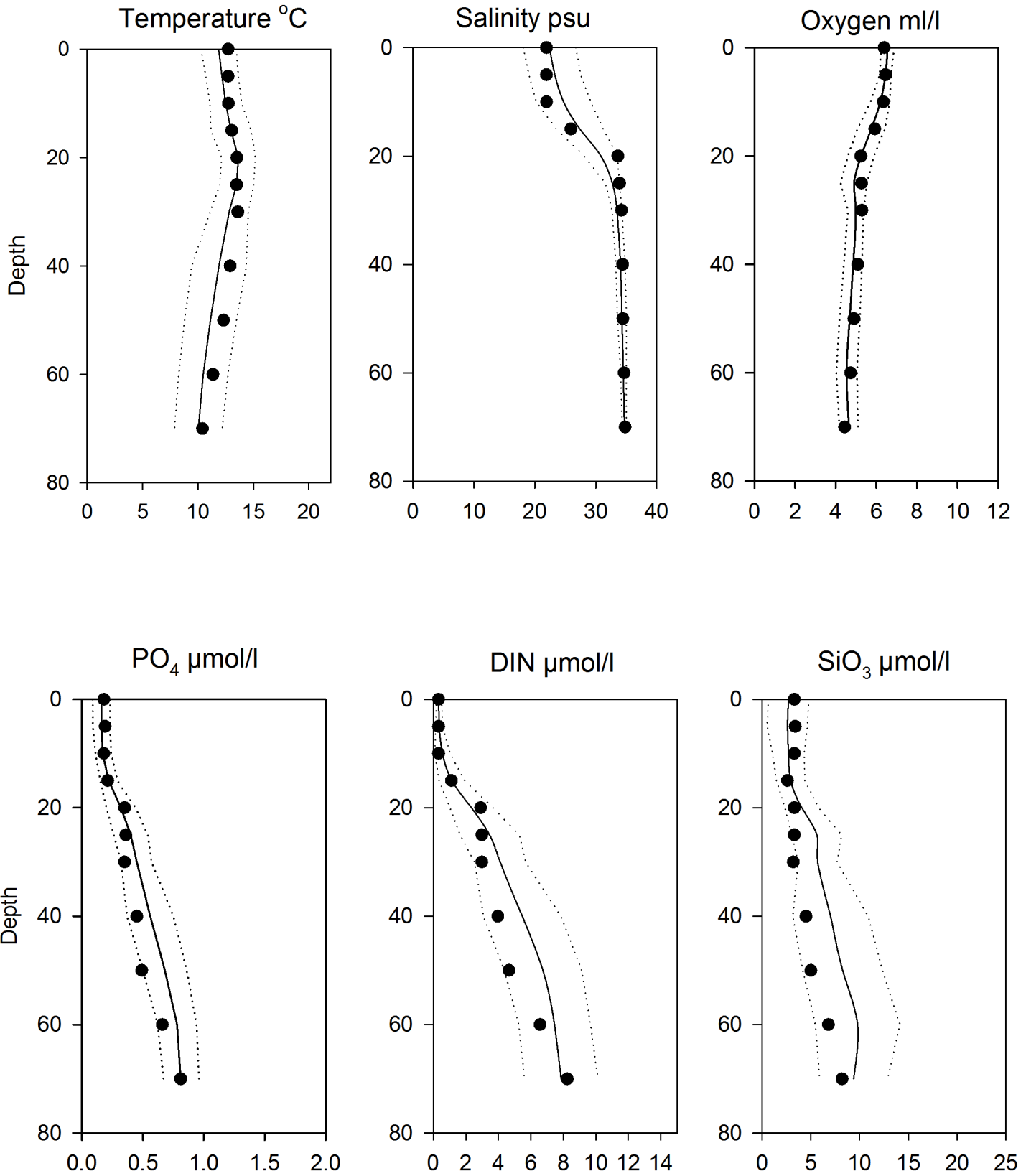


OXYGEN IN BOTTOM WATER (depth > 70m)



Vertical profiles Fladen October

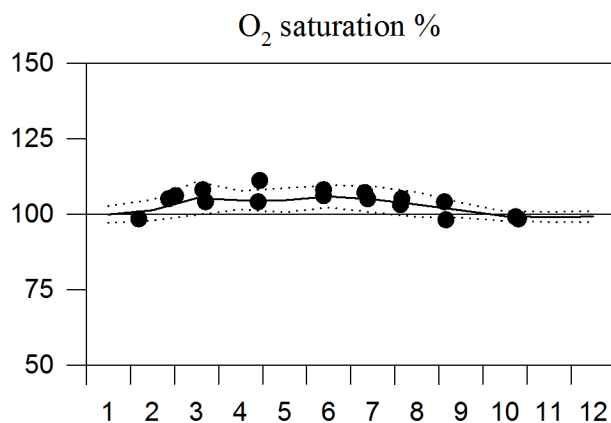
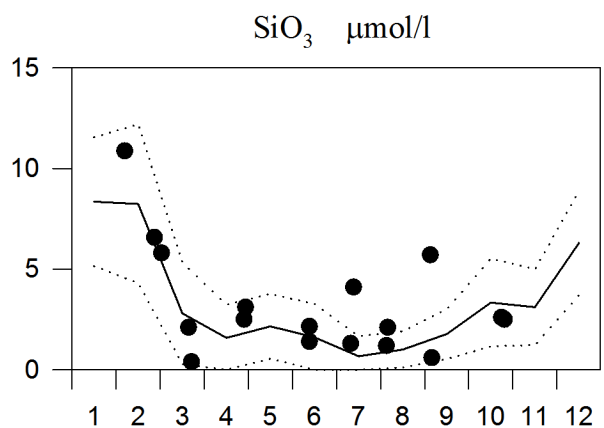
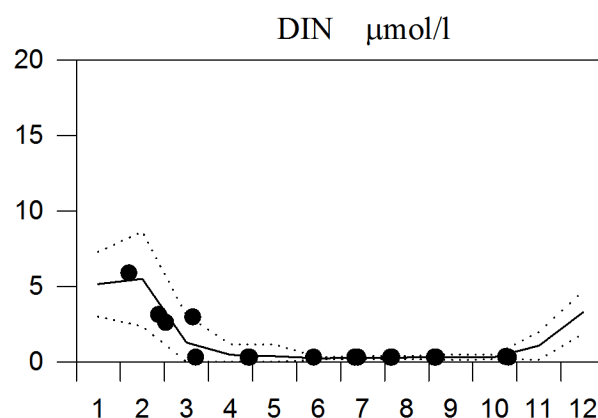
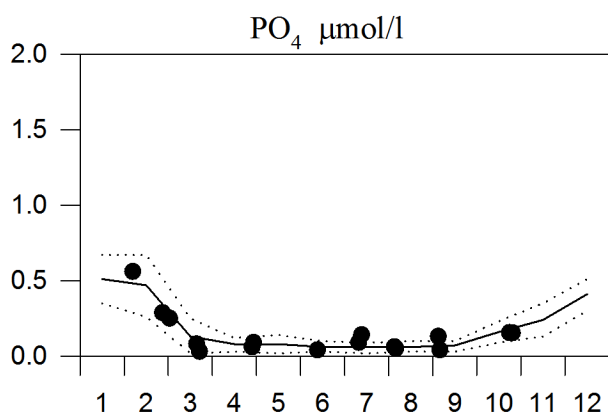
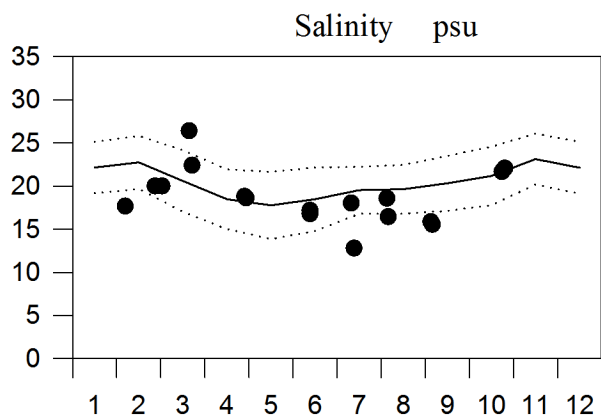
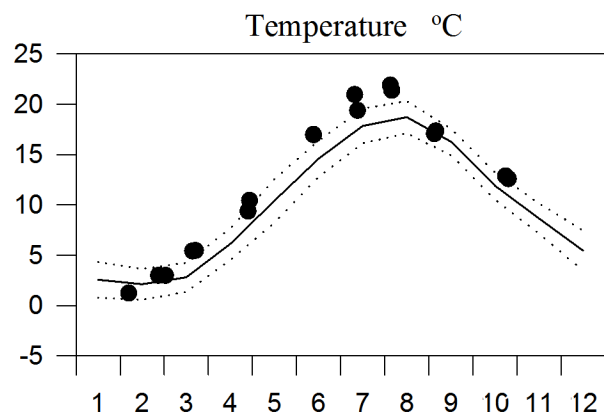
— Mean 1996-2010 St.Dev. ● 2014



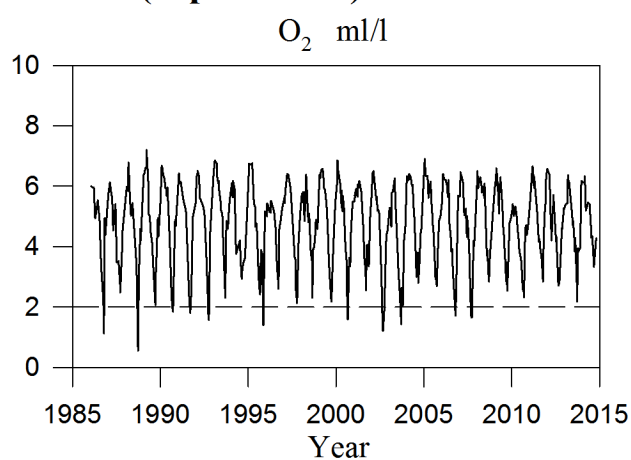
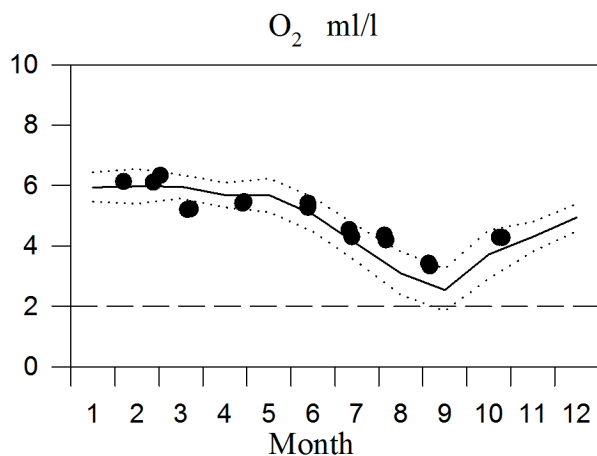
STATION ANHOLT E SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2014

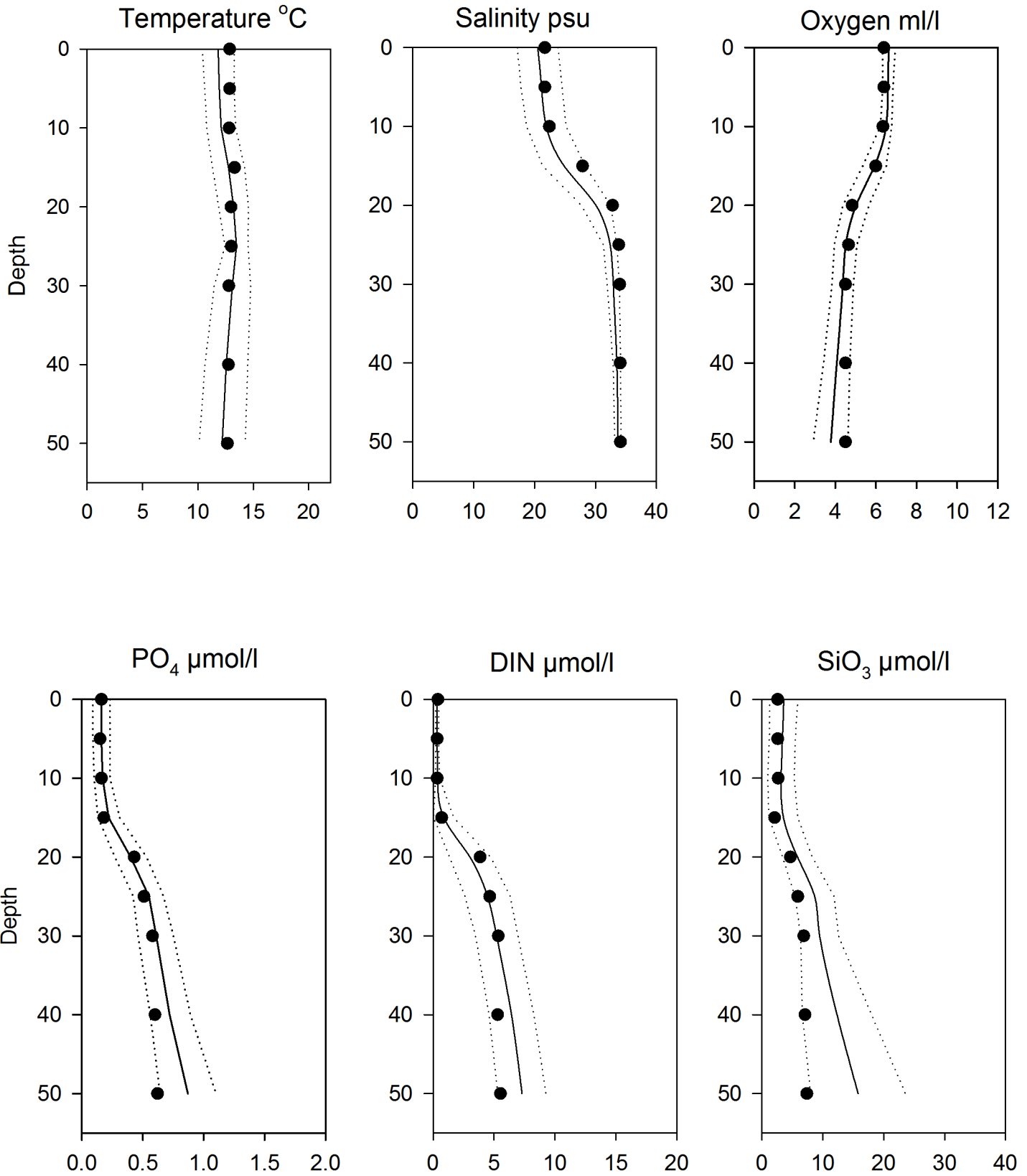


OXYGEN IN BOTTOM WATER (depth > 50m)



Vertical profiles Anholt E October

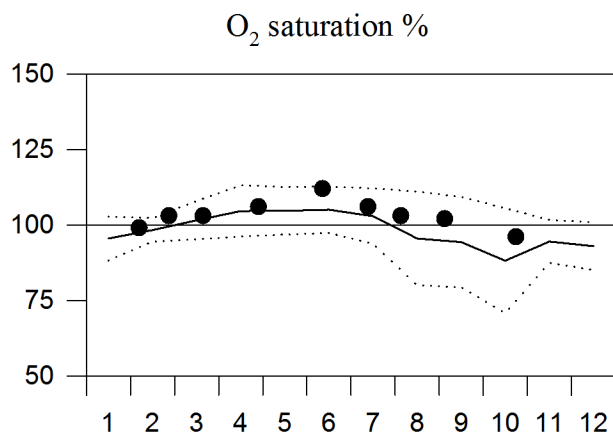
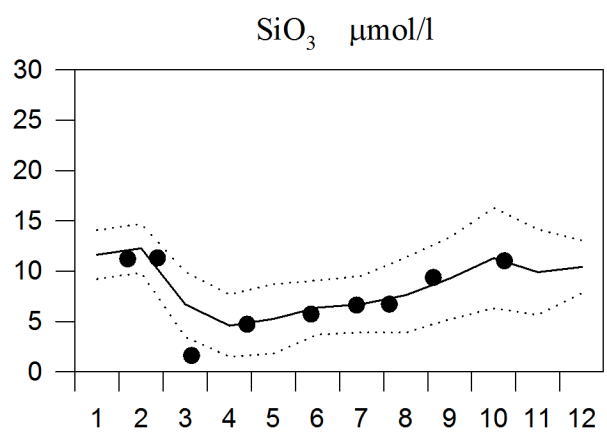
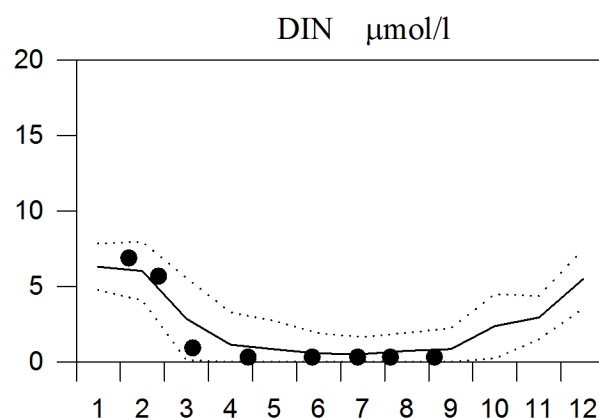
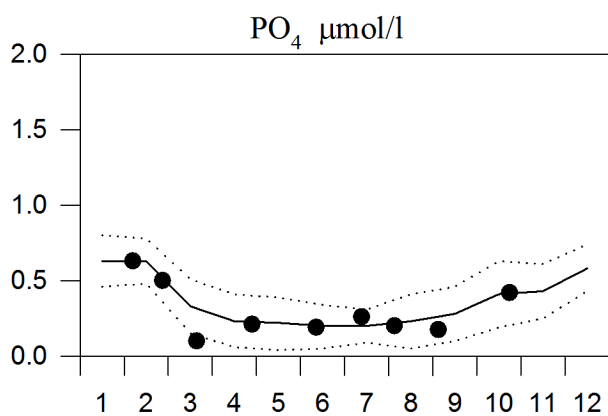
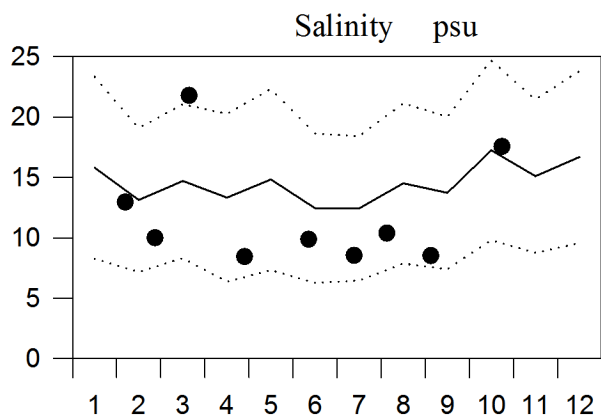
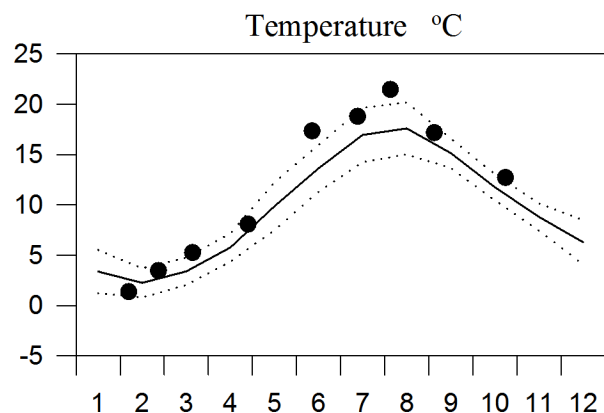
— Mean 1996-2010 St.Dev. ● 2014



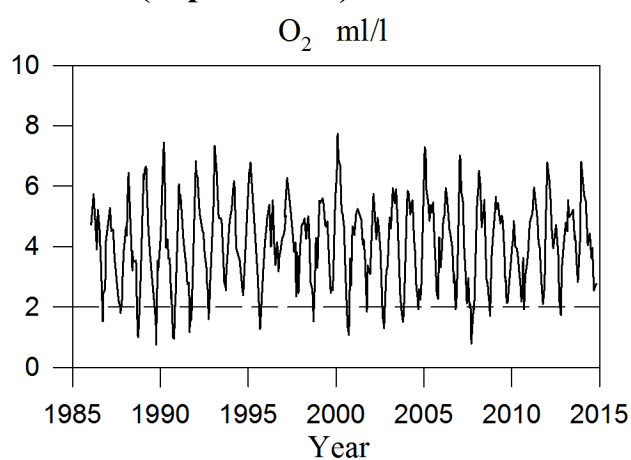
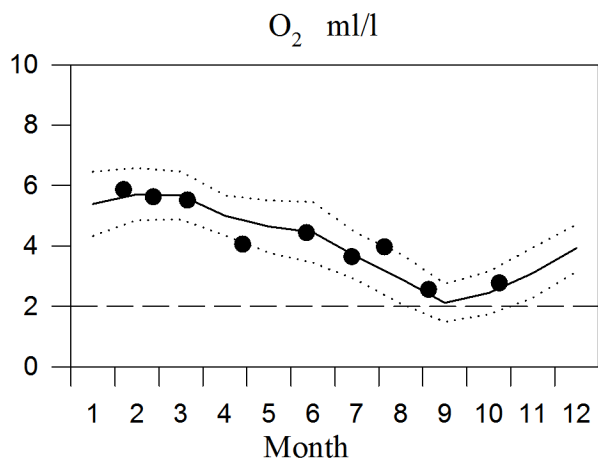
STATION W LANDSKRONA SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2014

