

## Report from the SMHI monitoring cruise with R/V Aranda



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**Survey period:** 2015-01-07 - 2015-01-15  
**Survey area:** 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 Kattegat, the Sound and the Baltic Proper. Mapping of winter nutrients were performed in Kattegat. Skagerrak could not be visited due to the storm *Egon*. Extra sampling was made to follow up the inflow from December 2014 when ca. 200 km<sup>3</sup> entered the Baltic. Data presented in this report have been subject to preliminary quality control procedures only.

The water temperature in the surface layer was still above normal in Kattegat but normal in the Baltic Proper. Surface nutrients showed, for the season, almost normal values, except for silicate and phosphate in the Baltic which were elevated, while the Hanö Bight was exceptional with lower silicate concentration. The effect of the large inflow in December was during the expedition most evident in the Hanö Bight. During the last expedition in December 2014, acute hypoxia (<2 ml / l) was present in the bottom water of Hanö Bight. During this expedition the oxygen concentration was as high as 6.21 ml/l. In the central parts of eastern Gotland Basin, BY15, acute hypoxia was present from depths exceeding 60 meters and complete anoxic conditions were found from depths exceeding 175. However, at 235 meter oxygen was present in small concentrations, 0.11 ml/l. At station BY29, in the northern Baltic Proper, hydrogen sulphide occurred already from 70 meters. In the western Gotland Basin the oxygen situation was serious as acute hypoxia started from 70 meters and acute hypoxia was present ca. 90 meters depth.

The next cruise is planned to start on week 8 in February 2015.

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## PRELIMINARY RESULTS

The cruise, performed on board the Finnish research vessel *Aranda*, began in Helsinki on 7<sup>th</sup> of January and ended in the same port on the 15<sup>th</sup>. Due to the storm *Egon*, the expedition had a two day stop in the port of Falkenberg, and as a result of this Skagerrak could not be monitored. Clearance for sampling on Danish water failed to materialize and therefore winter mapping of nutrients in the western part of Kattegat couldn't be carried out, nor any sampling of stations in Arkona and Bornholm Basins which are on Danish water. No measurements were done in Skagerrak due to severe weather conditions.

No fluorescence data exist from this expedition, since the fluorescence sensor was on calibration.

During the first part of the expedition winds were of gale to storm strength, around 15 - 20 m/s, but decreased during the later part. Wind direction was mainly from south west. Air temperature varied between 3 - 7°C.

An inflow through the Sound, to the Baltic, of ca. 18 km<sup>3</sup> took place during the cruise.

### The Skagerrak

No sampling was carried out in Skagerrak due to harsh weather conditions.

### The Kattegat and the Sound

In this area, surface temperatures were still above normal, with values between 4.4 – 6.2°C. The salinity of the surface water in Kattegat was higher than normal, 31 – 25 psu, while it in the Sound was back to normal. Thermocline and halocline was weaker than normal and were found at 20 - 30 meters. The stratification in the Sound was present around 10 – 15 meters depth.

The concentrations of nutrients showed values typical for the season; phosphate was around 0.6 µmol/l, inorganic nitrogen was in the span 6 – 8 µmol/l and silicate levels varied between 7.0 and 10.4 µmol/l.

The lowest oxygen levels in the bottom waters were measured at Anholt E, in Kattegat, 5.37 ml/l and at W Landskrona in the Sound, 5.51 ml/l.

### The Baltic Proper

The sea surface temperature was only a bit above normal, around 5°C in the whole region. Sea surface salinity was normal except from the Arkona basin (almost 10 psu), Bornholm basin and Hanö Bight (almost 8 psu) where it were higher than normal. The surface salinity in the eastern Gotland Basin had increased since the December expedition and was now higher than normal, 7.25 psu which is 0.25 above the normal 7 psu. The halocline was found at 60 – 80 meters depth in the western and eastern Gotland basin, while it was shallower in in the southern parts where it was found between 30 and 50 meter.