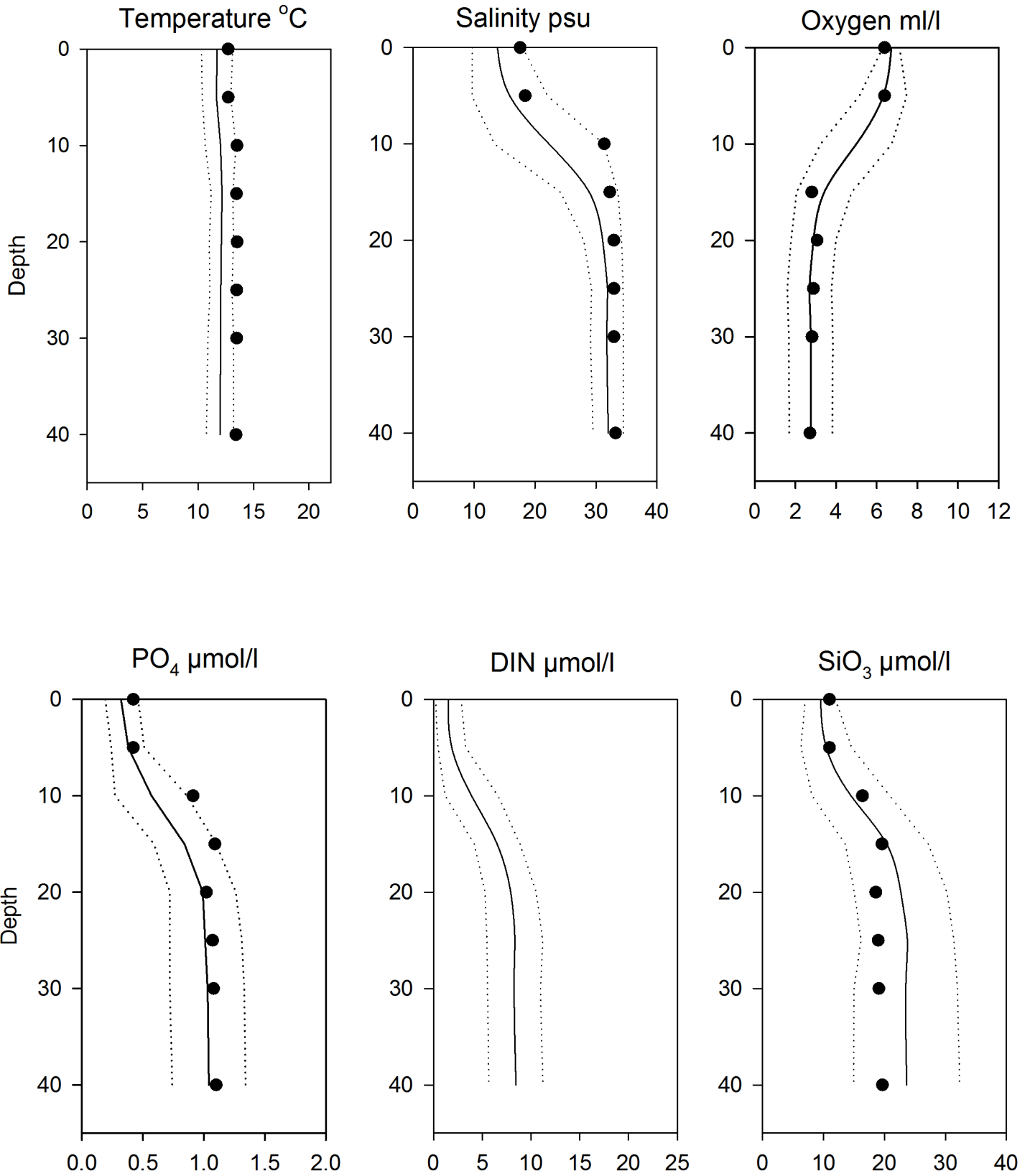


OXYGEN IN BOTTOM WATER (depth >40m)



Vertical profiles W Landskrona October

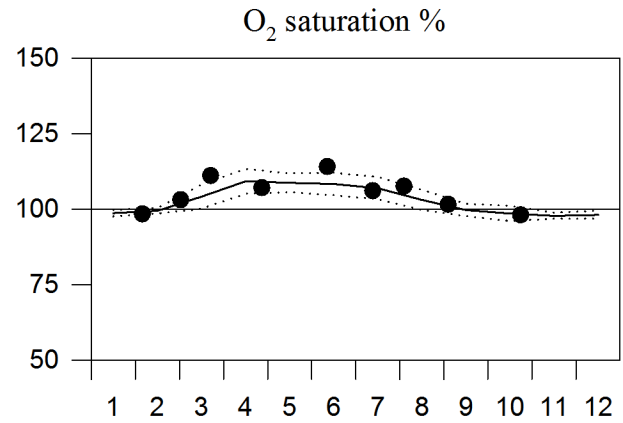
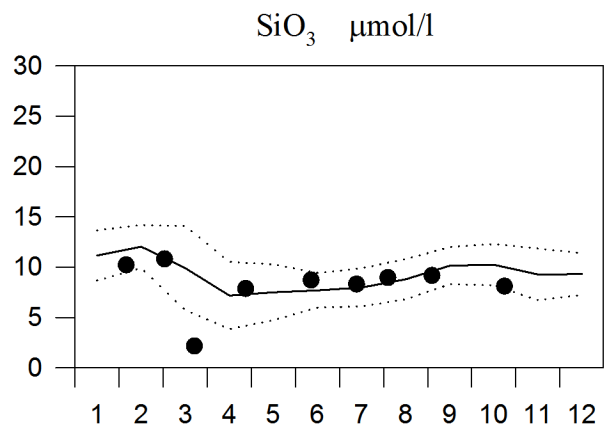
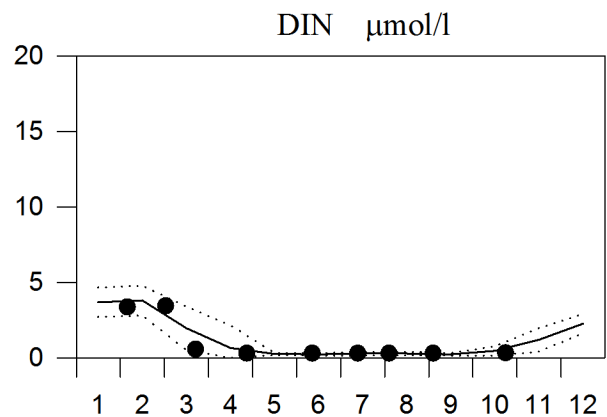
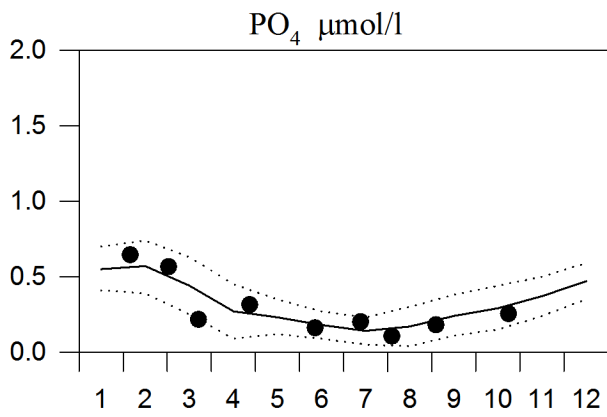
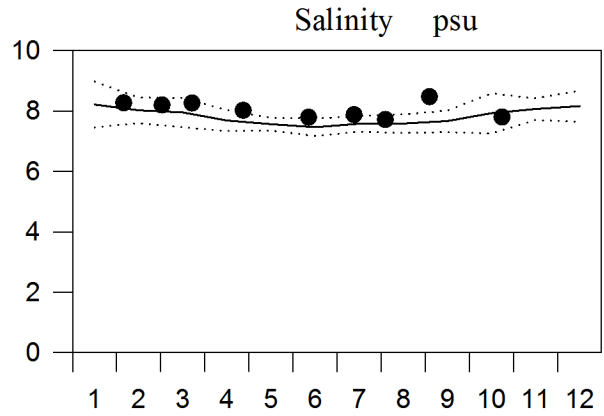
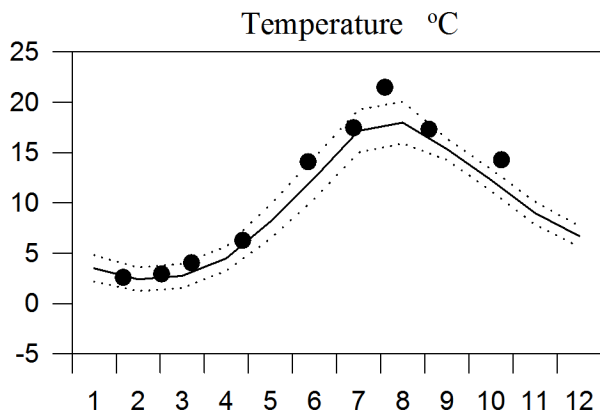
— Mean 1996-2010 St.Dev. ● 2014



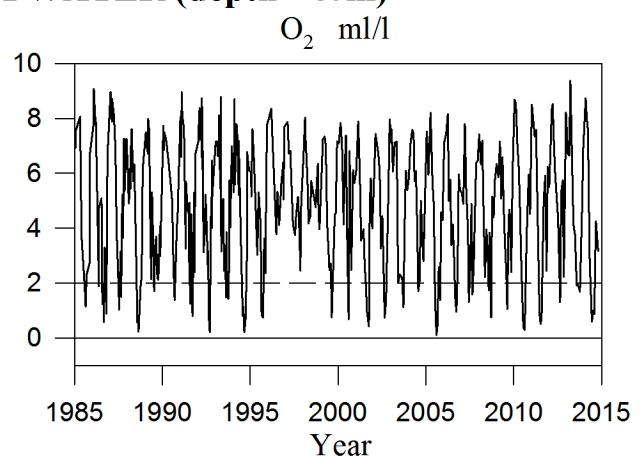
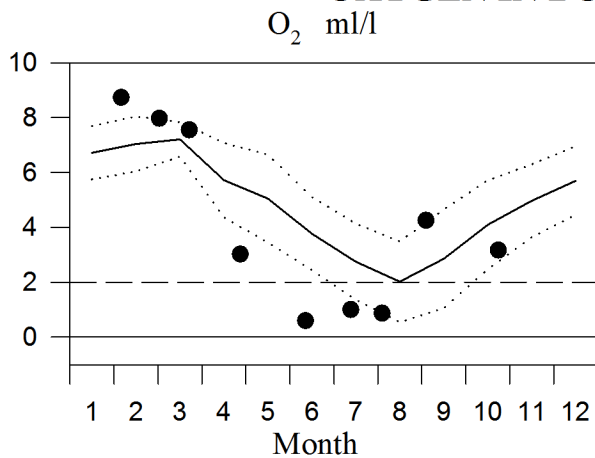
STATION BY1 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2014

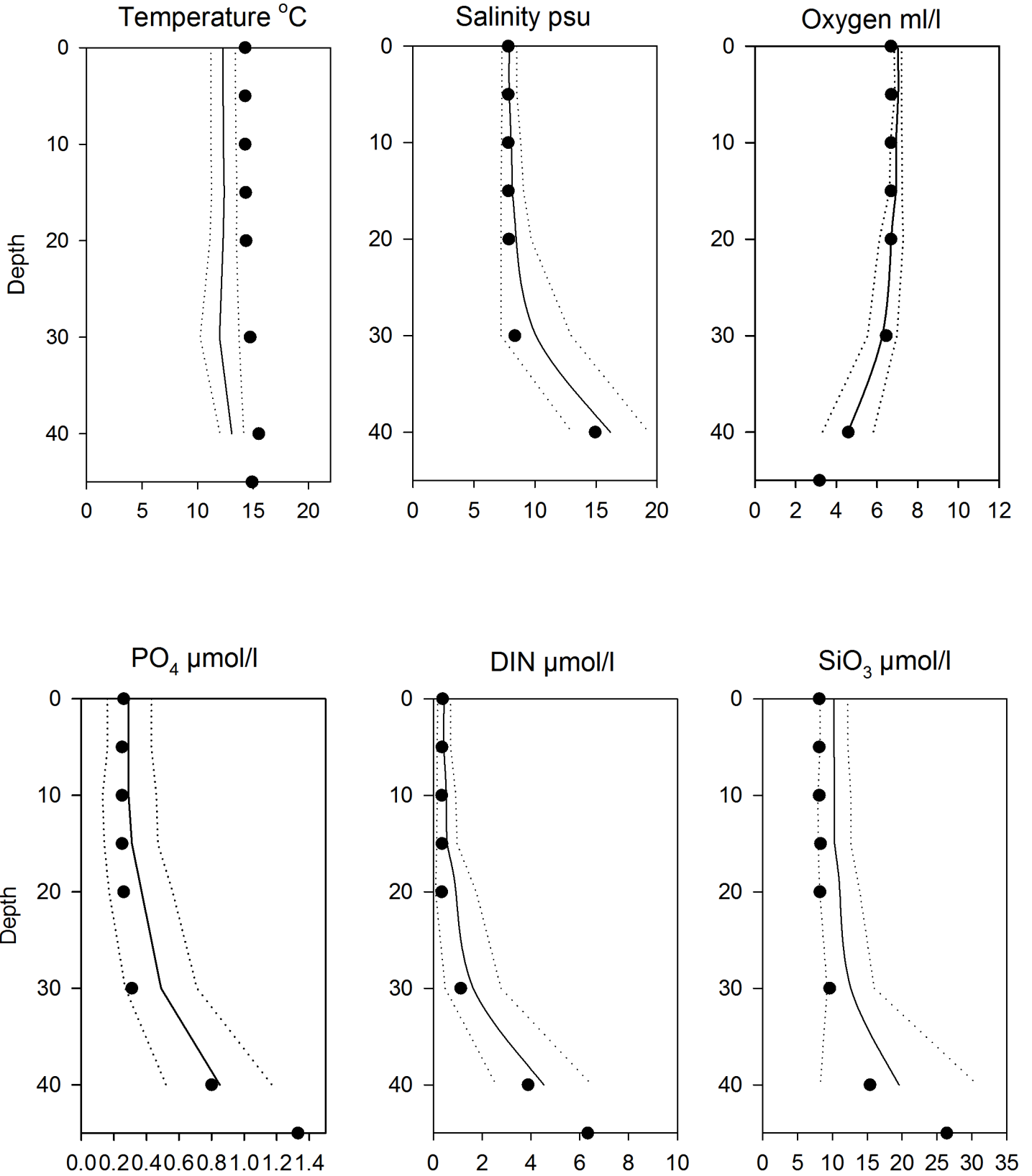


OXYGEN IN BOTTOM WATER (depth >40m)



Vertical profiles BY1 October

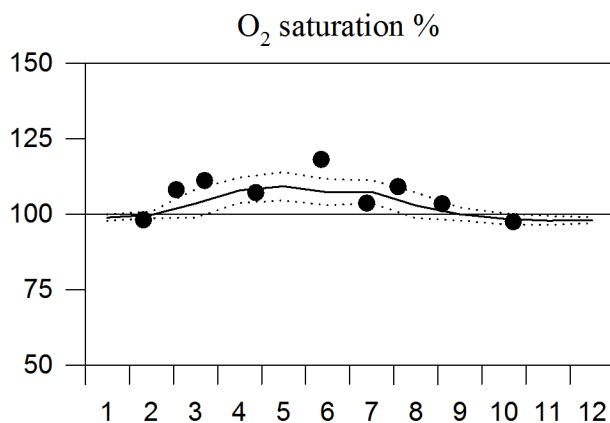
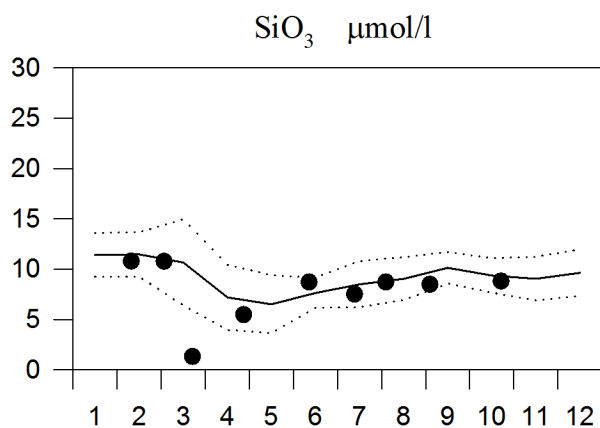
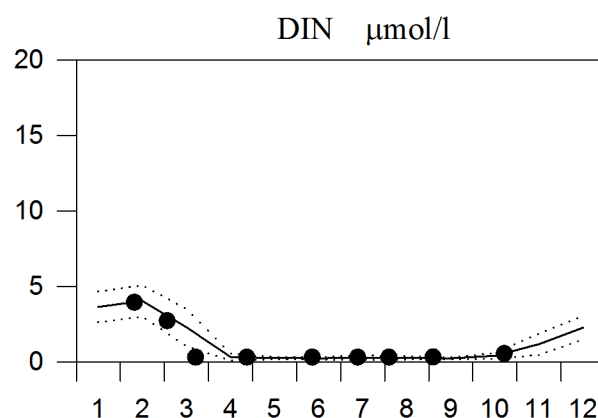
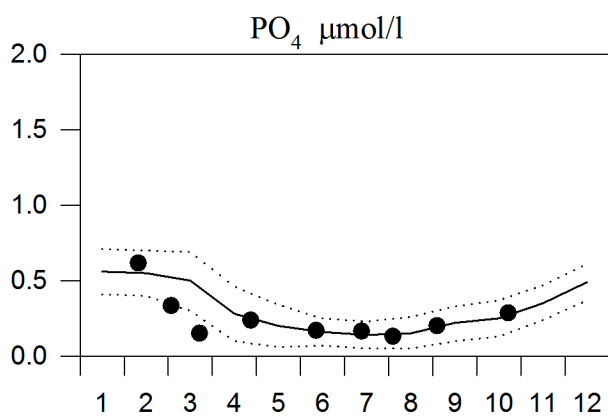
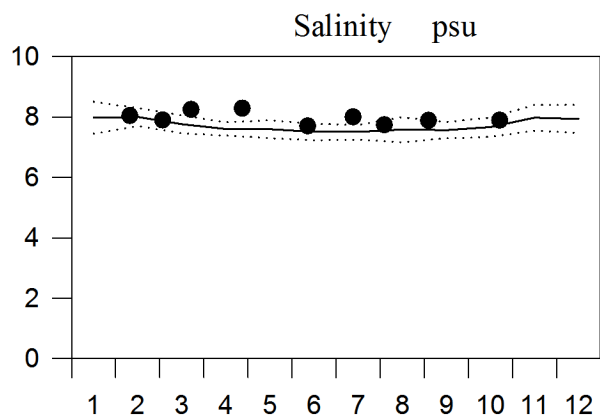
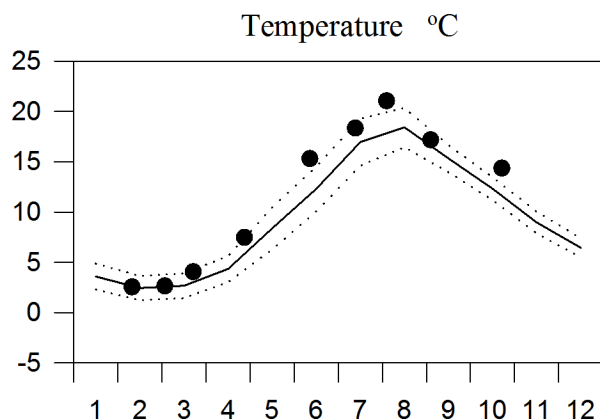
— Mean 1996-2010 St.Dev. ● 2014



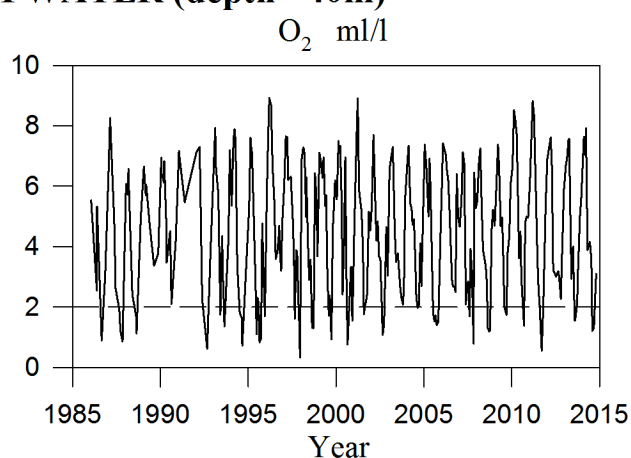
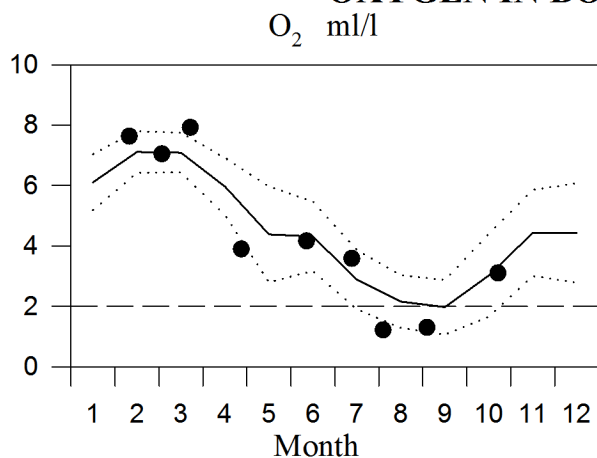
STATION BY2 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2014

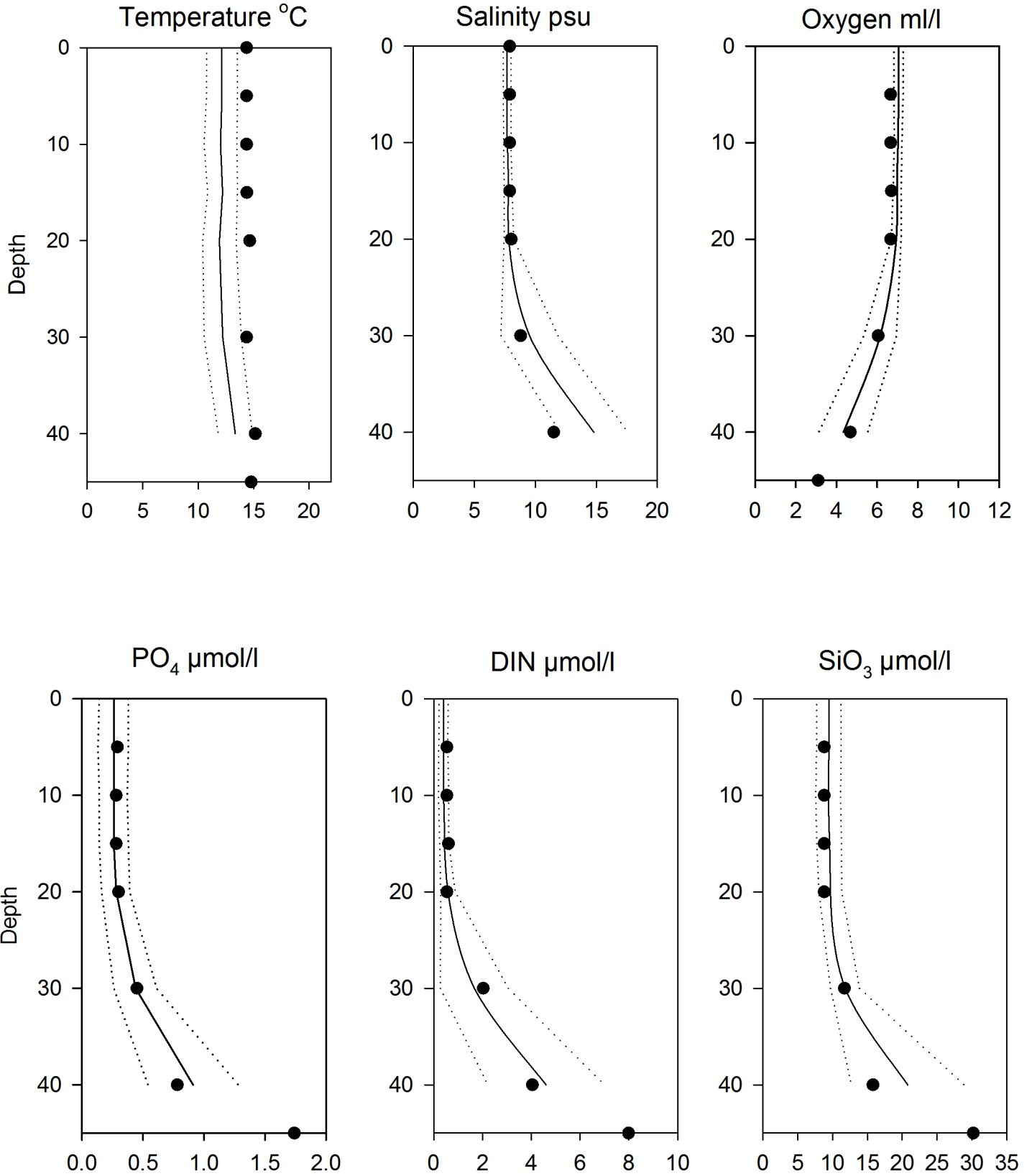


OXYGEN IN BOTTOM WATER (depth >40m)



Vertical profiles BY2 October

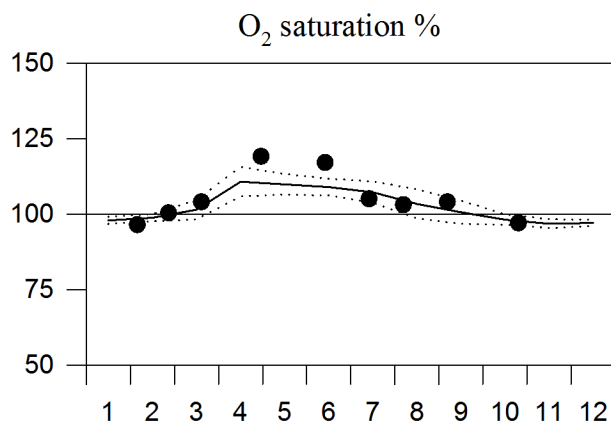
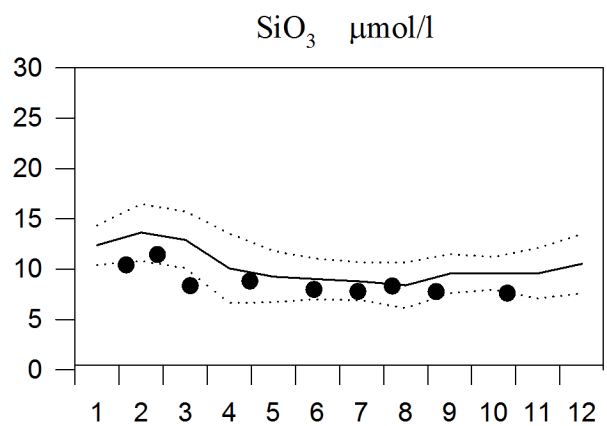
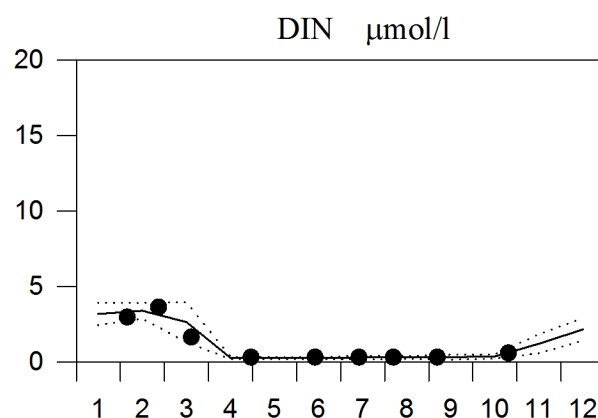
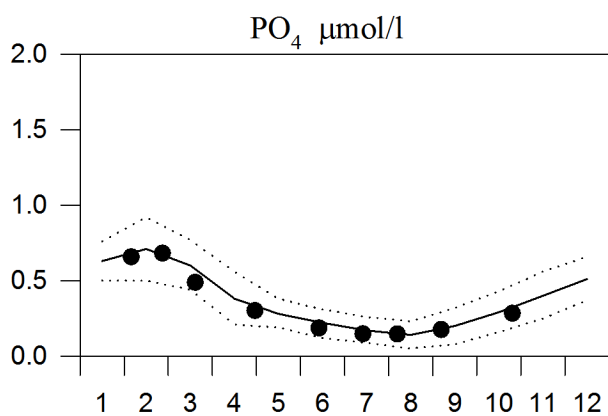
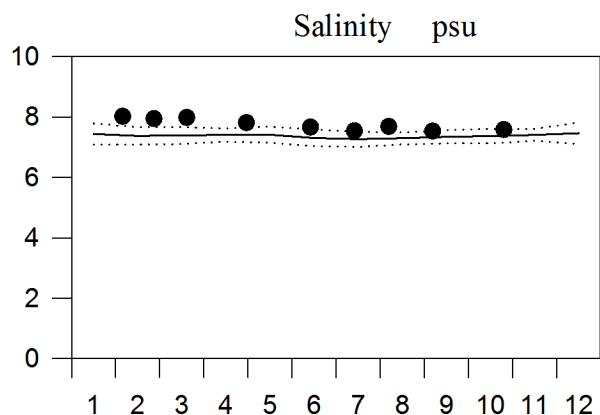
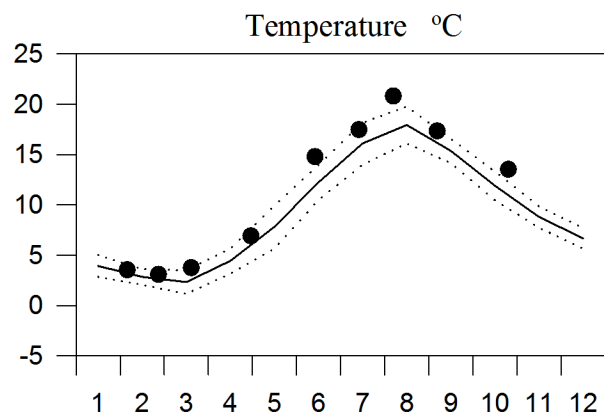
— Mean 1996-2010 St.Dev. ● 2014



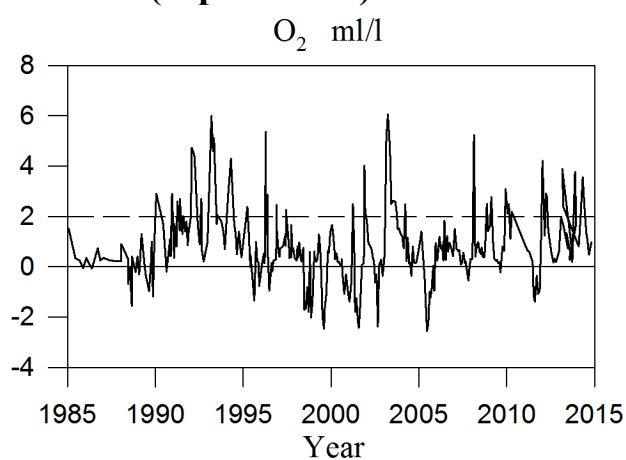
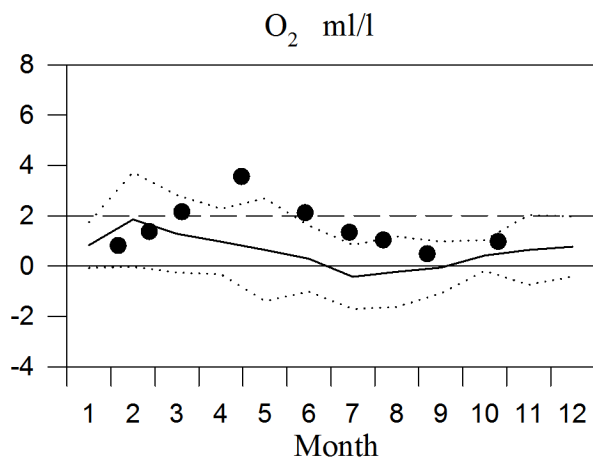
STATION HANÖBUKTEN SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2014

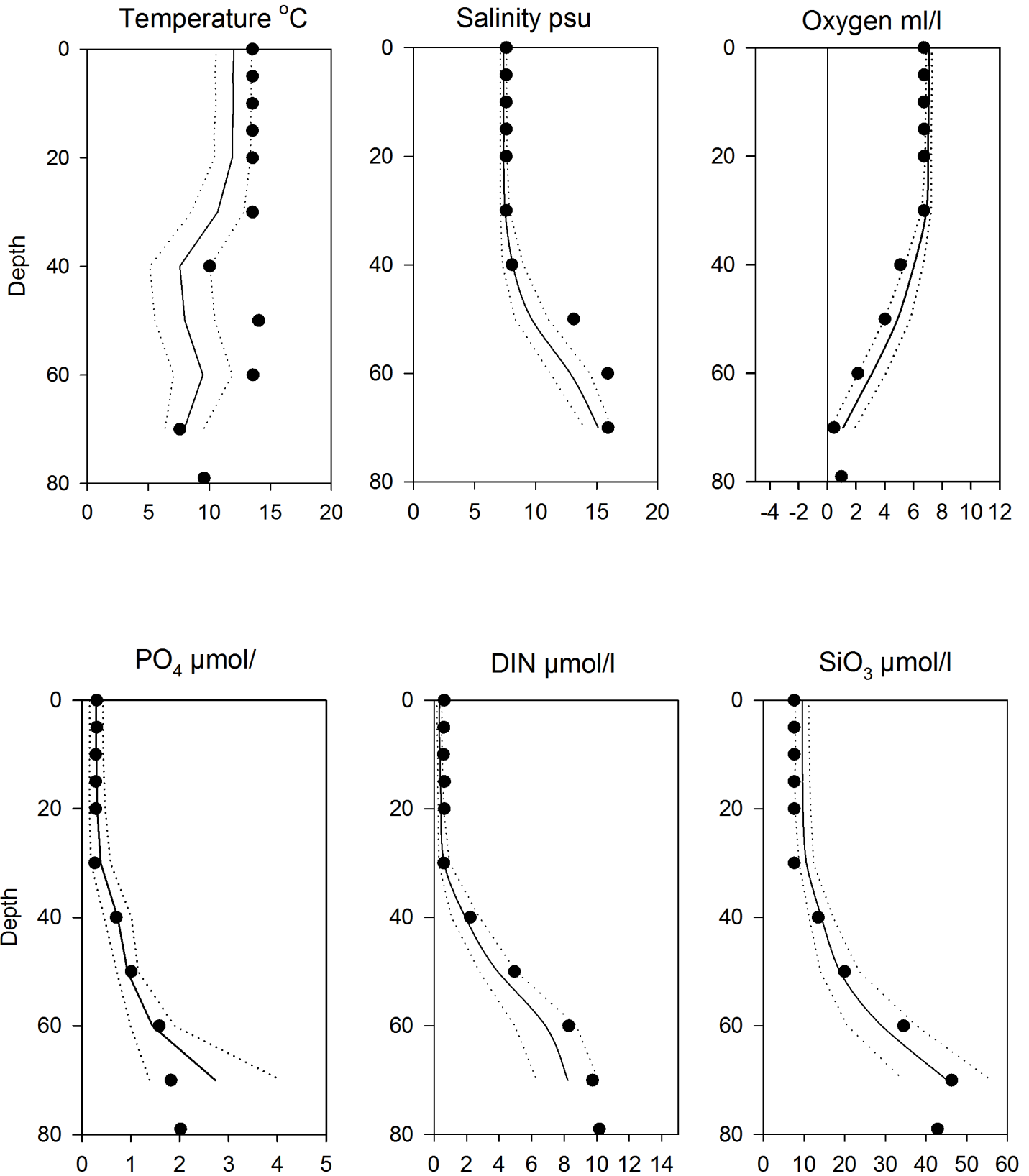


OXYGEN IN BOTTOM WATER (depth > 70m)



Vertical profiles Hanöbukten October

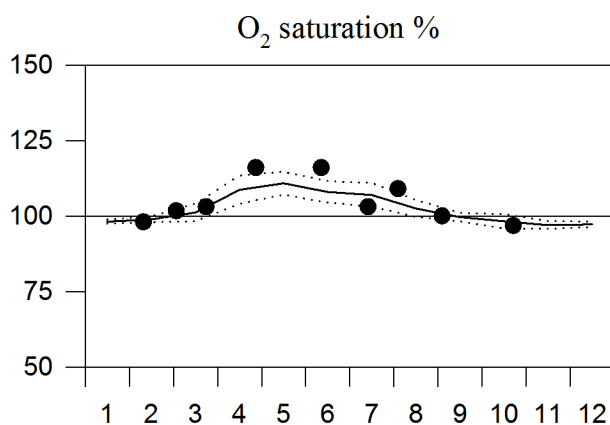
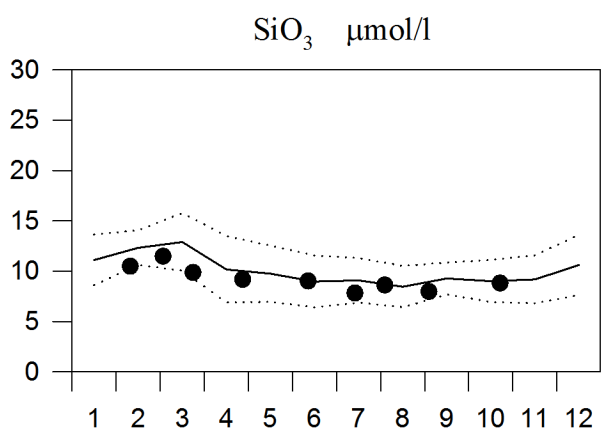
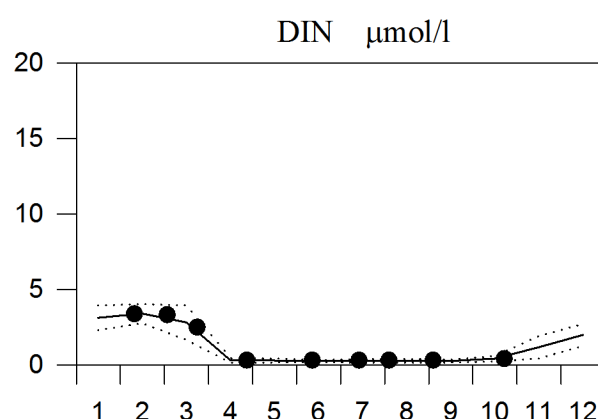
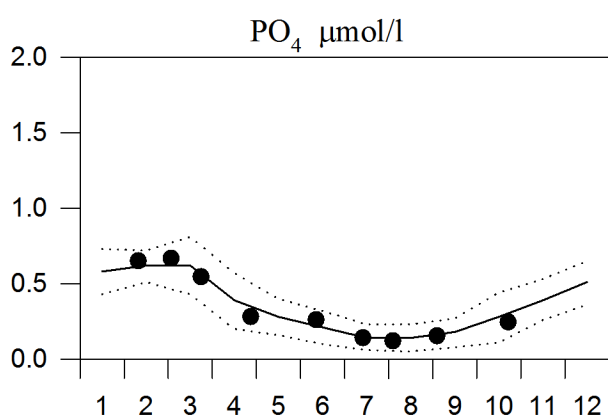
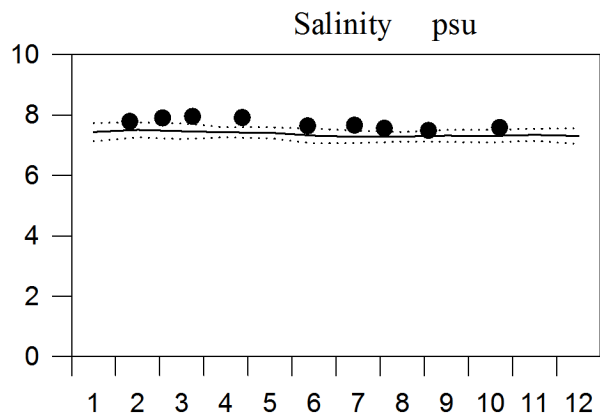
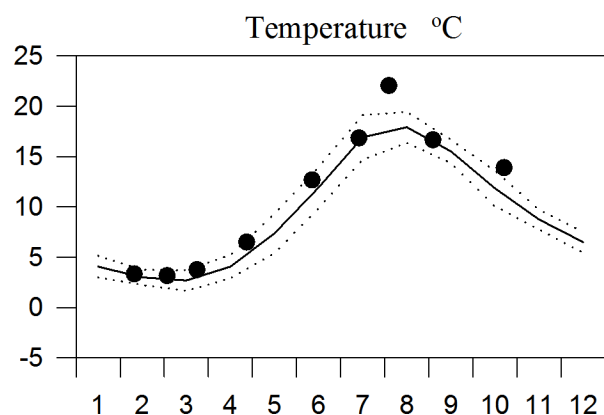
— Mean 1996-2010 St.Dev. ● 2014



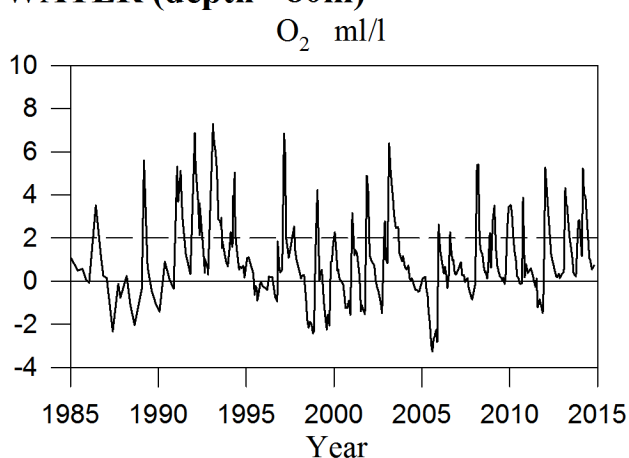
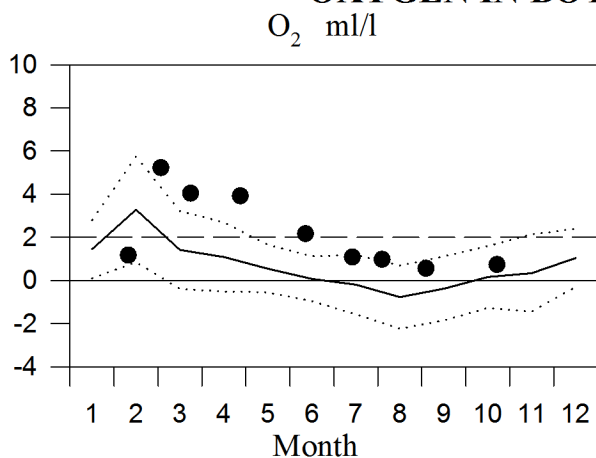
STATION BY4 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2014



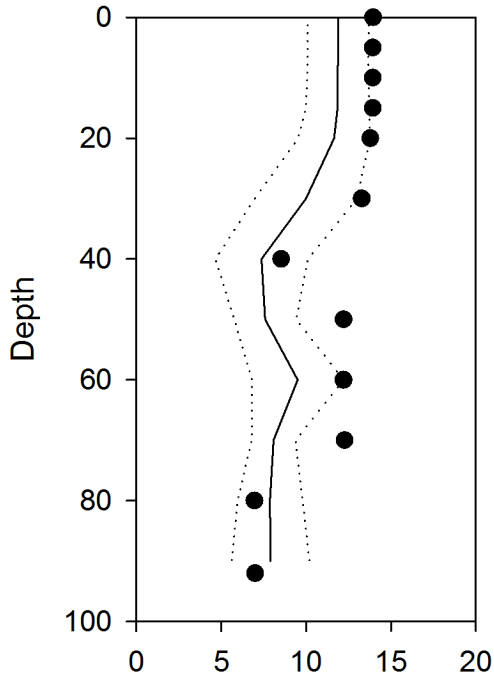
OXYGEN IN BOTTOM WATER (depth >80m)