Nutrients showed almost normal levels for the season, in the surface layer, with slightly elevated concentrations of phosphate and silicate. Phosphate concentrations ranged from 0.54 to 0.79 µmol/l, with the highest concentrations in the Western Gotland basin. The concentrations of inorganic nitrogen (nitrite + nitrate) varied from 2.44 to 4.26 µmol/l. Silicate showed slightly elevated levels in the northern and central parts, but were normal in Arkona and lower than normal in the Hanö Bight. The concentrations ranged between 8.8 and 16.5 µmol/l.

In December 2014, a large inflow of ca 200 km<sup>3</sup> to the Baltic, through the Sound and Belt Sea, occurred which is the largest in 20 years. The effects of the inflow were best seen in the Hanö Bight. At the former expedition in December 2014 it was acute hypoxia in the Hanö Bight bottom water. The oxygen concentration in the bottom water was now as high as 6.21 ml/l. The oxygen



concentration has not been this high since 2003. In Arkona basin, salinity was higher than normal in the whole water column and temperature was lower. The stations in the deep part of Bornholm Basin, BY4 and BY5, could unfortunately not be sampled but the bottom water in the shallower parts, north – north east of the deeper part was well oxygenized to 70 meter where the concentration where 3.58 ml/l. The inflow has probably reached the Bornholm deep. At BCS III-10 further east, the effects of the inflow is not that clear. Salinity and temperature at the bottom is a bit higher than normal but it is still acute hypoxia from 60 meters.

In the central parts of Eastern Gotland Basin, BY15, acute hypoxia was present from depths exceeding 60 meters and complete anoxic conditions were found from depths exceeding 175. However, at 235 meter oxygen was present in small concentrations, 0.11 ml/l. At station BY29, in the northern part of the Baltic Proper, hydrogen sulphide occurred already from 70 meters. In the Western Gotland Basin the oxygen situation was serious as acute hypoxia started from 70 meters and acute hypoxia was present ca. 90 meters depth.

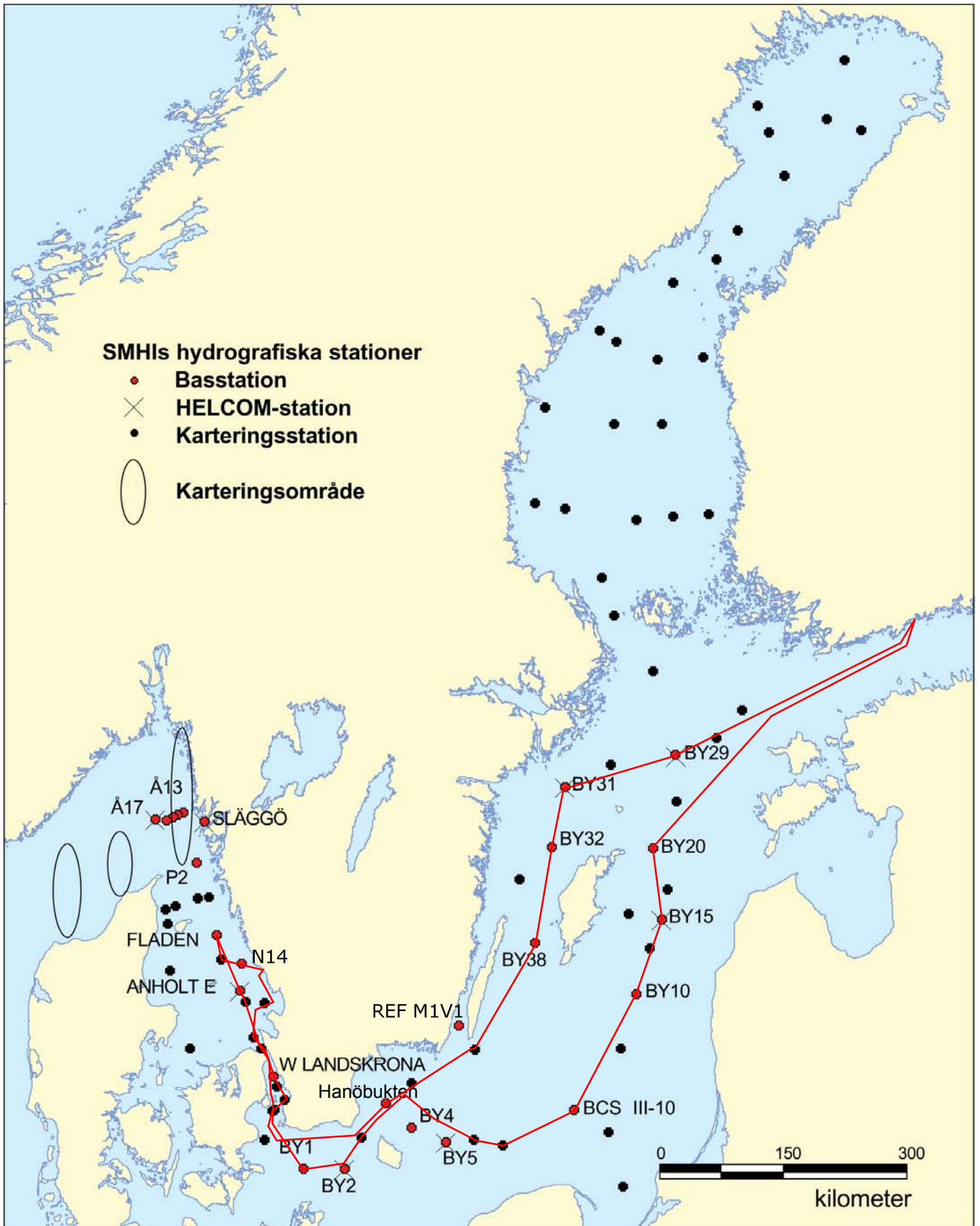
## **PARTICIPANTS**

<b>Name</b>		<b>Institute</b>
Anna-Kerstin Thell	Chief Scientist	SMHI
Örjan Bäck (Falkenberg-Helsingfors)		SMHI
Martin Hansson (Helsingfors-Falkenberg)		SMHI
Johan Håkansson		SMHI
Sari Sipilä		SMHI
Magnus Wenzler (Helsingfors-Falkenberg)		SMHI
Karin Wesslander		SMHI

## **APPENDICES**

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

TRACKCHART  
Country: Sweden  
Ship: R/V ARANDA  
Date: 20150107-20150115  
Series: 0001-0030