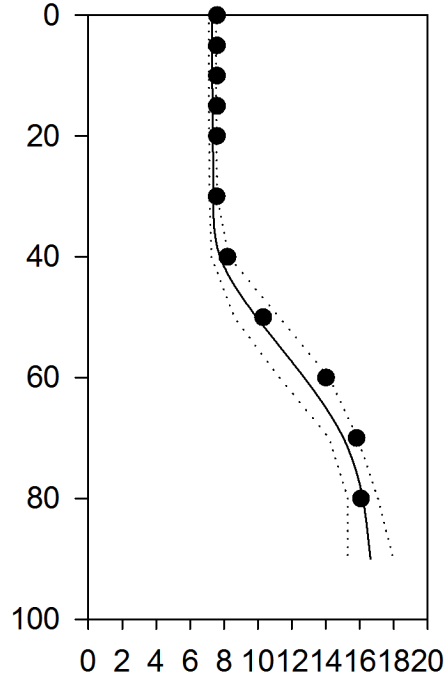
Vertical profiles BY4 October

— Mean 1996-2010 St.Dev. ● 2014

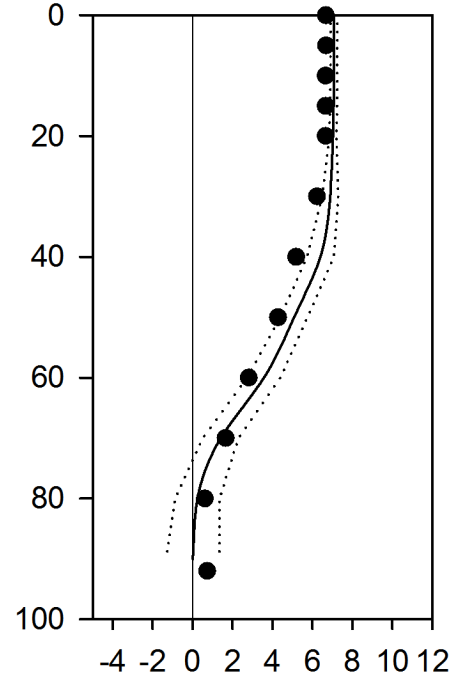
Temperature °C



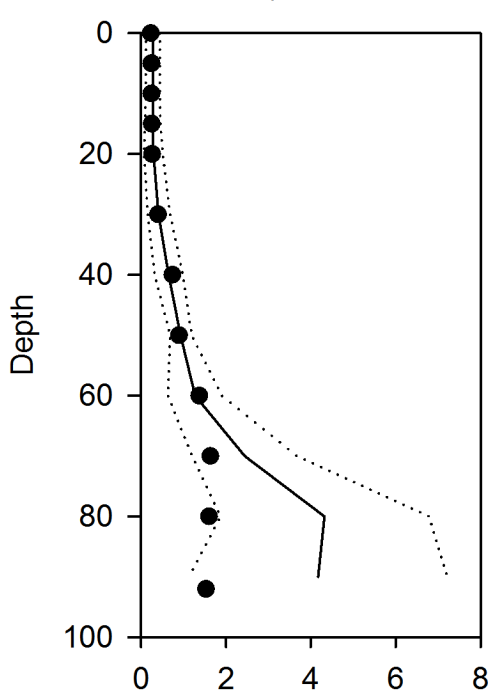
Salinity psu



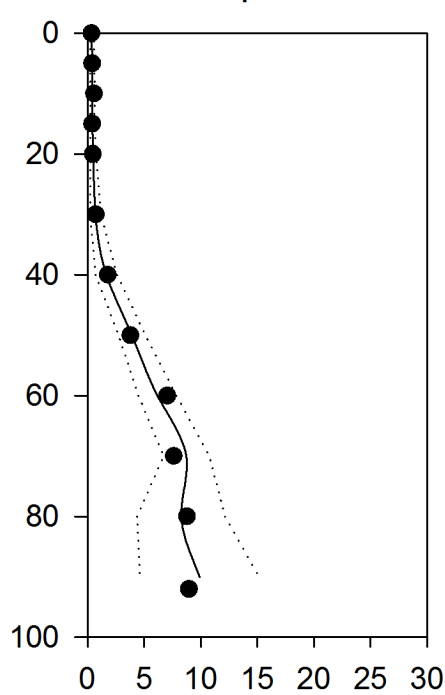
Oxygen ml/l



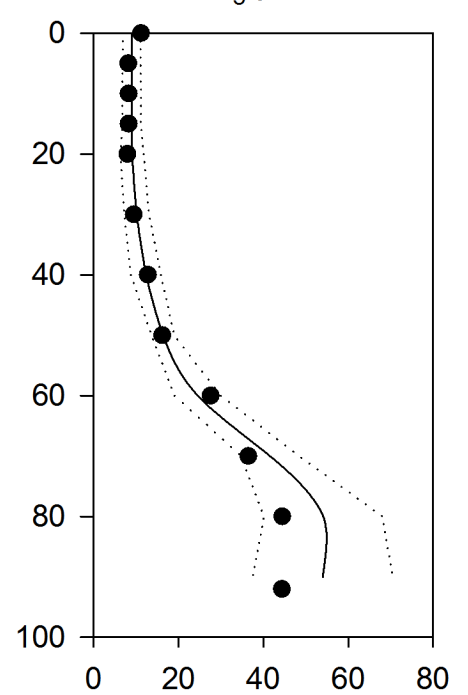
PO₄ μmol/l



DIN μmol/l



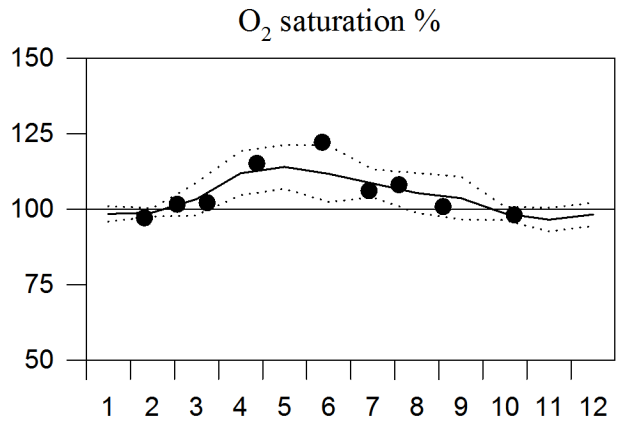
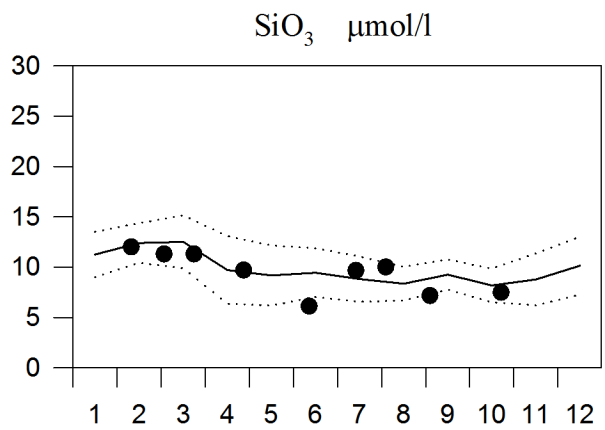
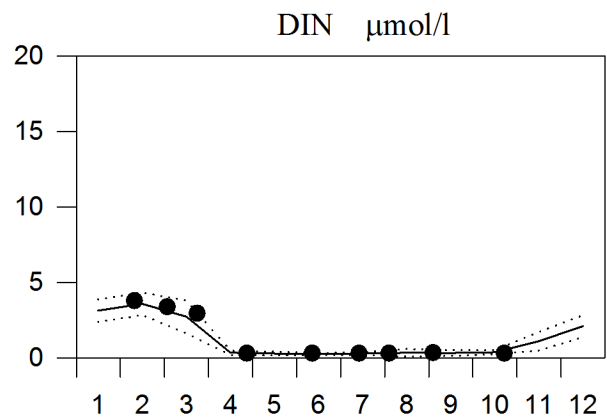
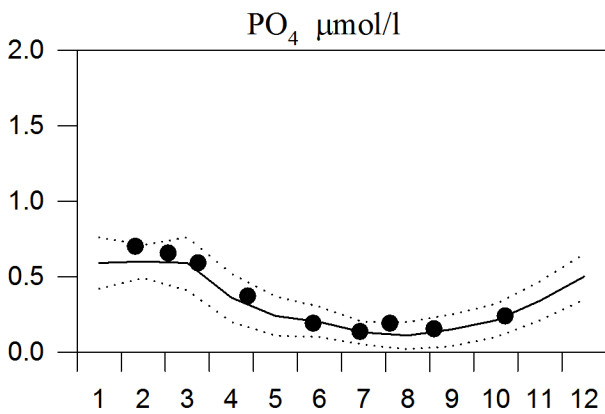
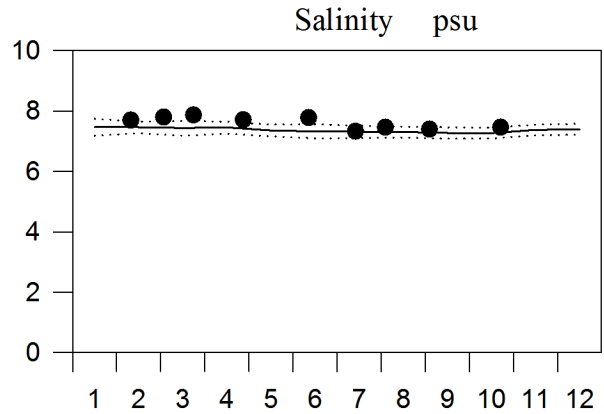
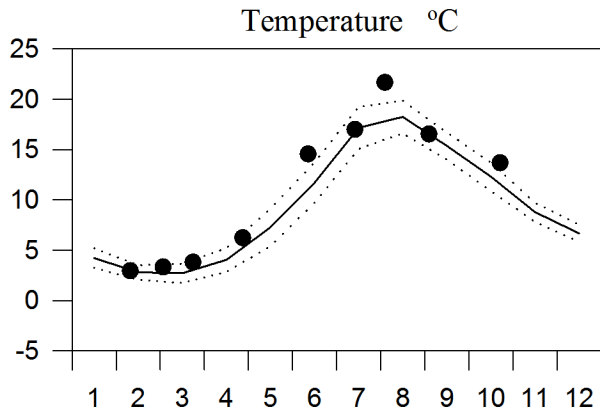
SiO₃ μmol/l



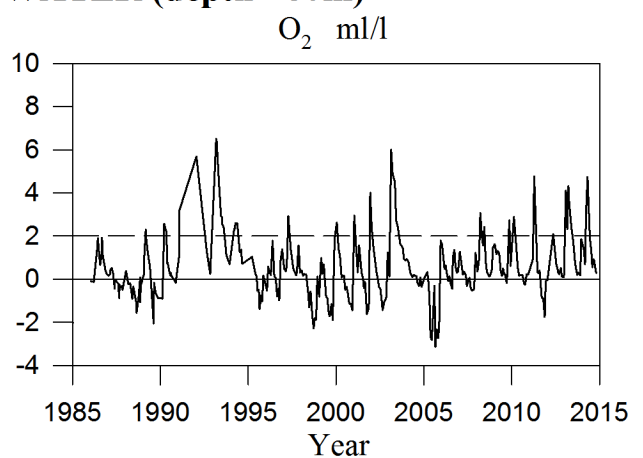
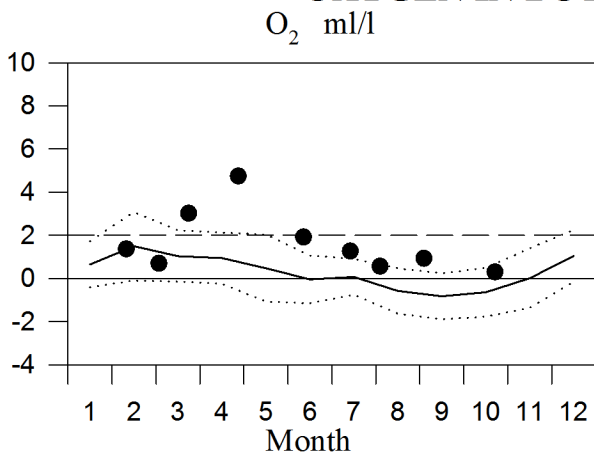
STATION BY5 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2014

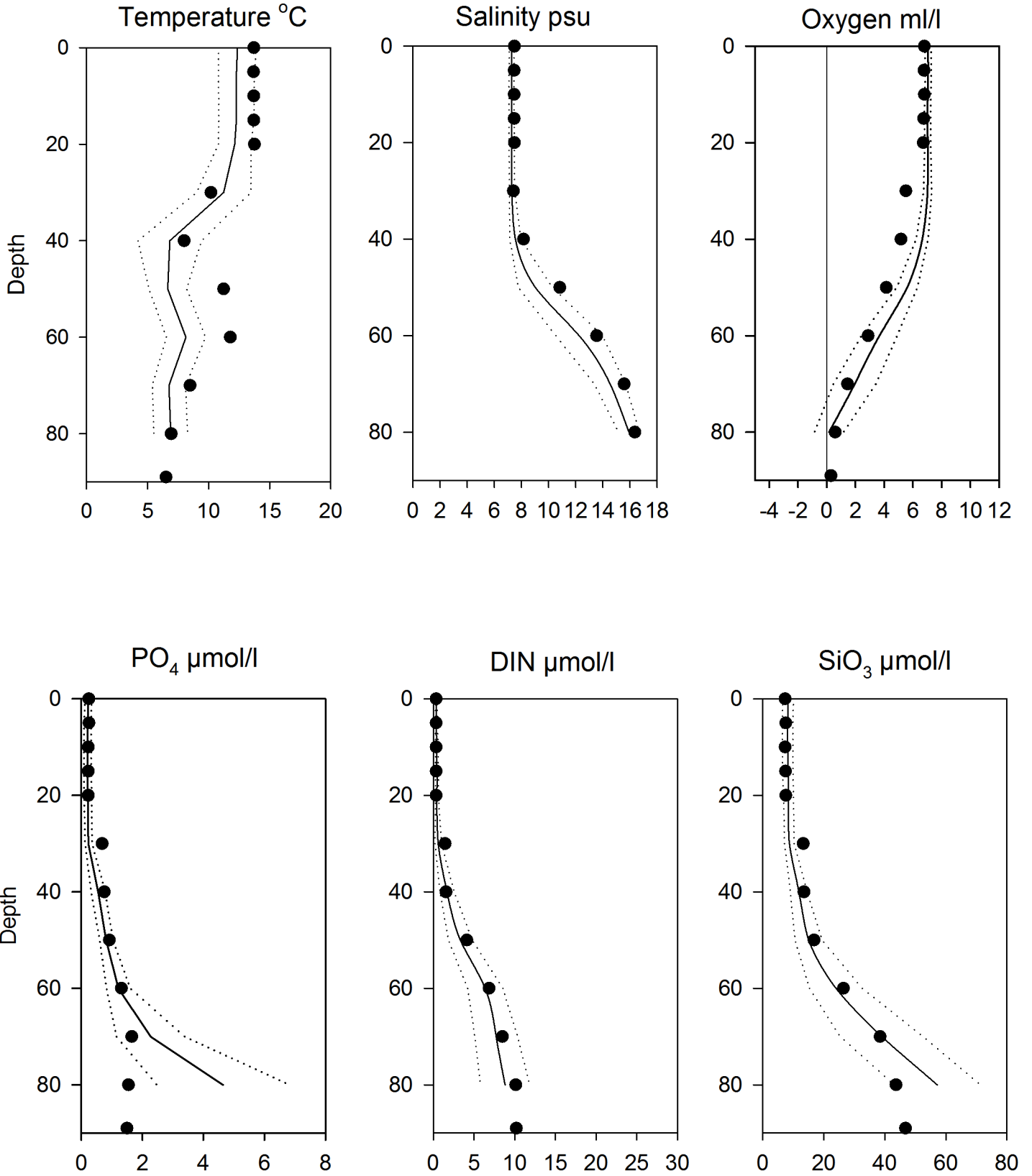


OXYGEN IN BOTTOM WATER (depth >80m)



Vertical profiles BY5 October

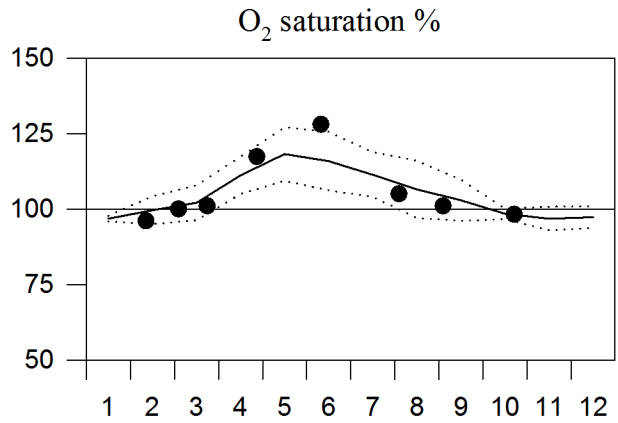
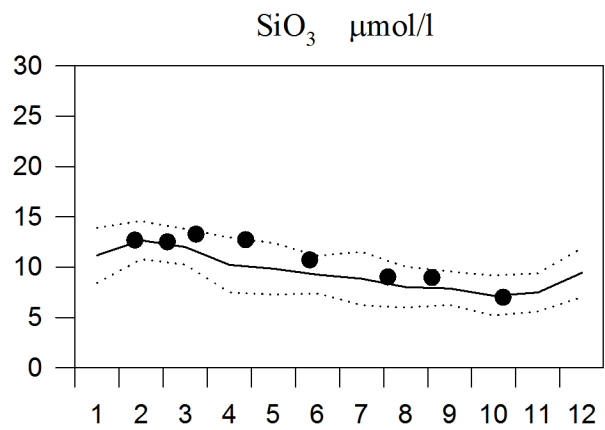
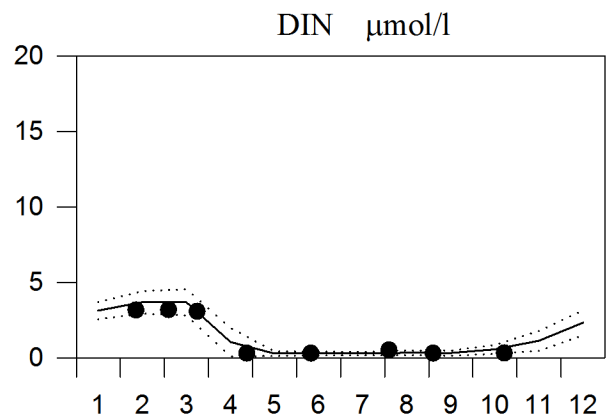
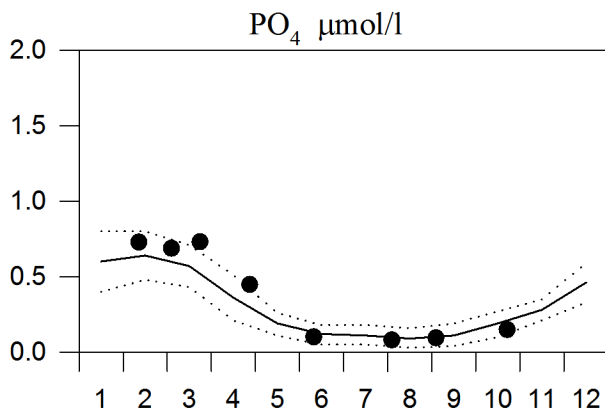
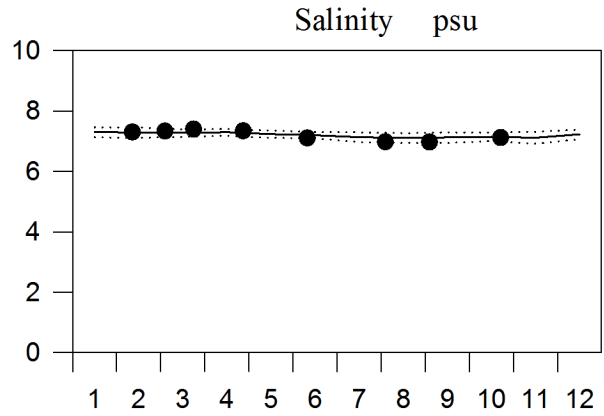
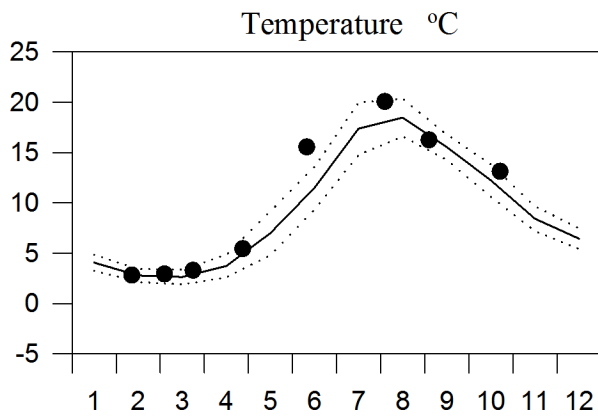
— Mean 1996-2010 St.Dev. ● 2014



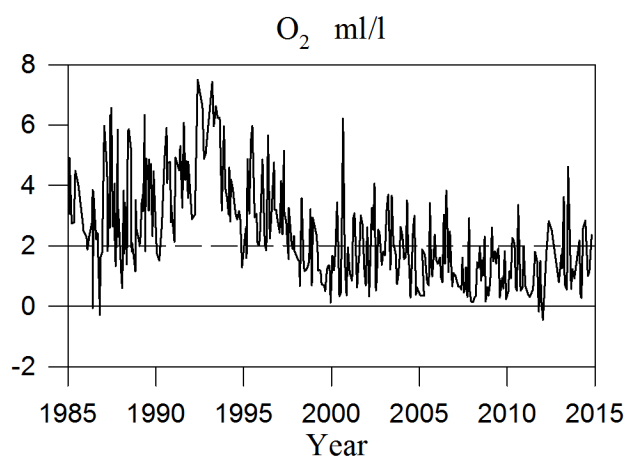
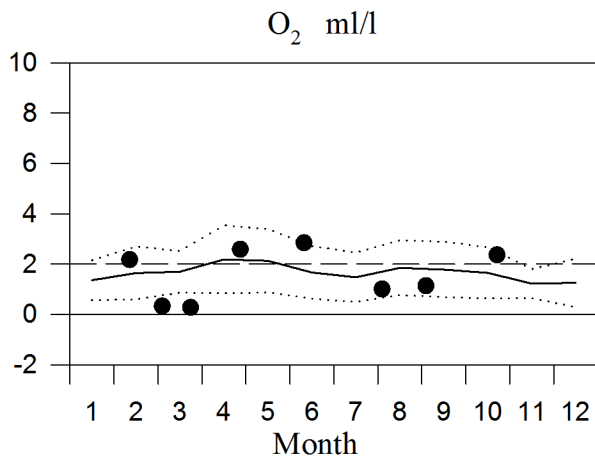
STATION BCS III-10 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2014

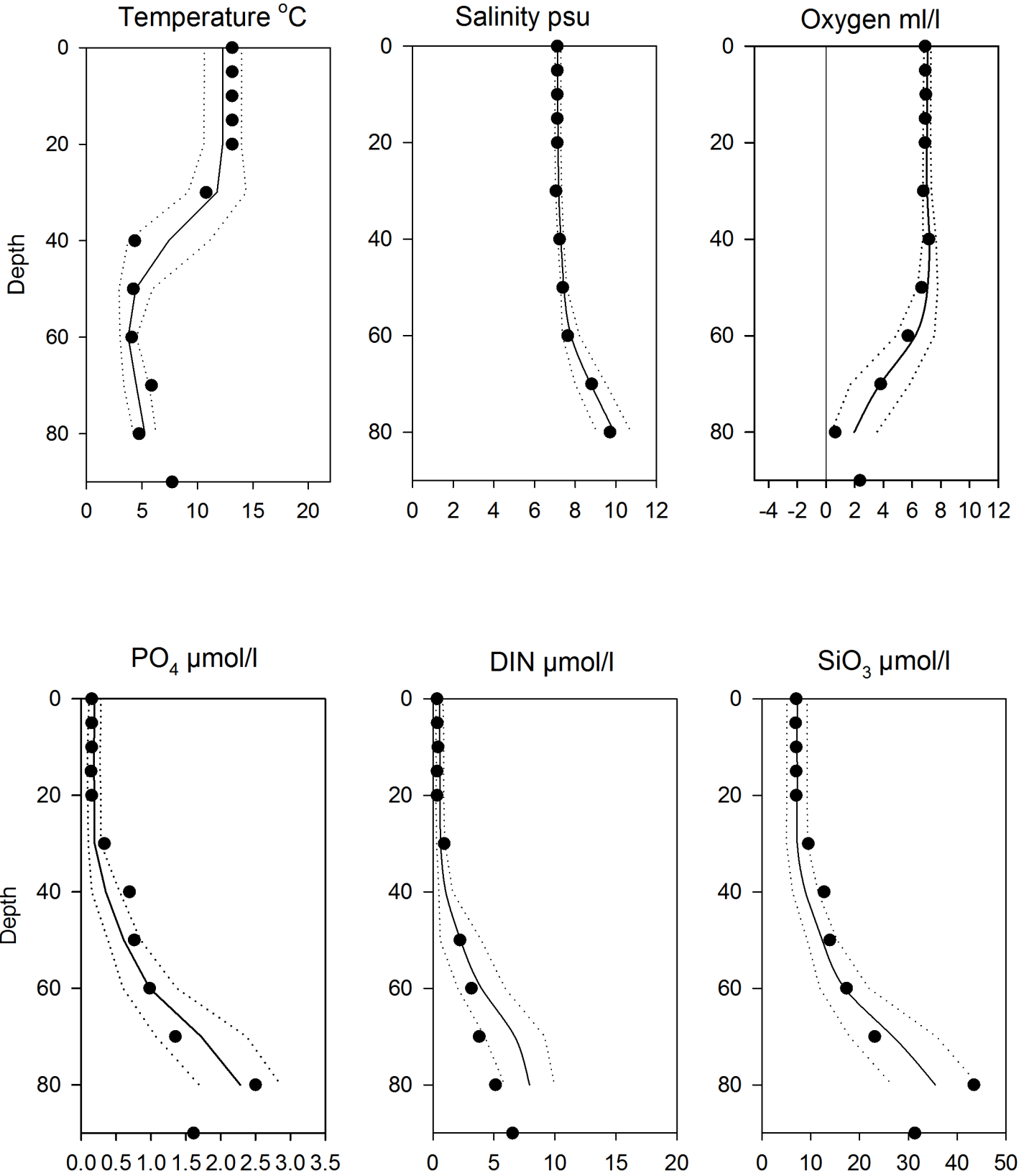


OXYGEN IN BOTTOM WATER (depth > 80m)