SMHI  
Ocean enh

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Hydrographic  
series

Ship: 01-Aranda  
Year: 2015

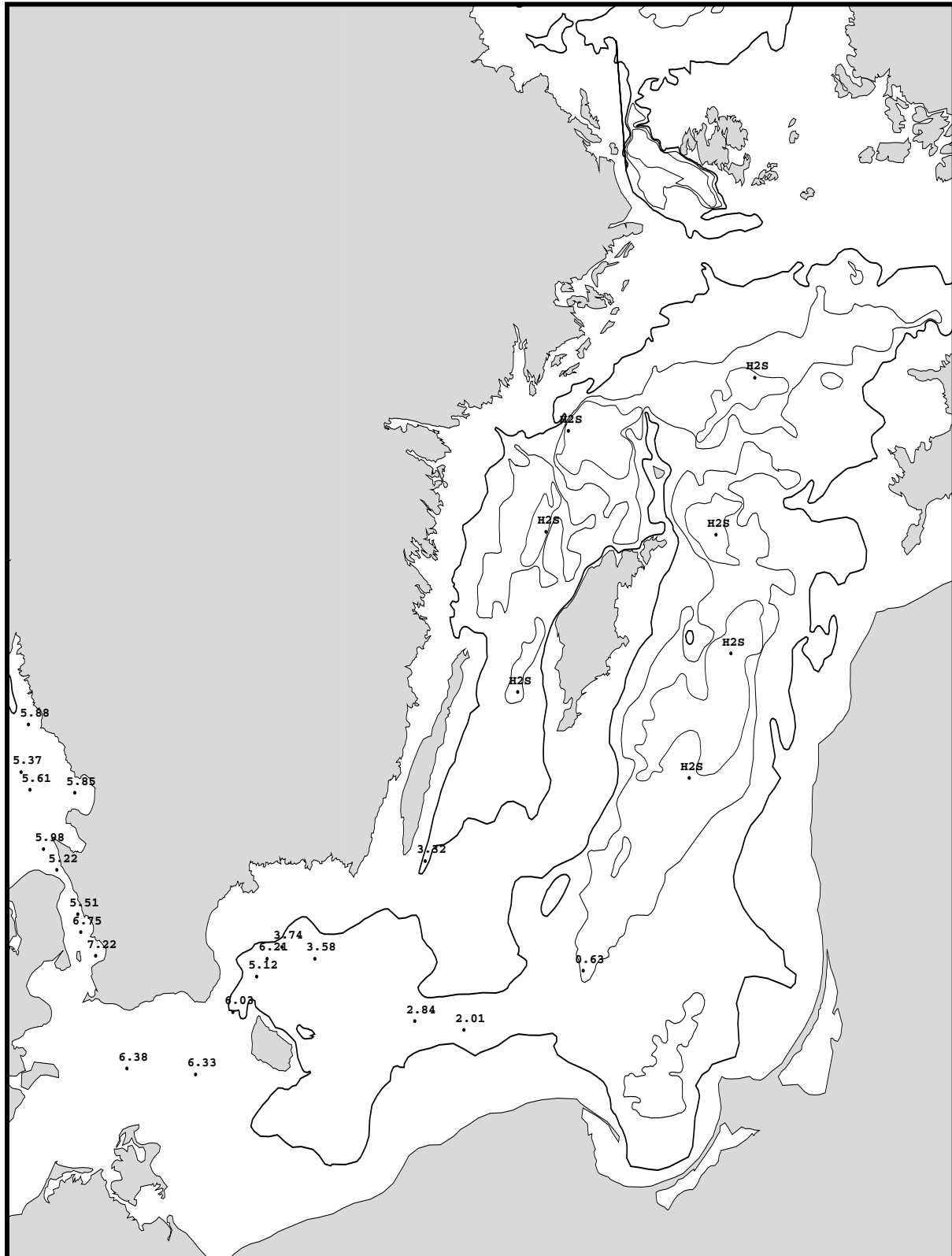
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Time: 15:13

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0030	BPEX26BAS	BY20	FÄRÖDJ	N5800	E1953	20150115	0030	198		25 9	3.3	1001	9990	x	--?----	17	x	?	-	x	x	?	x	x	?	-	x	-	-	-	-	-	-	-

# Bottom water oxygen concentration (ml/l)

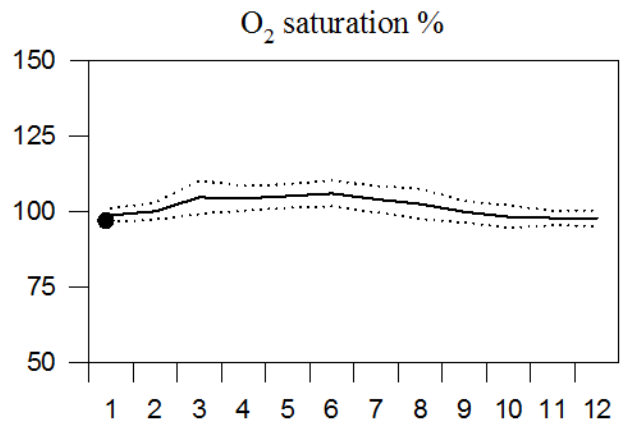
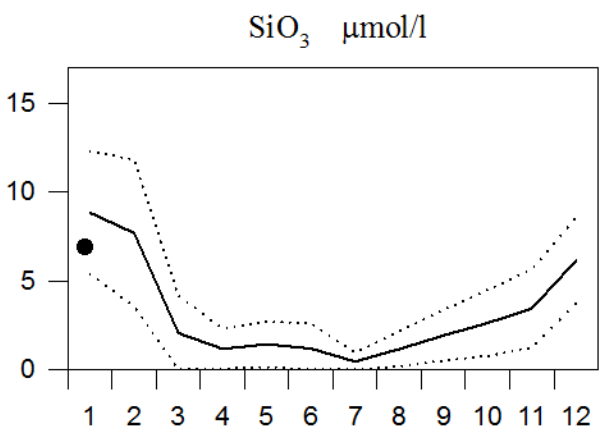
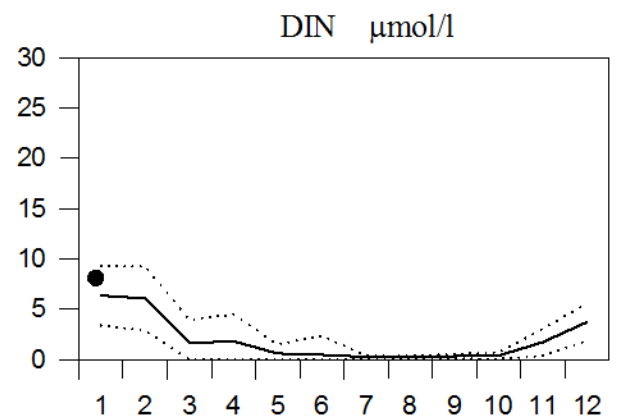
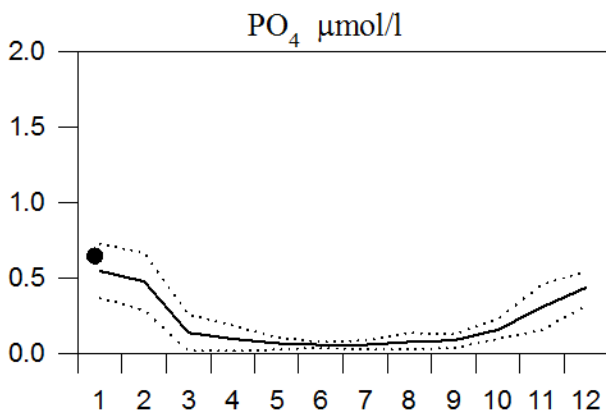
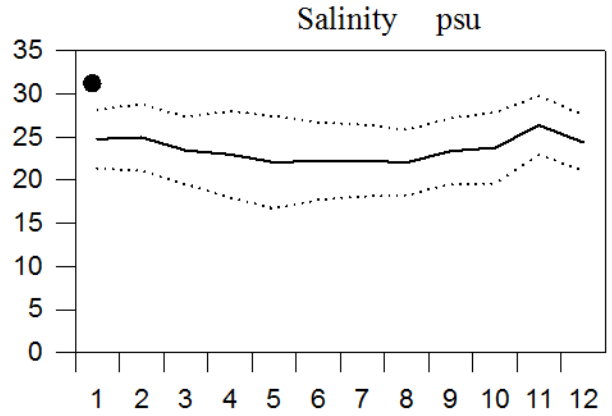
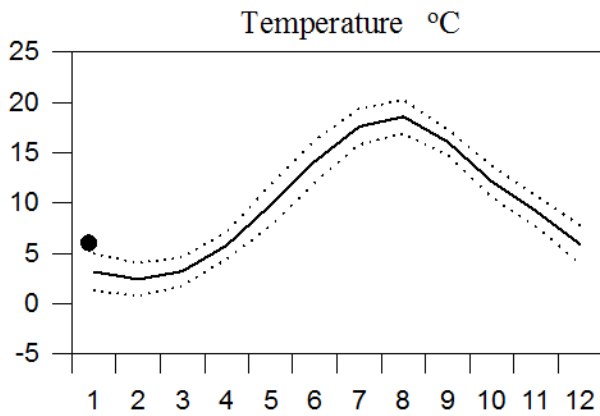
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Series : 0001-0030