Vertical profiles BCS III-10 October

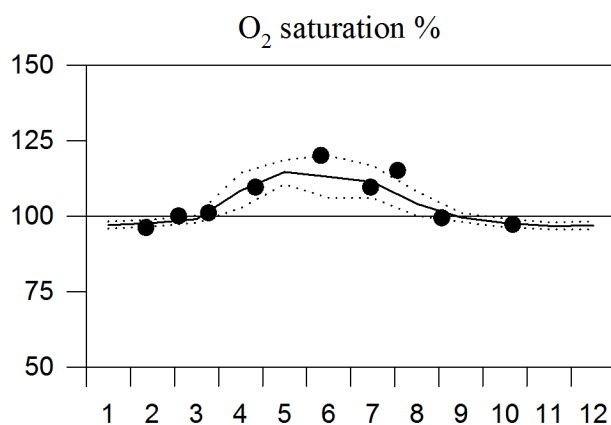
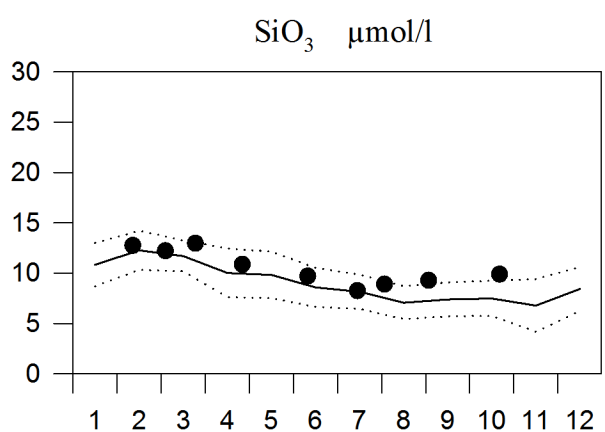
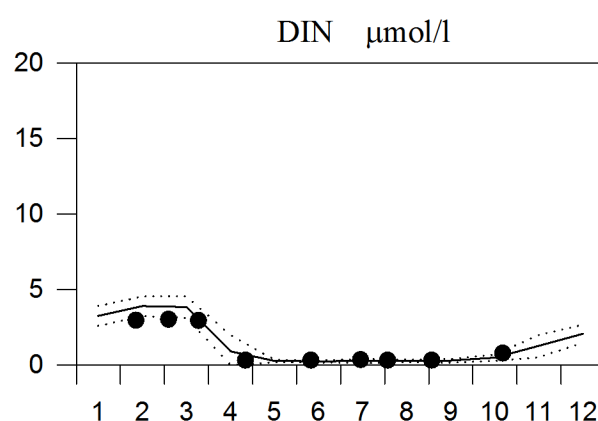
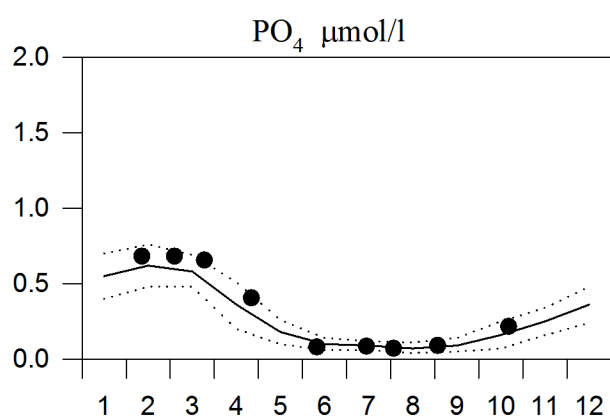
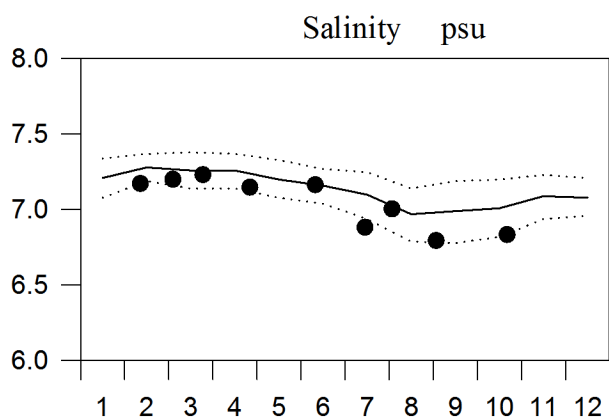
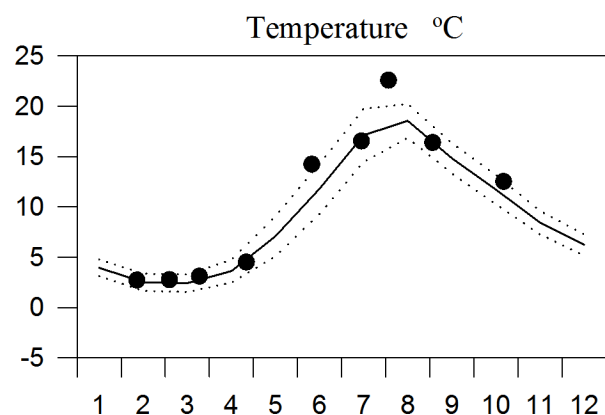
— Mean 1996-2010 St.Dev. ● 2014



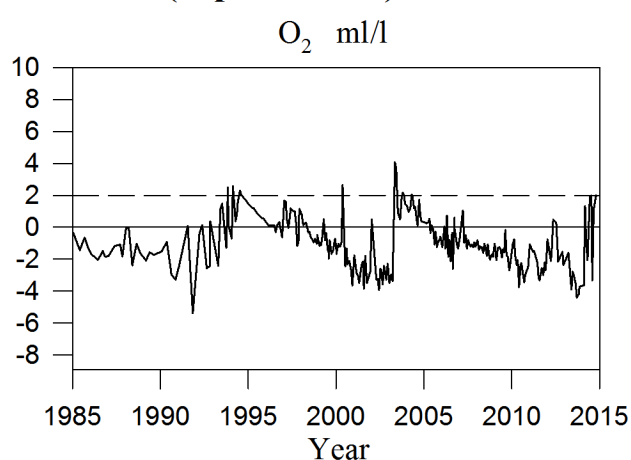
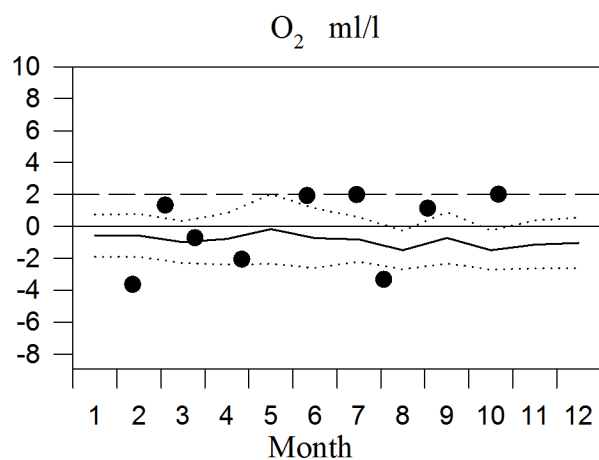
STATION BY10 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2014

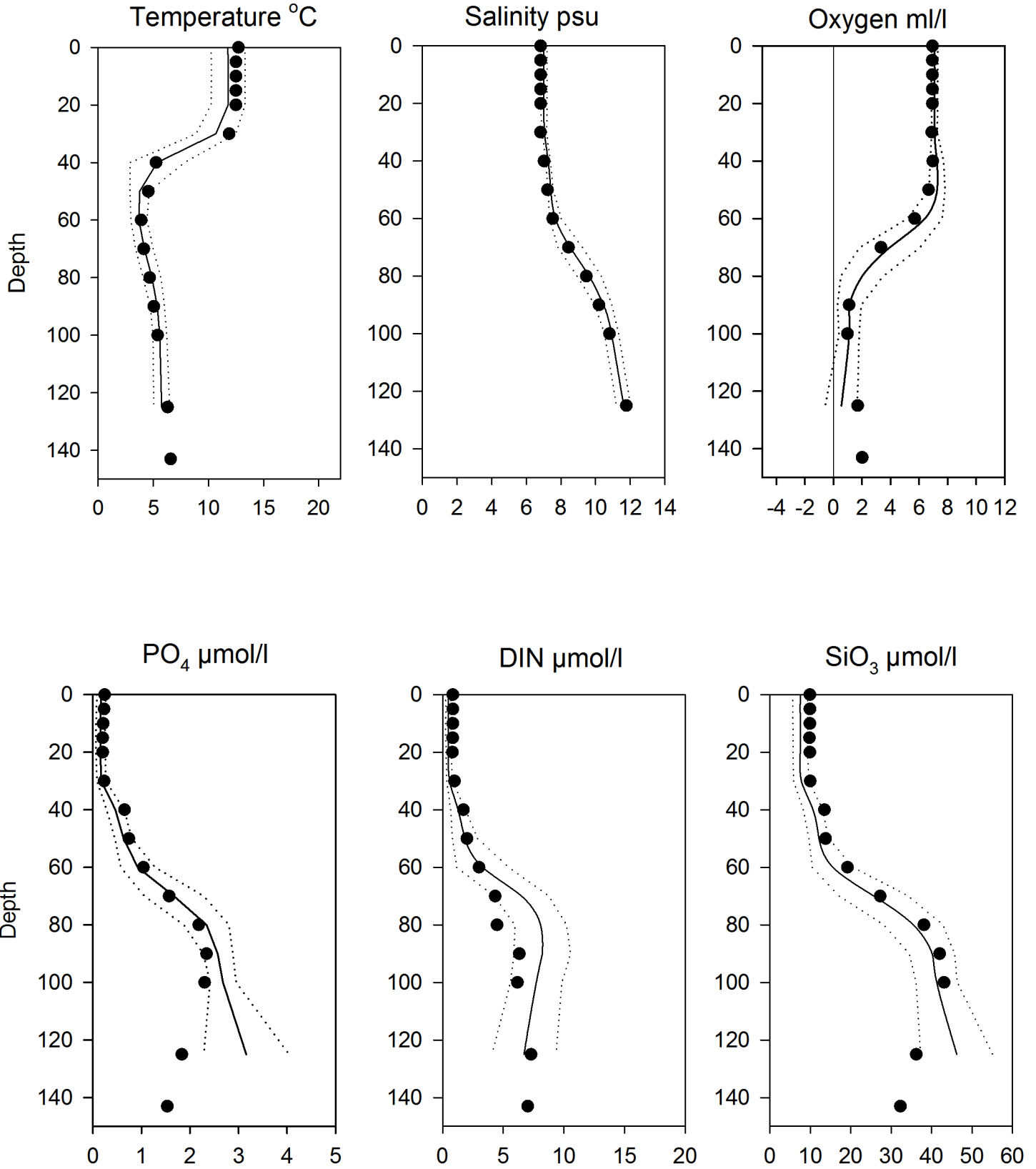


OXYGEN IN BOTTOM WATER (depth >125m)



Vertical profiles BY10 October

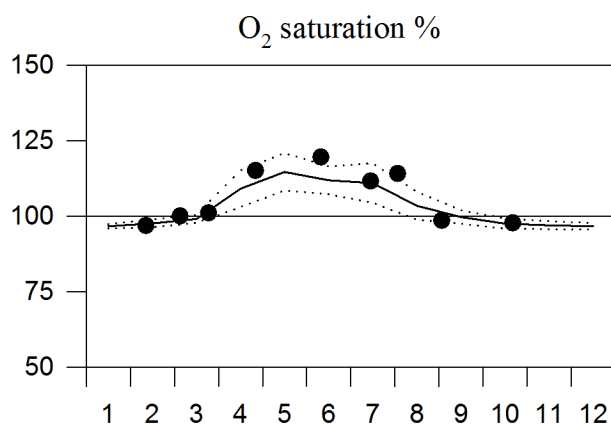
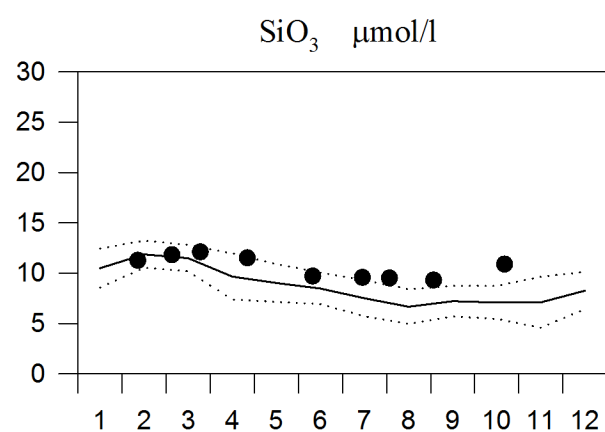
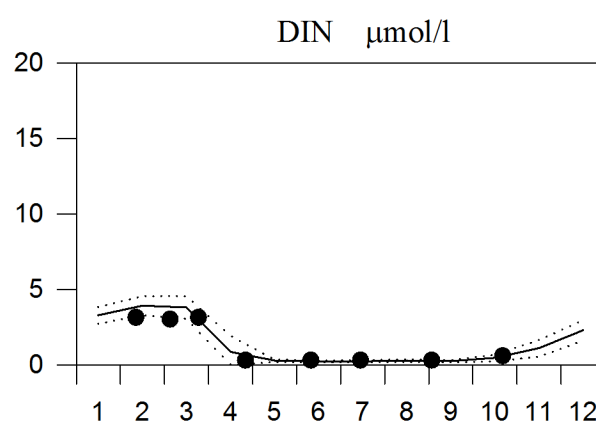
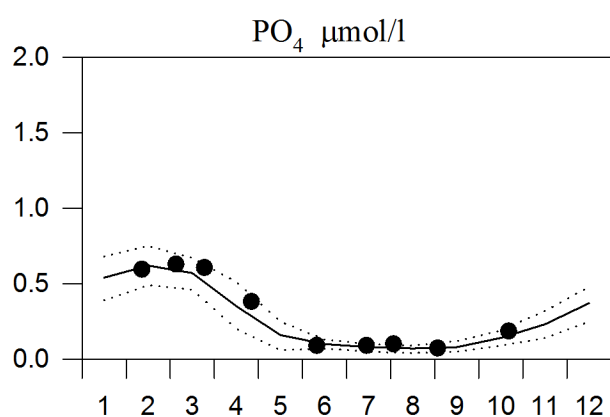
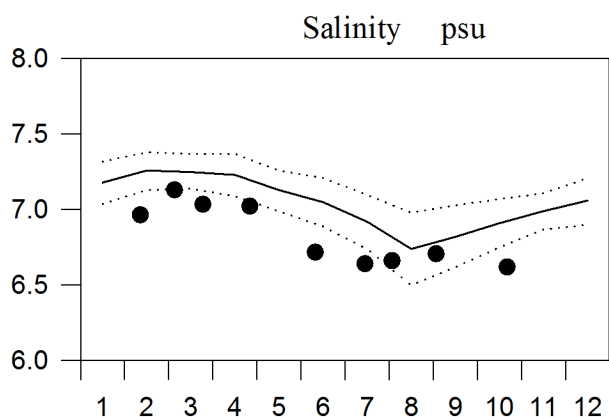
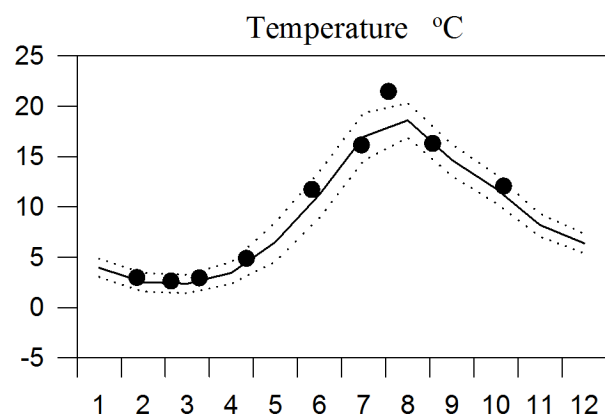
— Mean 1996-2010 St.Dev. ● 2014



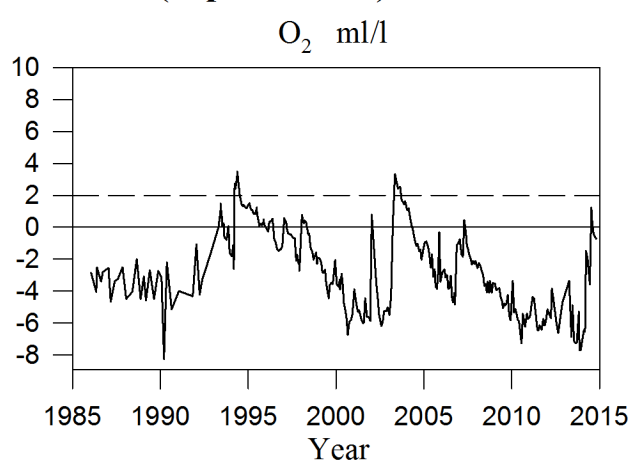
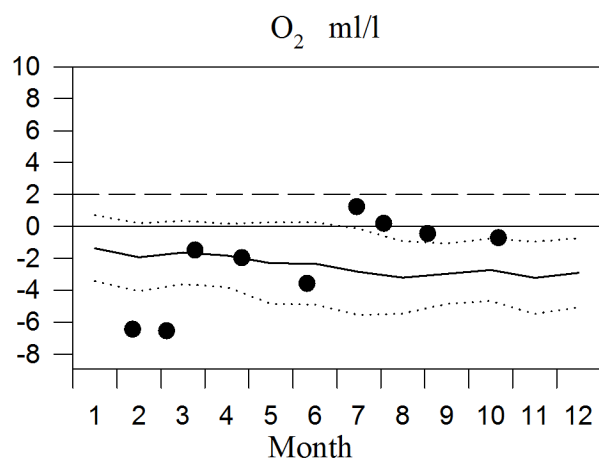
STATION BY15 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2014



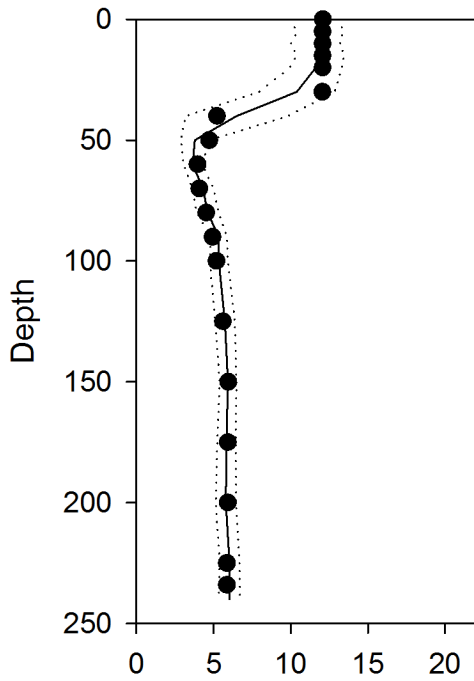
OXYGEN IN BOTTOM WATER (depth >225m)