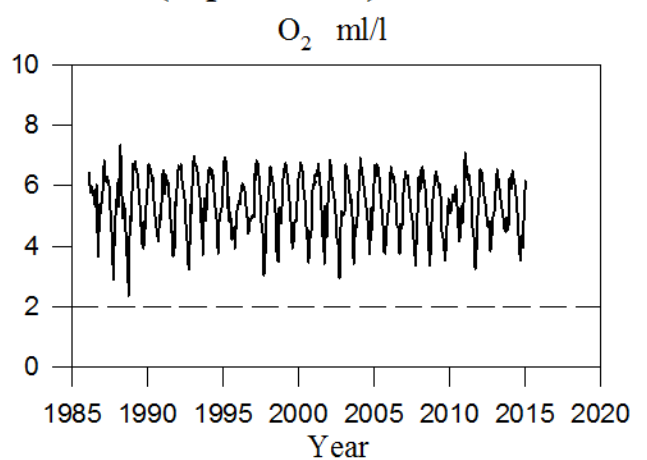
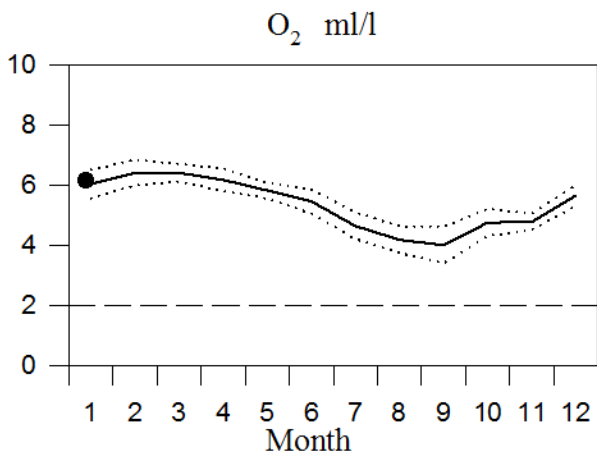
# STATION FLADEN SURFACE WATER

## Annual Cycles

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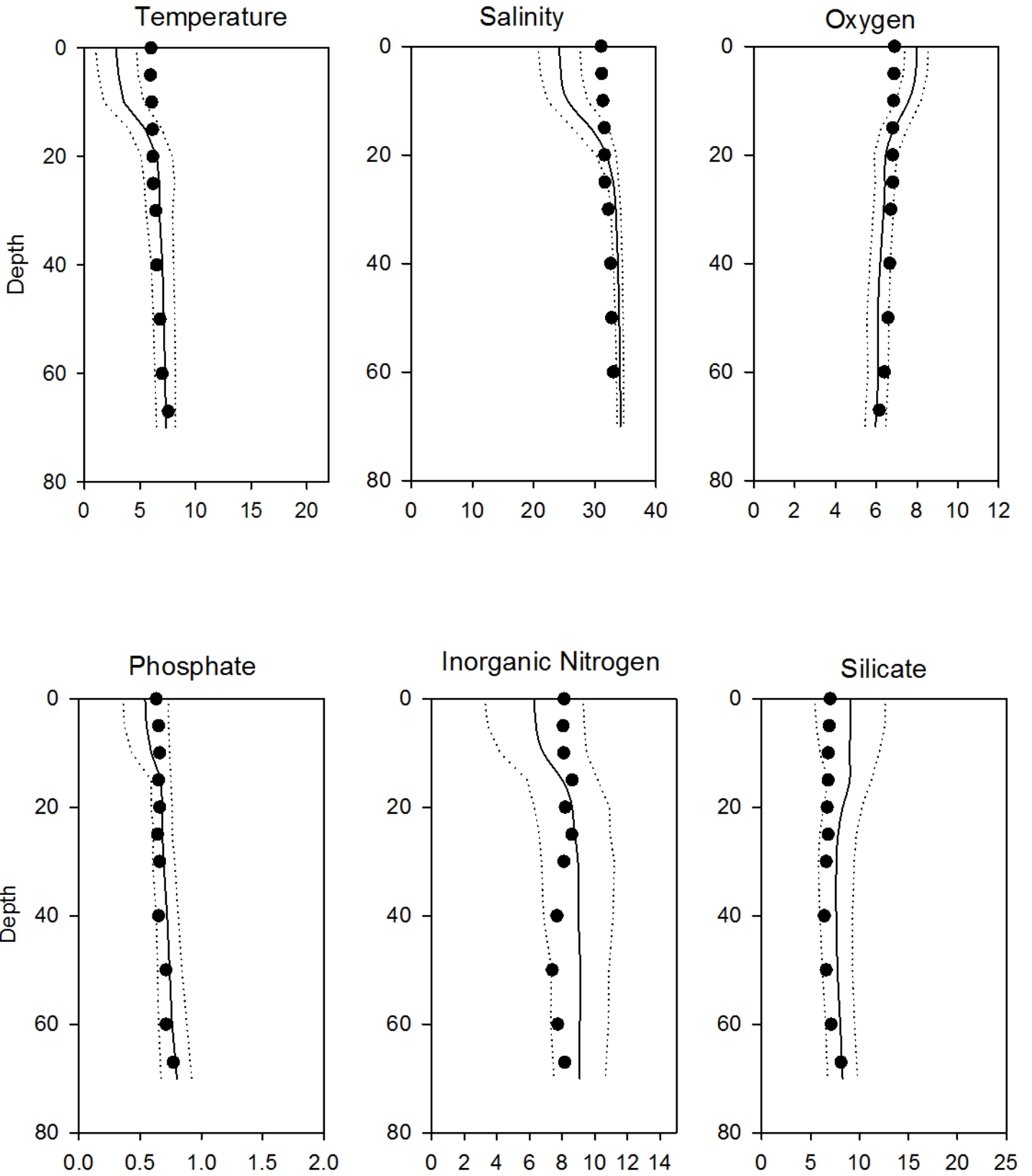
## OXYGEN IN BOTTOM WATER (depth > 70m)