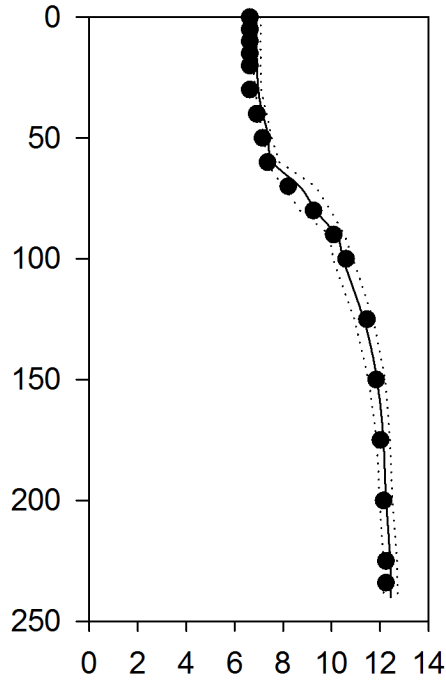
Vertical profiles BY15 October

— Mean 1996-2010 St.Dev. ● 2014

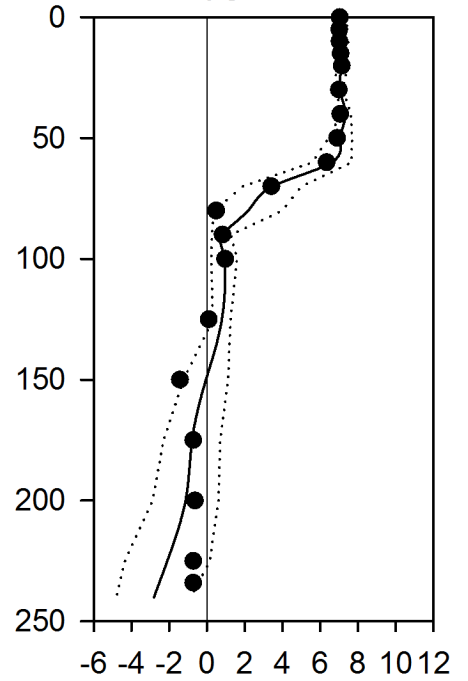
Temperature °C



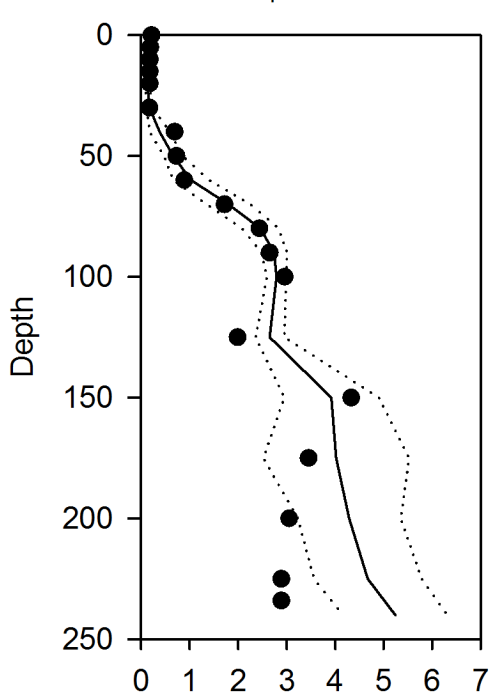
Salinity psu



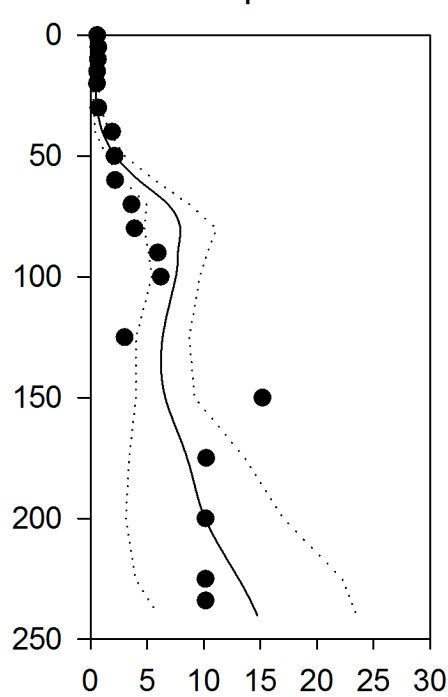
Oxygen ml/l



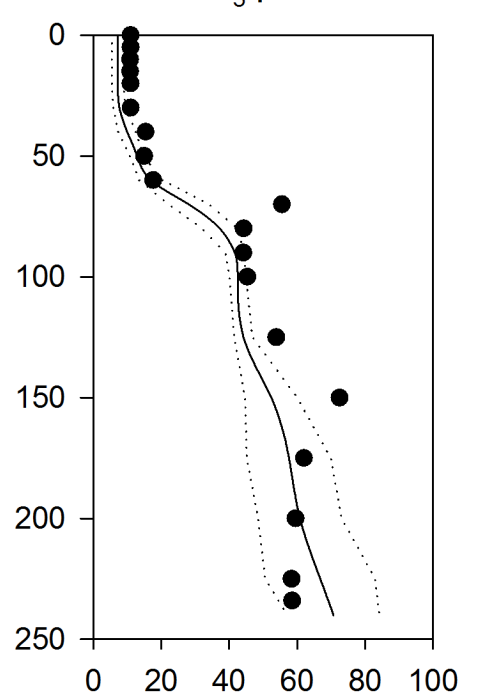
PO₄ μmol/l



DIN μmol/l



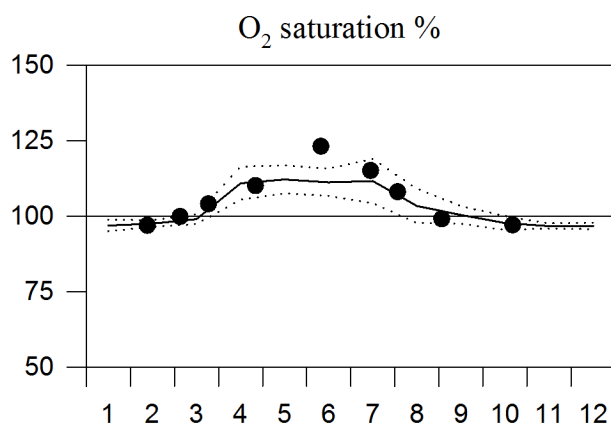
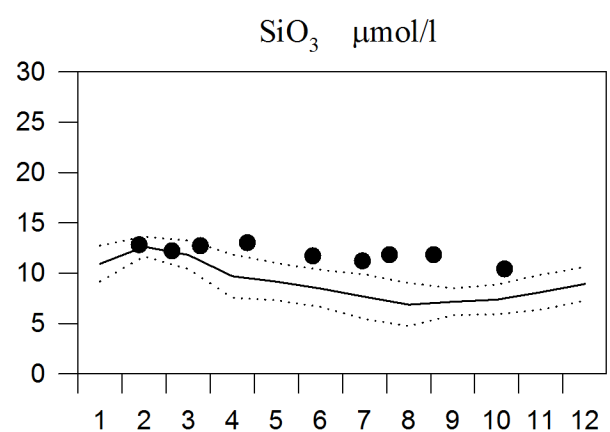
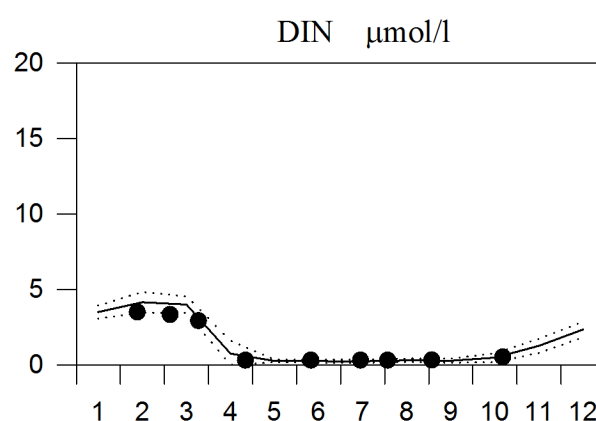
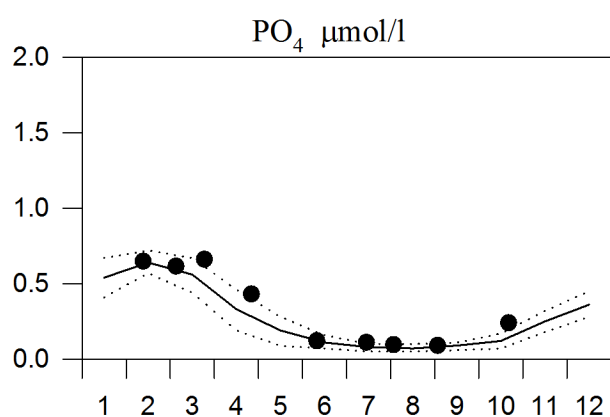
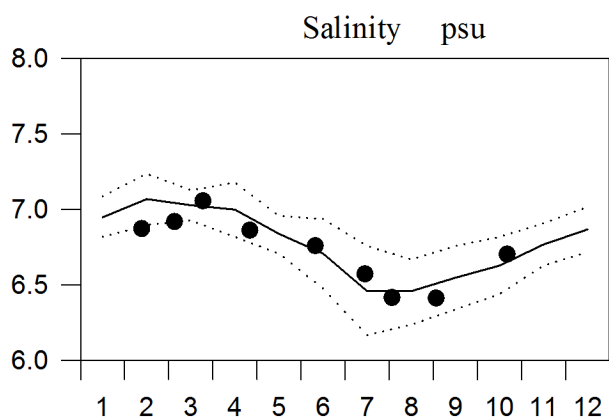
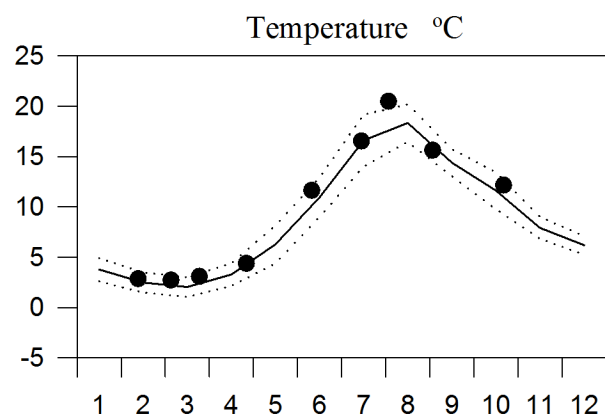
SiO₃ μmol/l



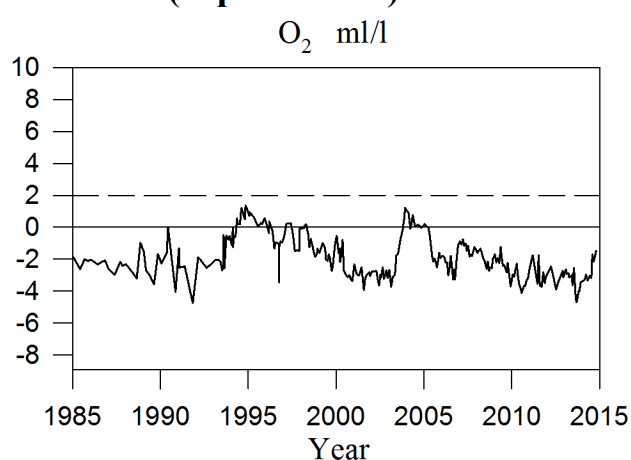
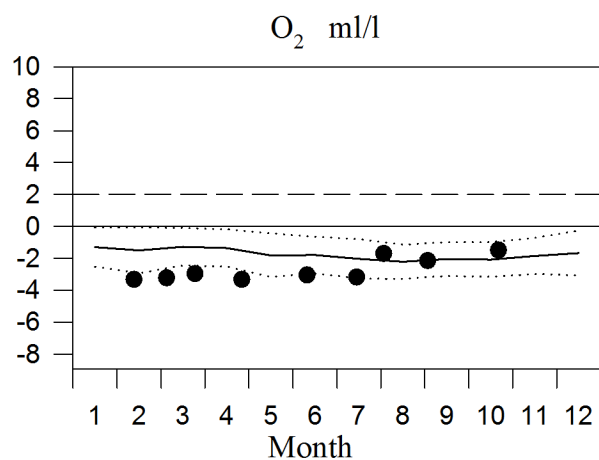
STATION BY20 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2014



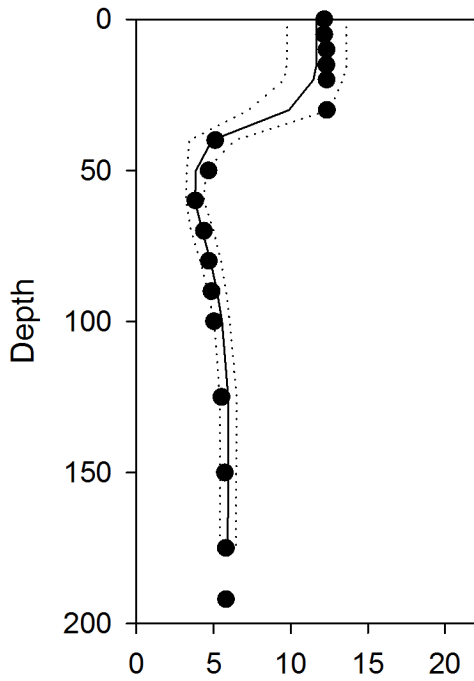
OXYGEN IN BOTTOM WATER (depth >175m)



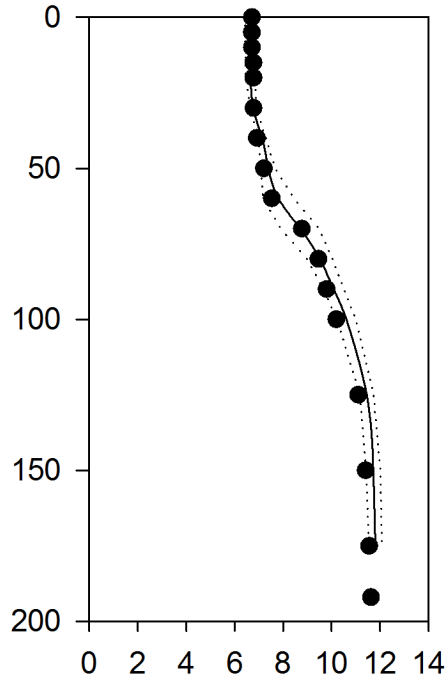
Vertical profiles BY20 October

— Mean 1996-2010 St.Dev. ● 2014

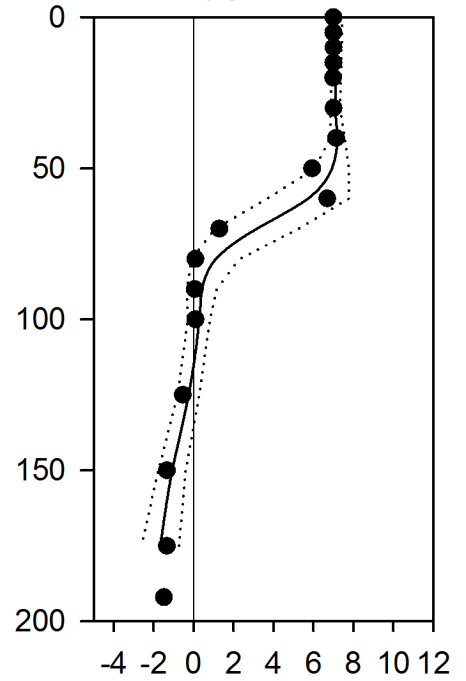
Temperature °C



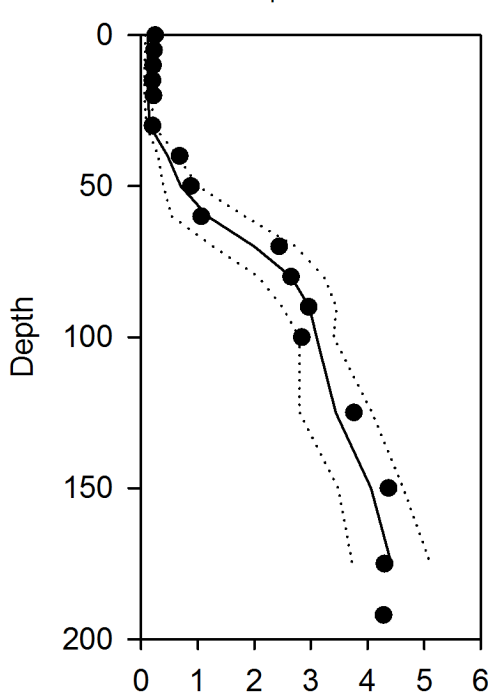
Salinity psu



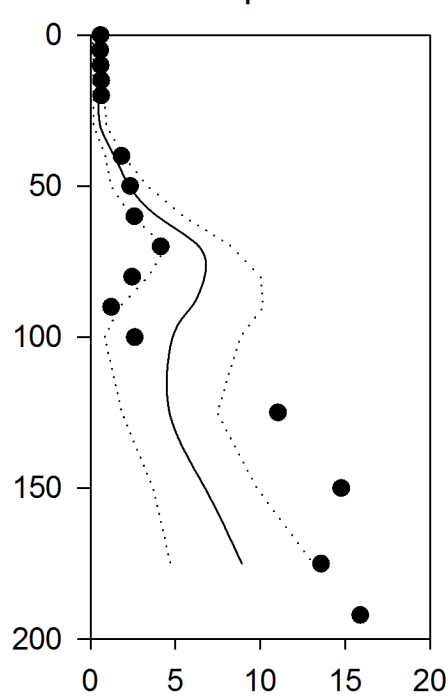
Oxygen ml/l



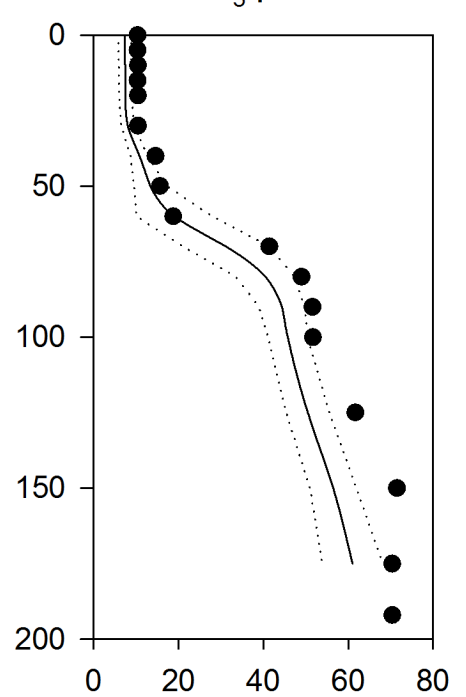
PO₄ μmol/l



DIN μmol/l



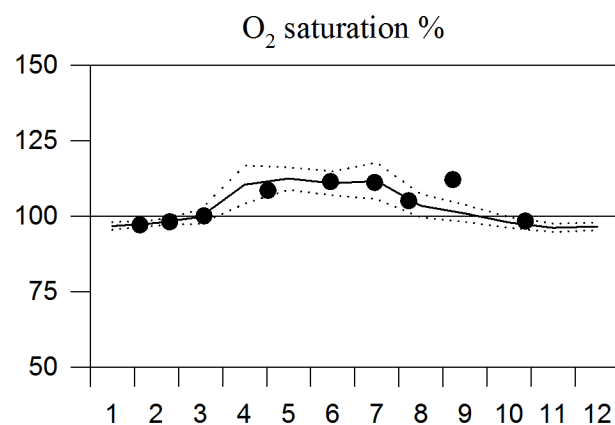
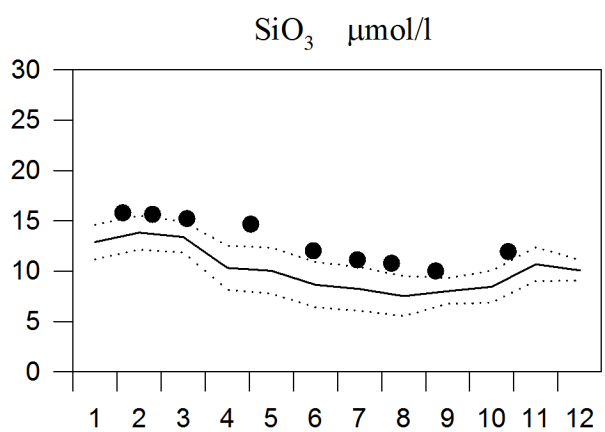
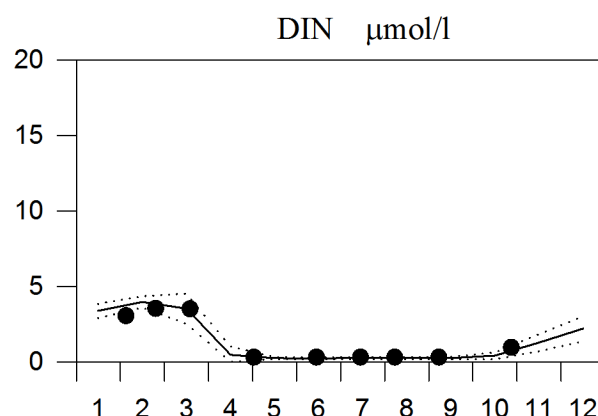
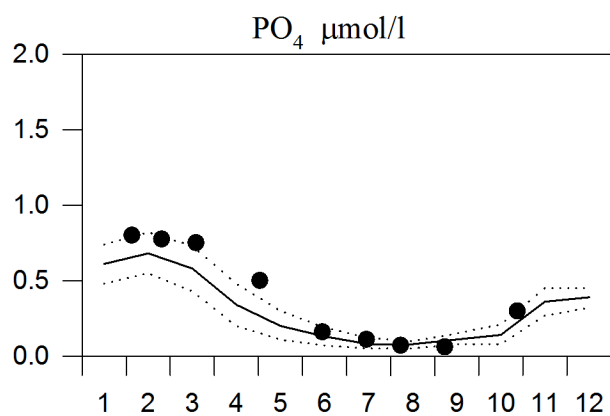
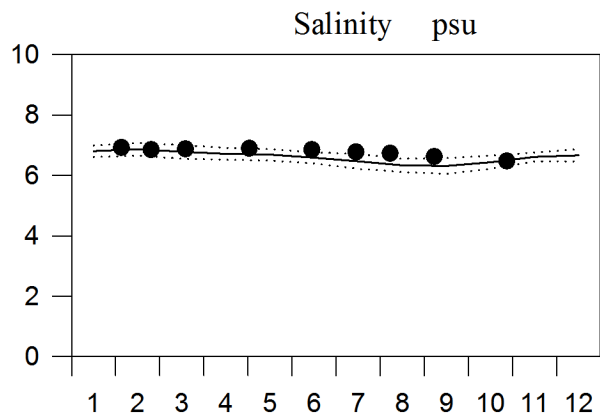
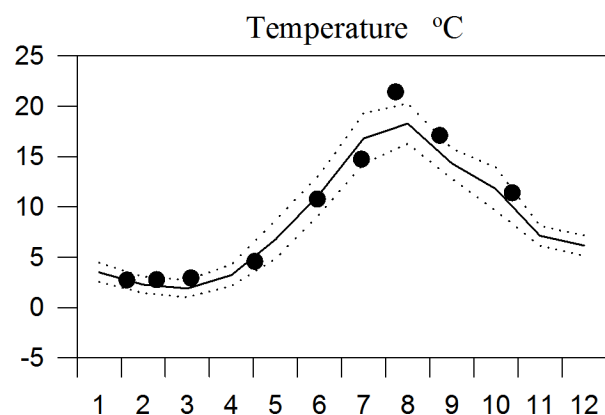
SiO₃ μmol/l



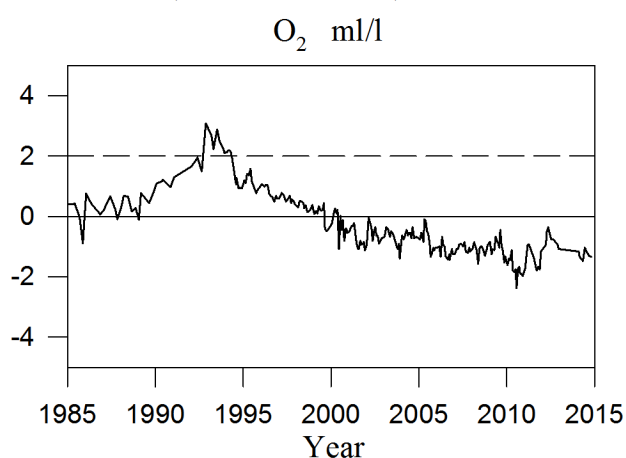
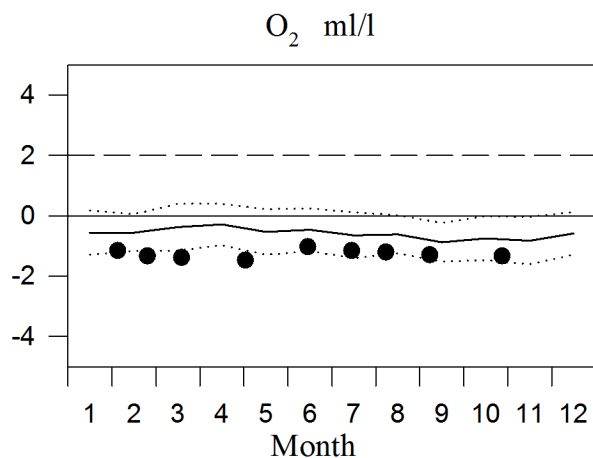
STATION BY32 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2014



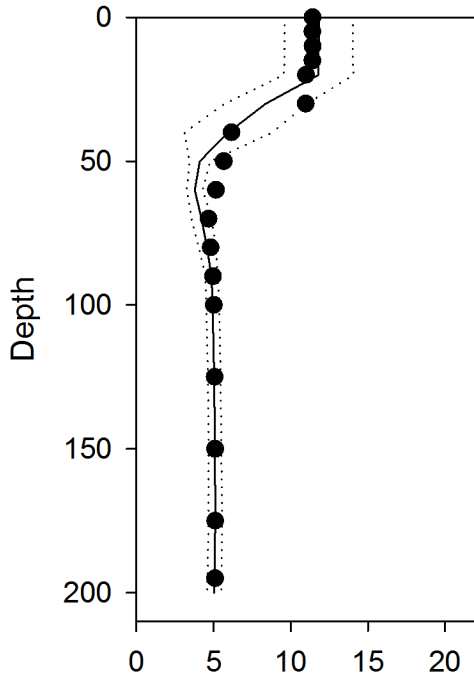
OXYGEN IN BOTTOM WATER (depth > 175m)



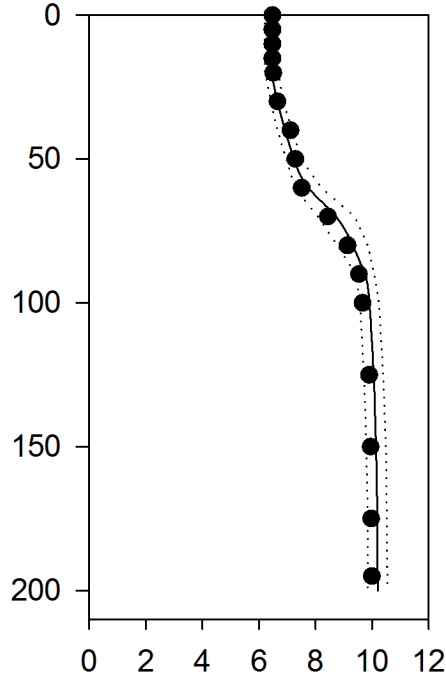
Vertical profiles BY32 October

— Mean 1996-2010 St.Dev. ● 2014

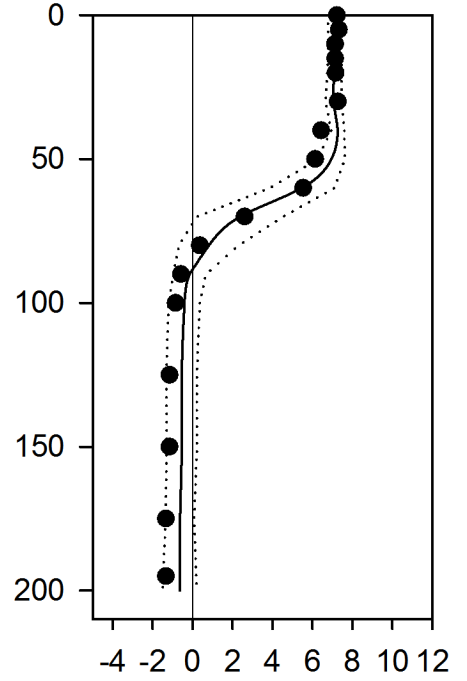
Temperature °C



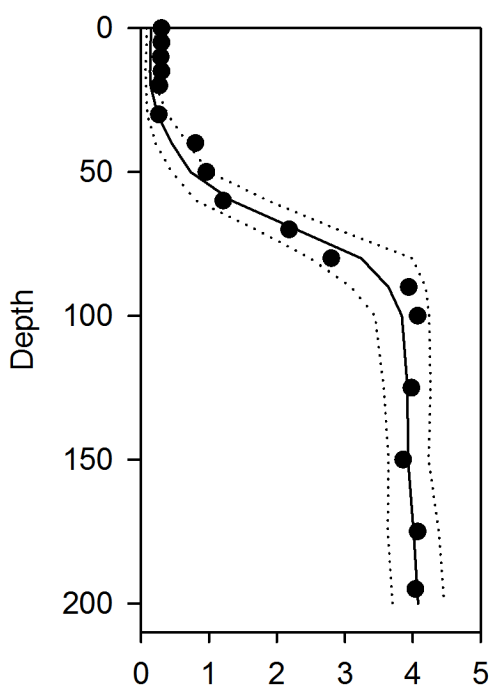
Salinity psu



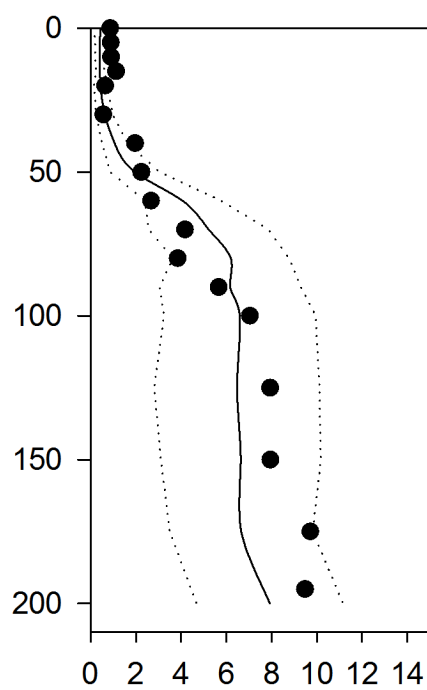
Oxygen ml/l



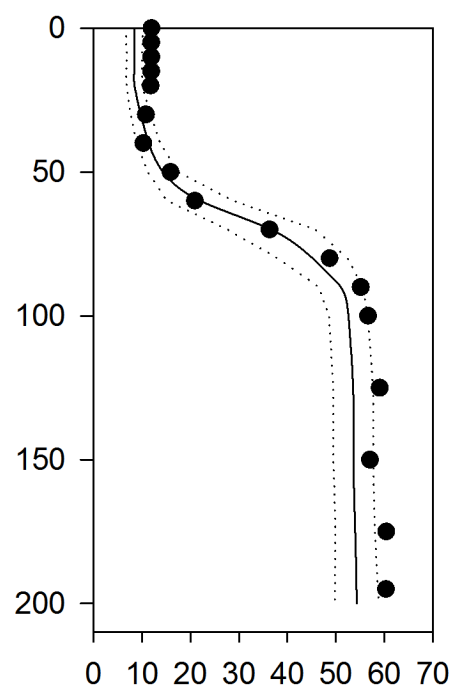
PO₄ μmol/l



DIN μmol/l



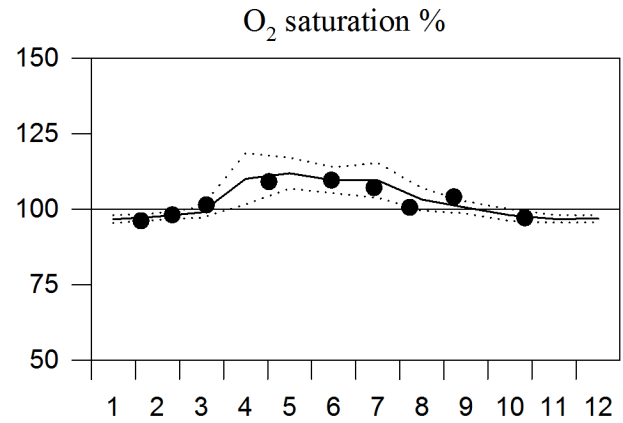
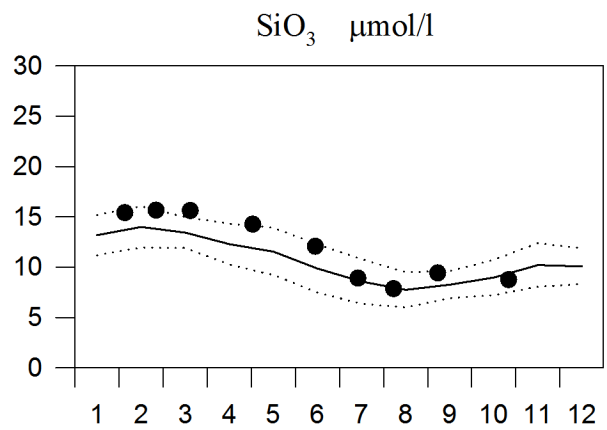
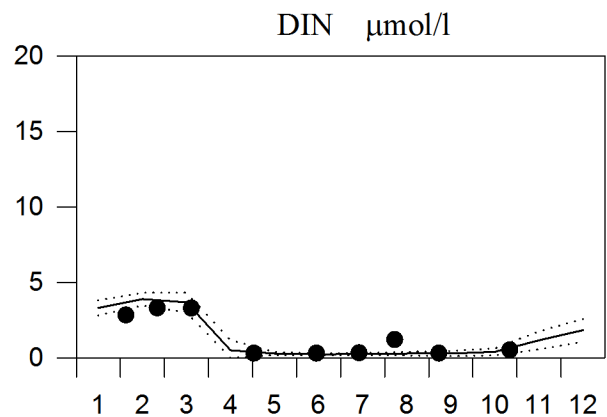
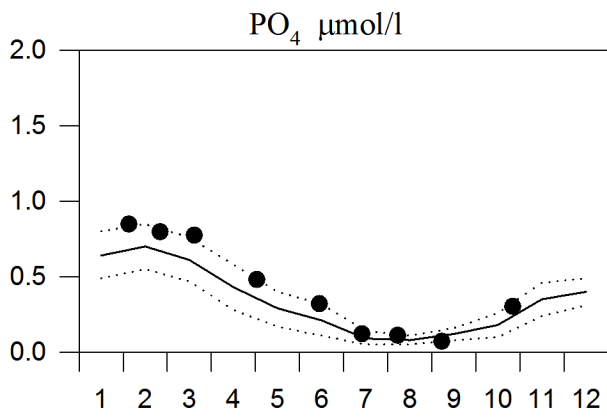
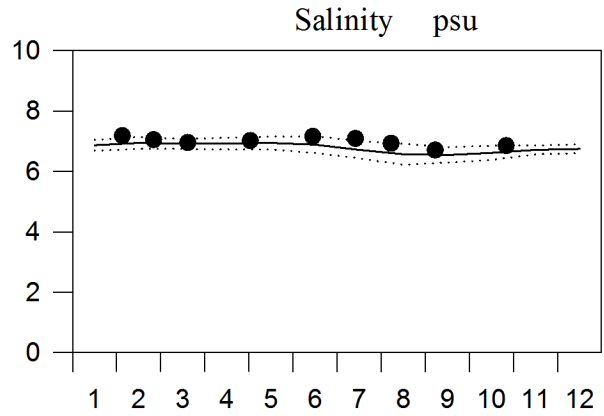
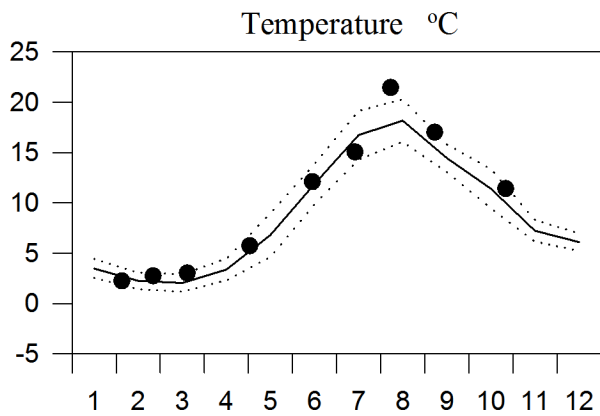
SiO₃ μmol/l



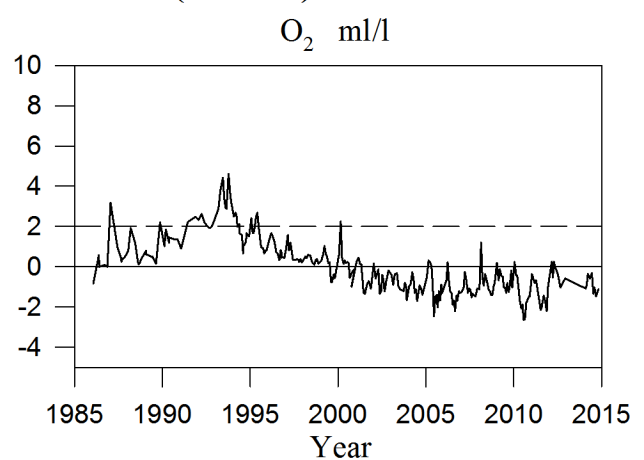
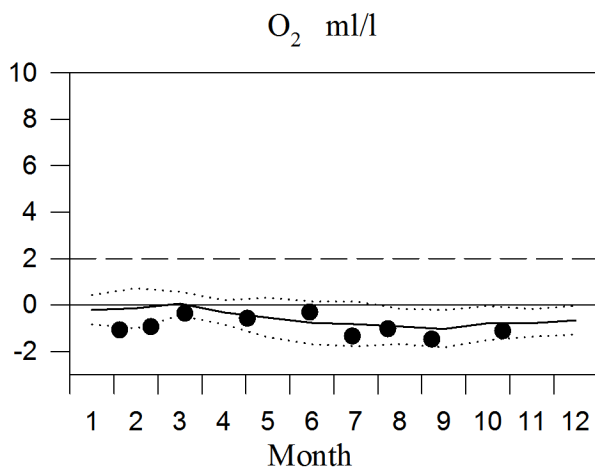
STATION BY38 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2014

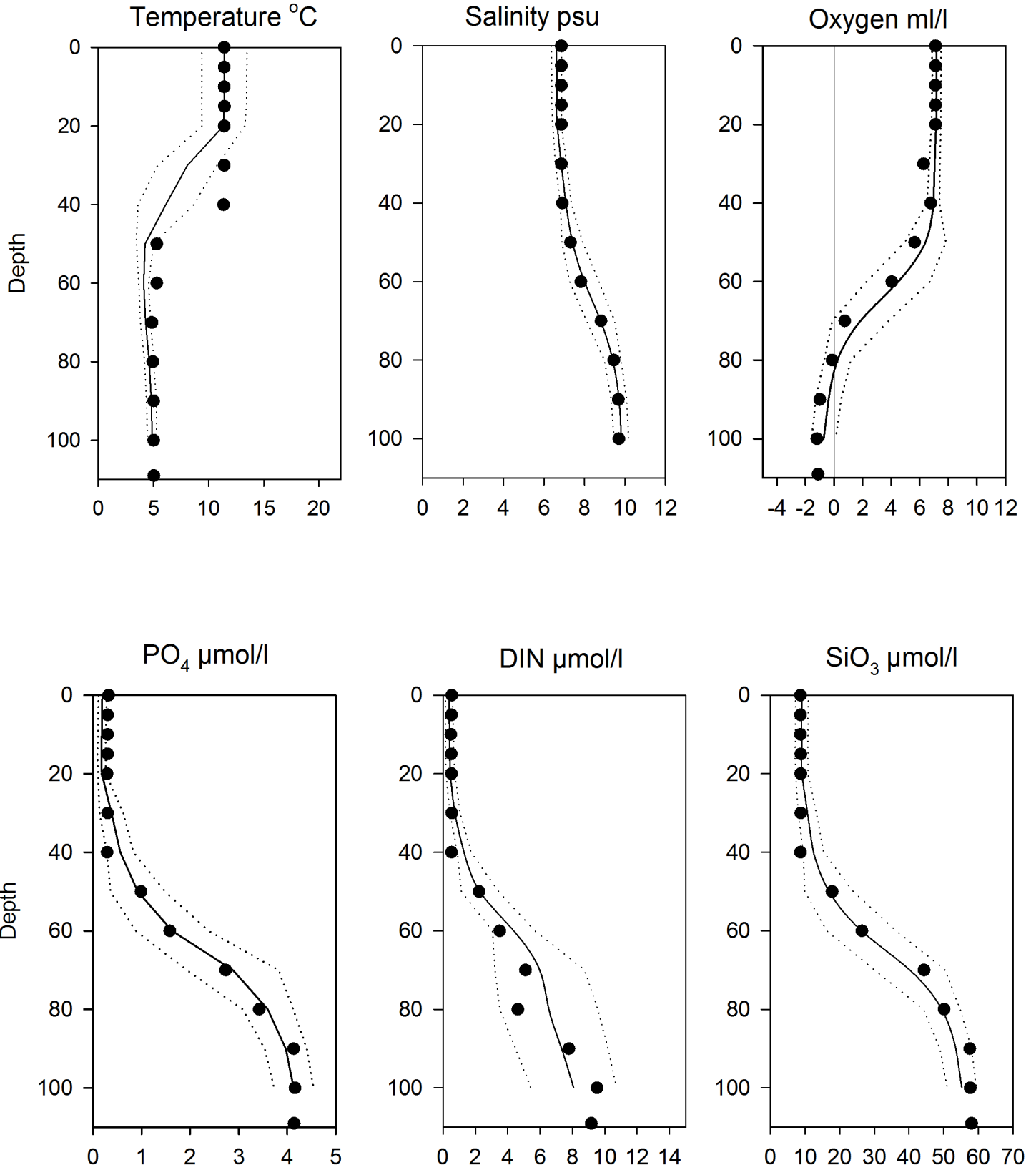


OXYGEN IN BOTTOM WATER (> 100m)



Vertical profiles BY38 October

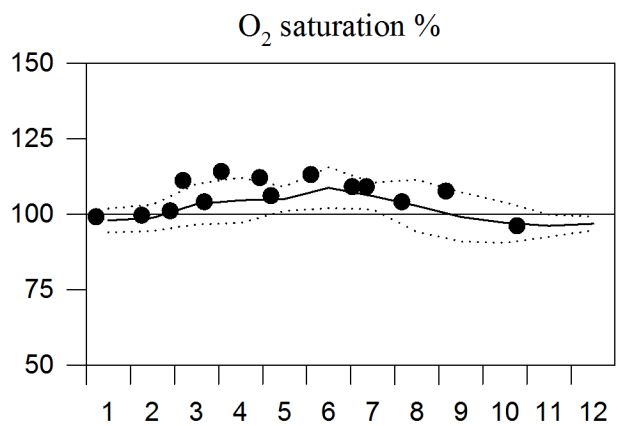
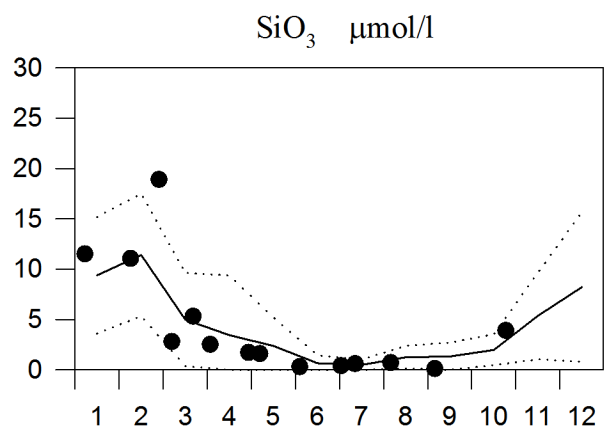
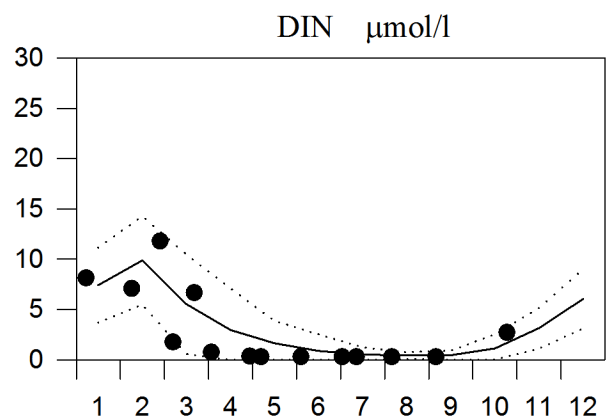
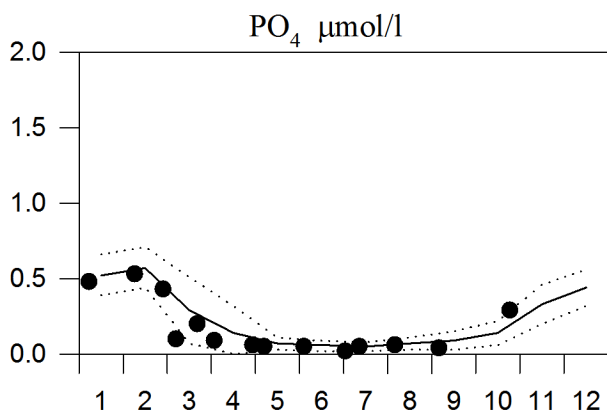
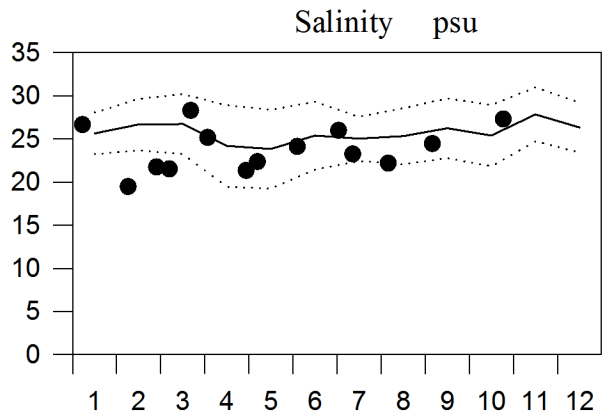
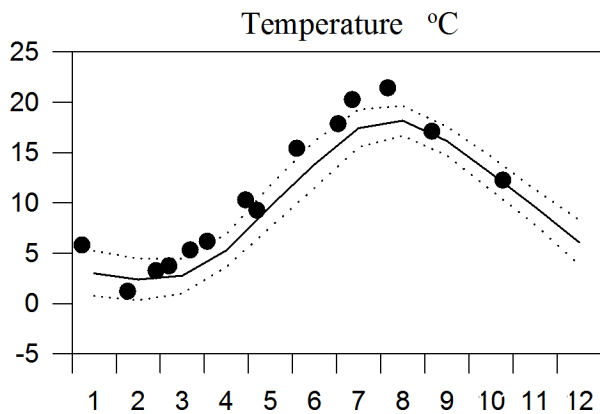
— Mean 1996-2010 St.Dev. ● 2014