# Vertical profiles Fladen January

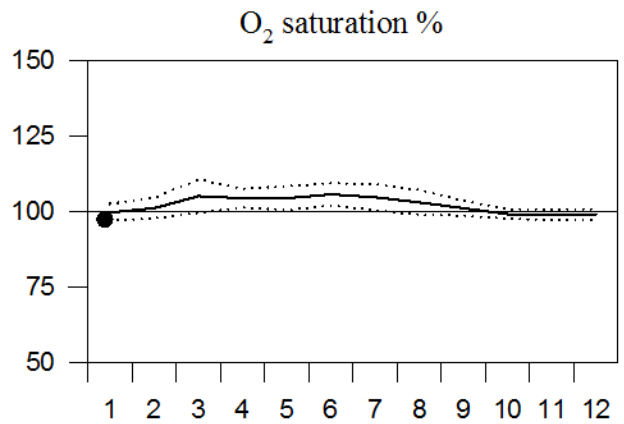
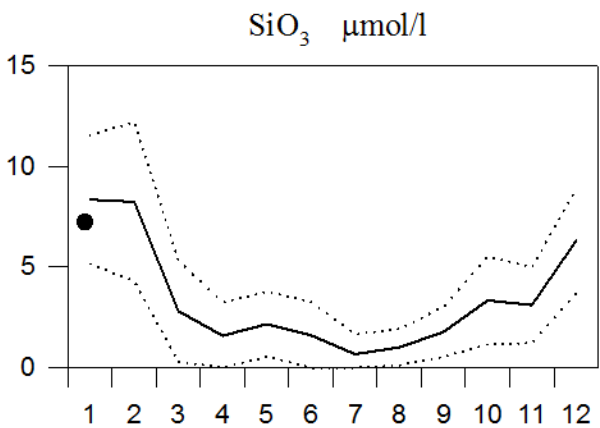
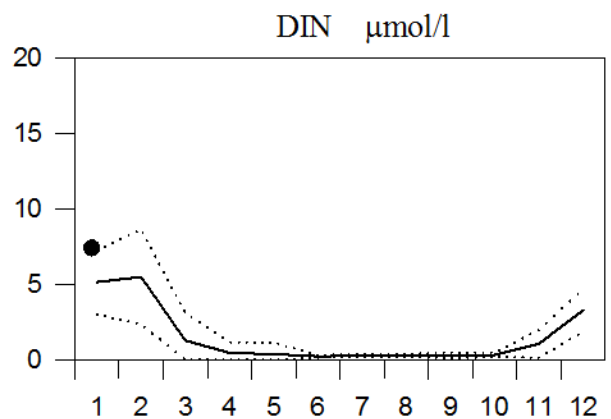
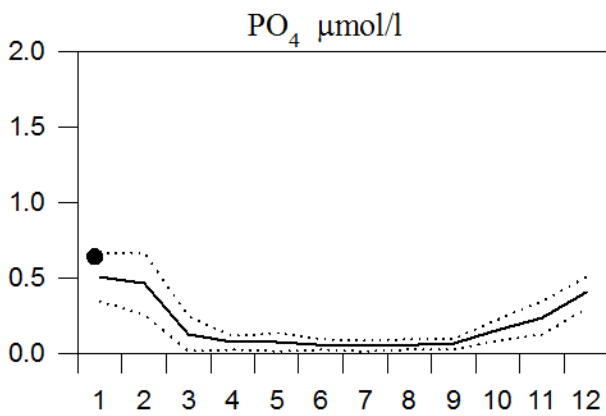
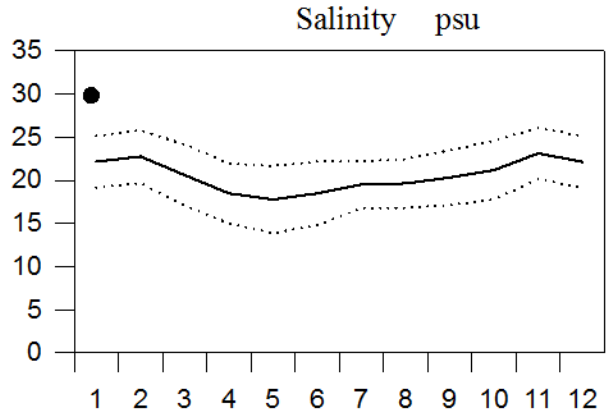
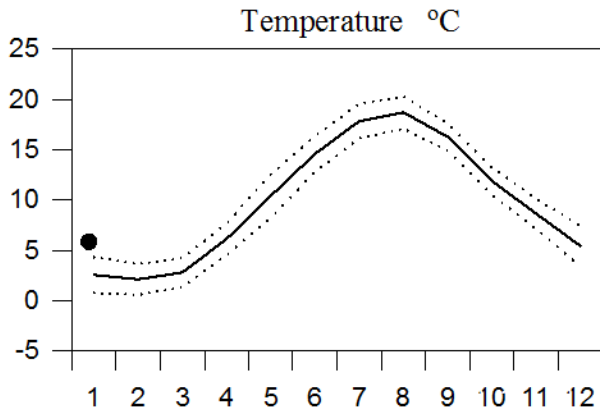