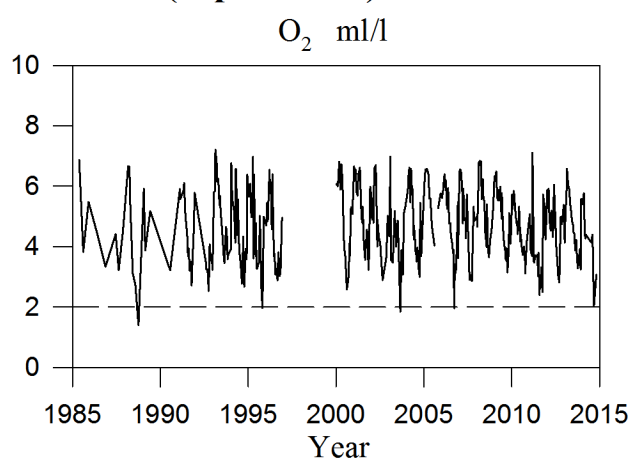
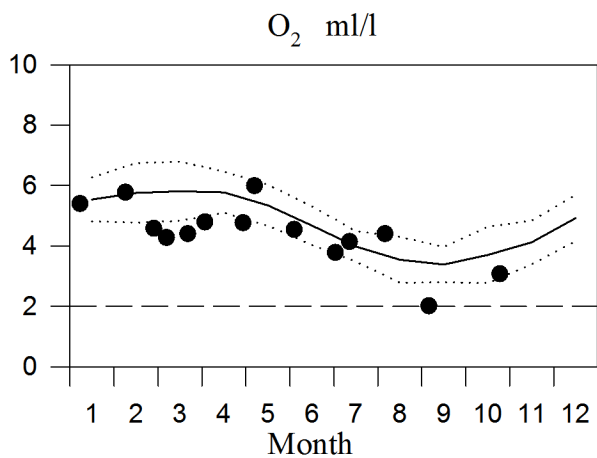
STATION SLÄGGÖ SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2014

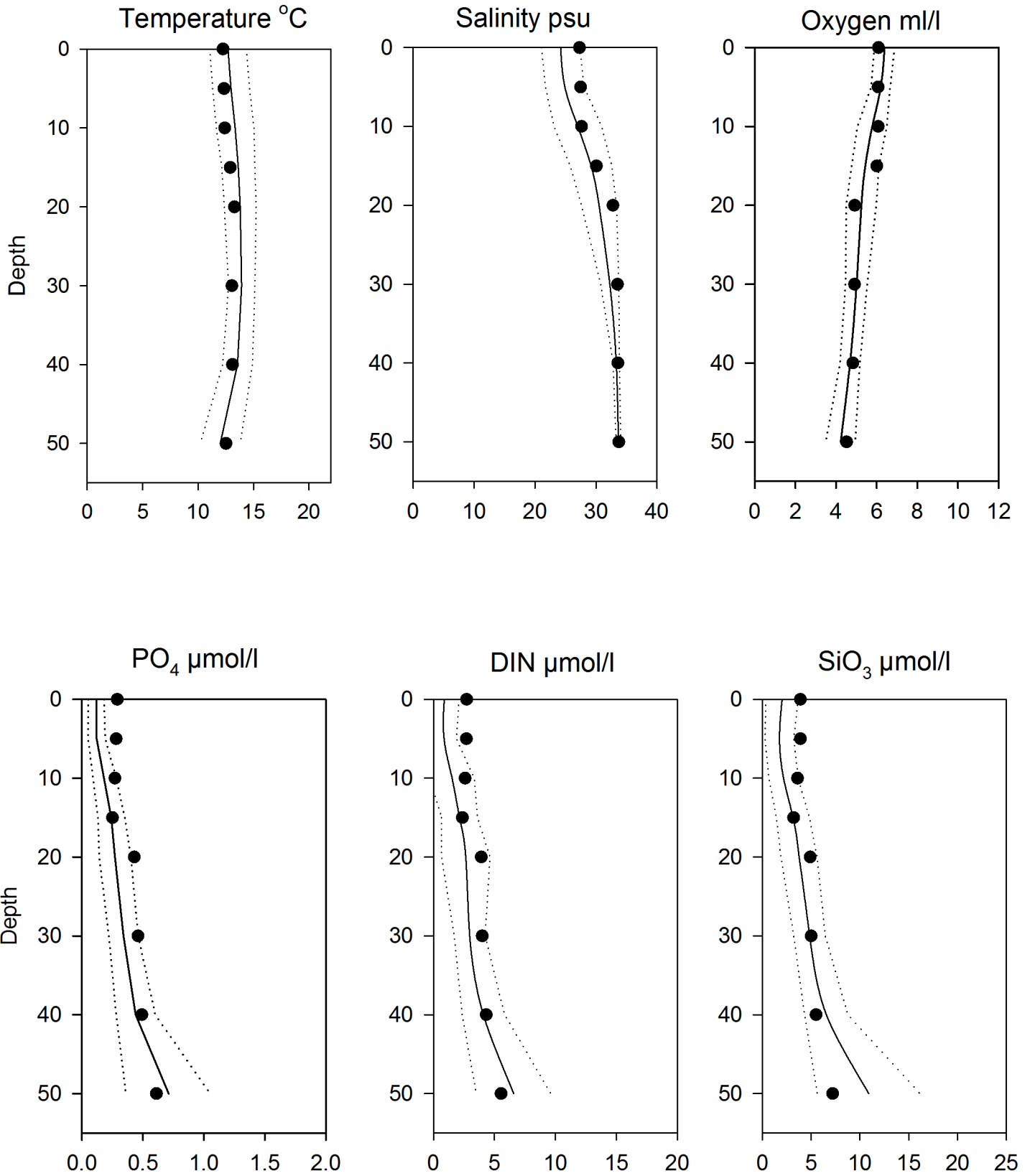


OXYGEN IN BOTTOM WATER (depth >50m)



Vertical profiles Släggö October

— Mean 1996-2010 St.Dev. ● 2014



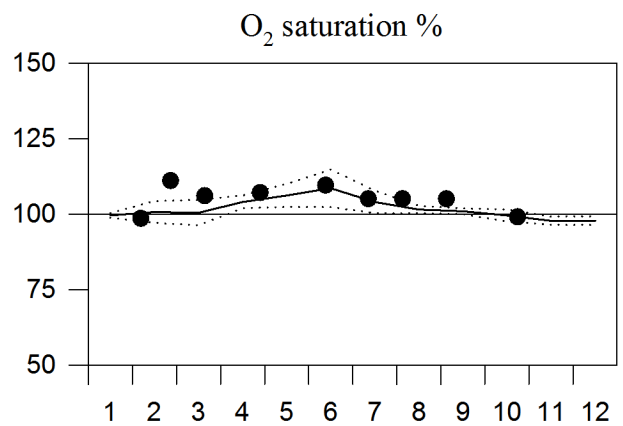
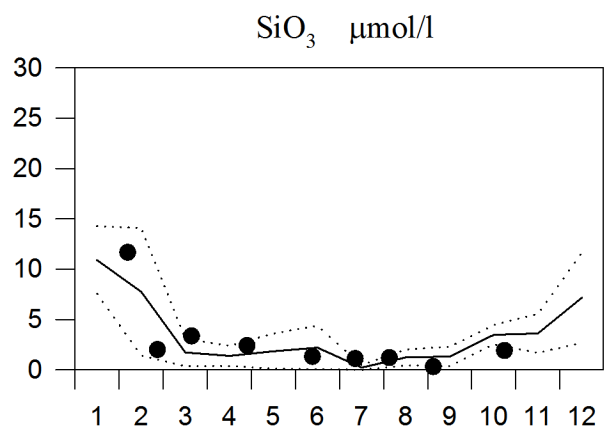
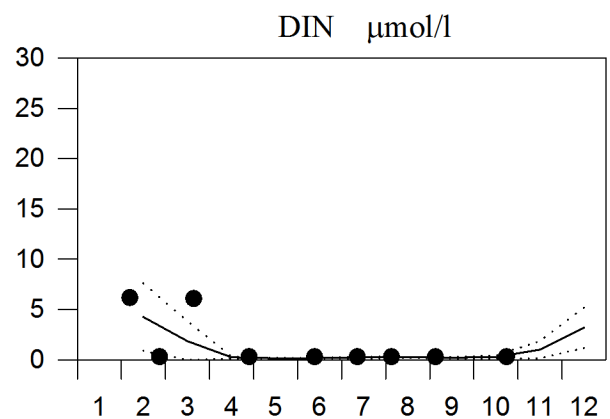
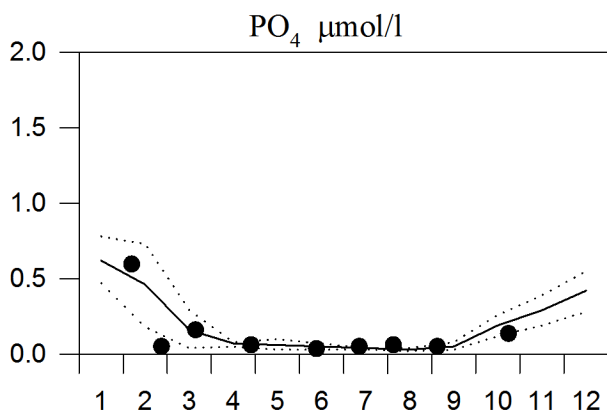
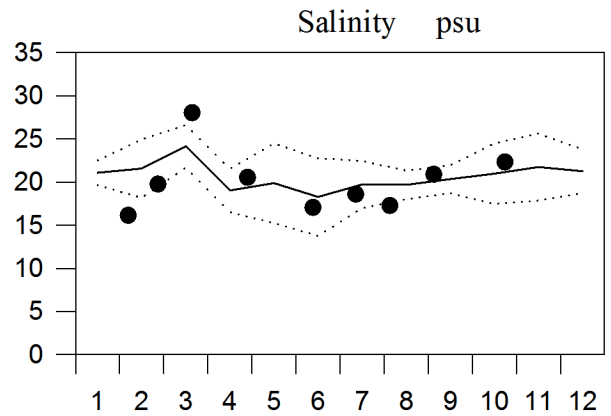
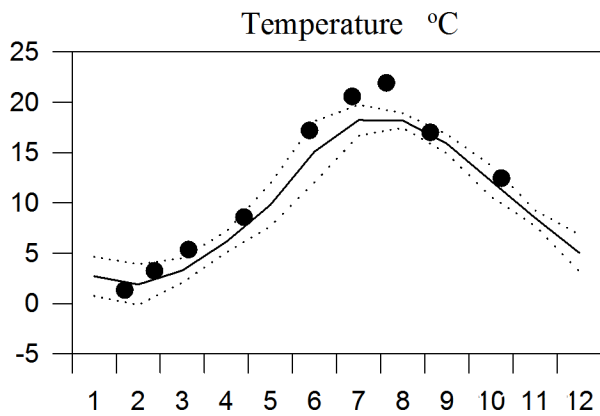
STATION N14 Falkenberg SURFACE WATER

Annual Cycles

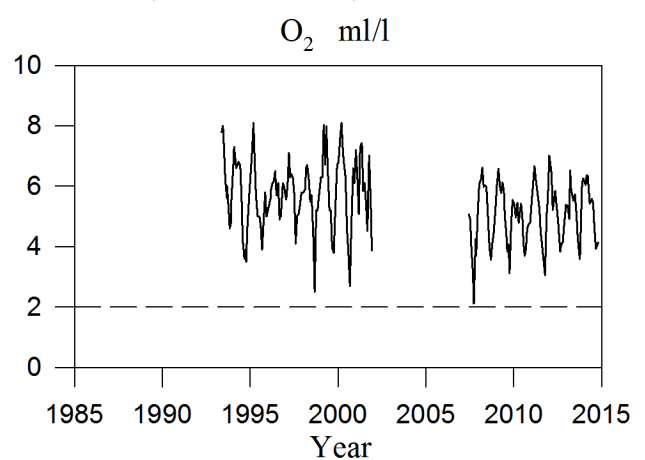
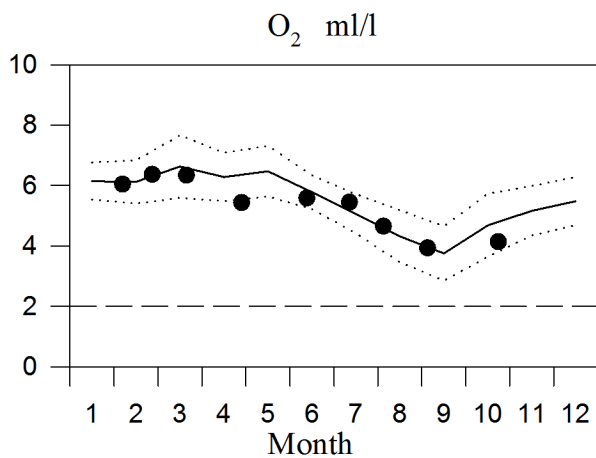
— Mean 2007-2010

..... St.Dev.

● 2014

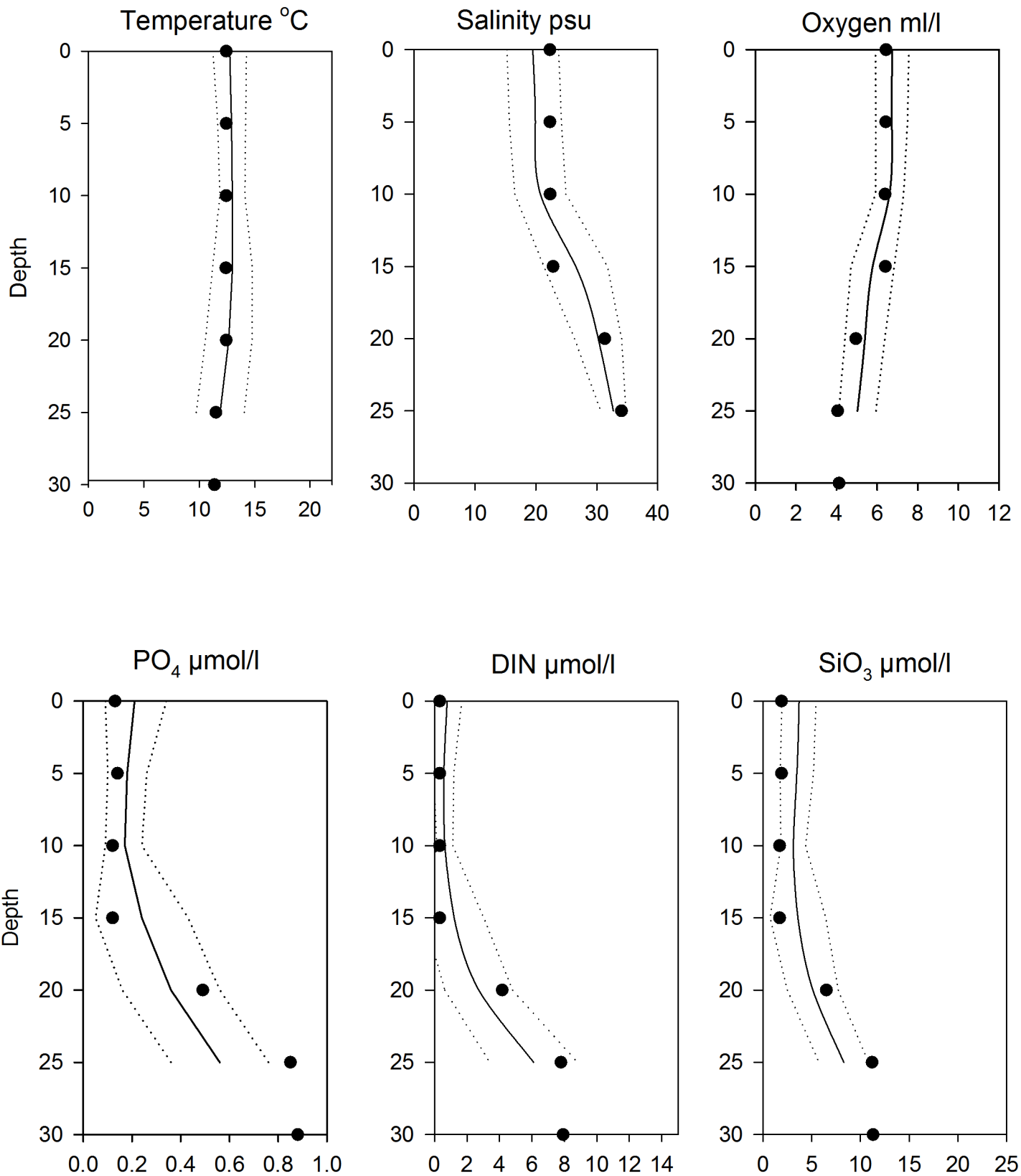


OXYGEN IN BOTTOM WATER (depth > 25m)



Vertical profiles N14 Falkenberg October

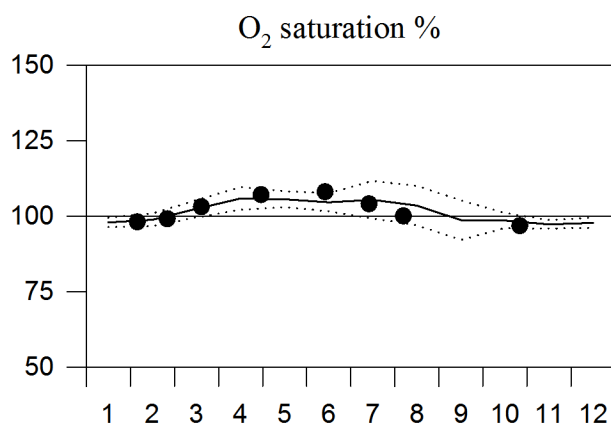
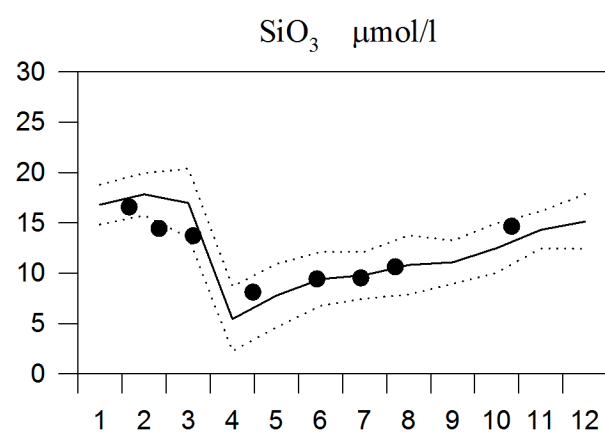
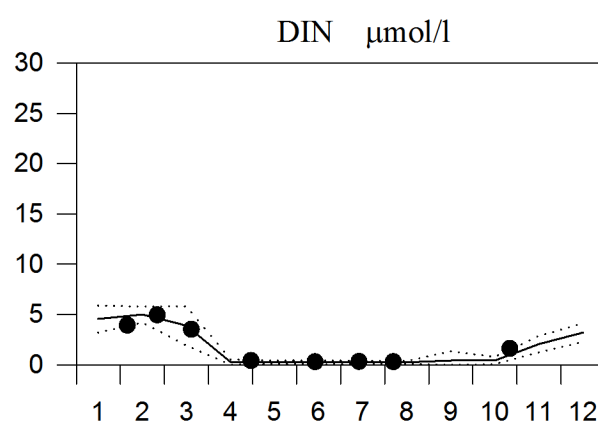
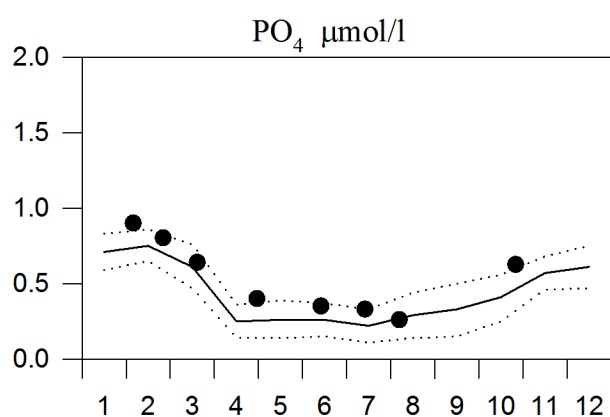
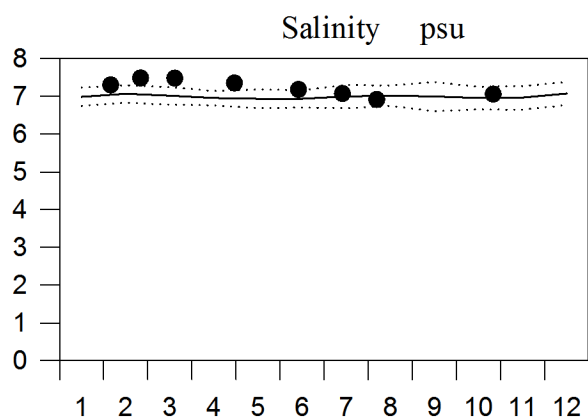
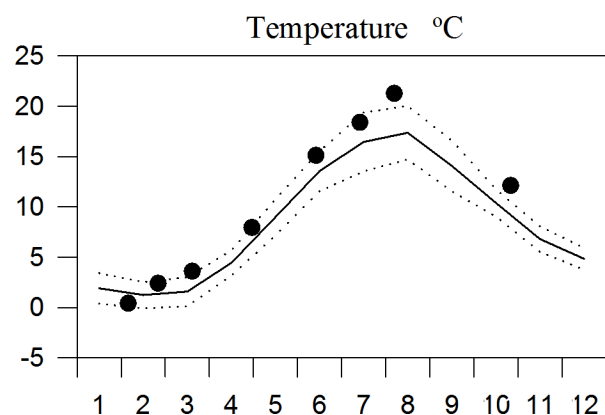
— Mean 1996-2010 St.Dev. ● 2014



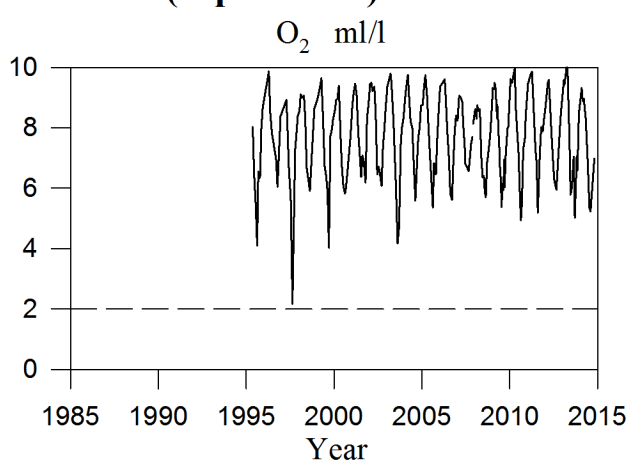
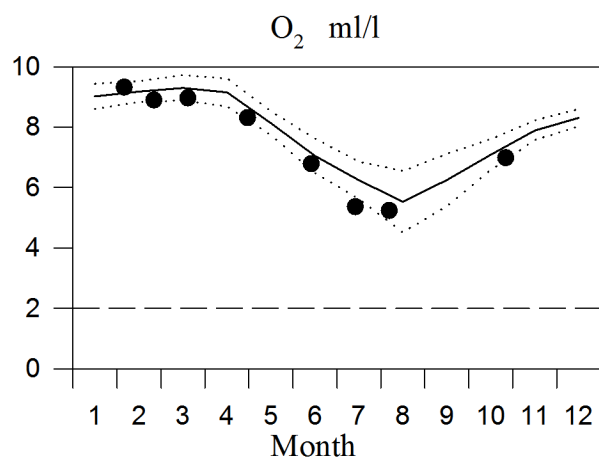
STATION REF M1V1 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2014



OXYGEN IN BOTTOM WATER (depth >15m)



Vertical profiles Ref M1V1 October

— Mean 1996-2010 St.Dev. ● 2014