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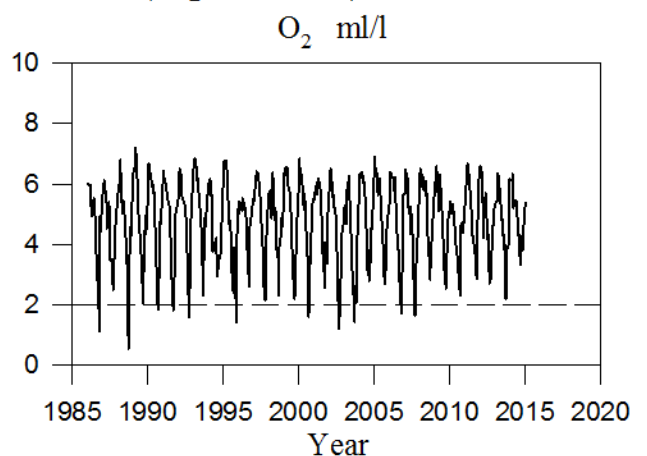
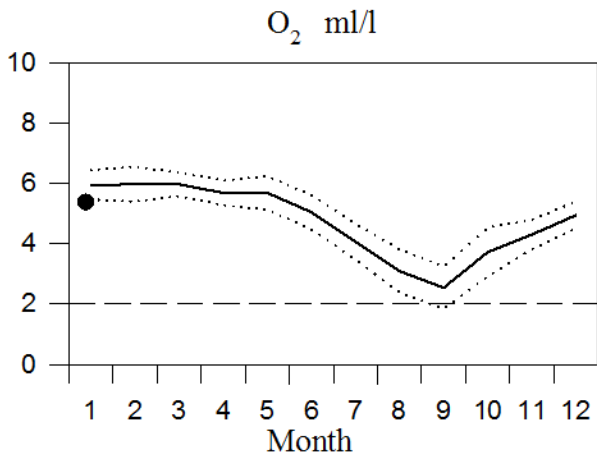
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## Annual Cycles

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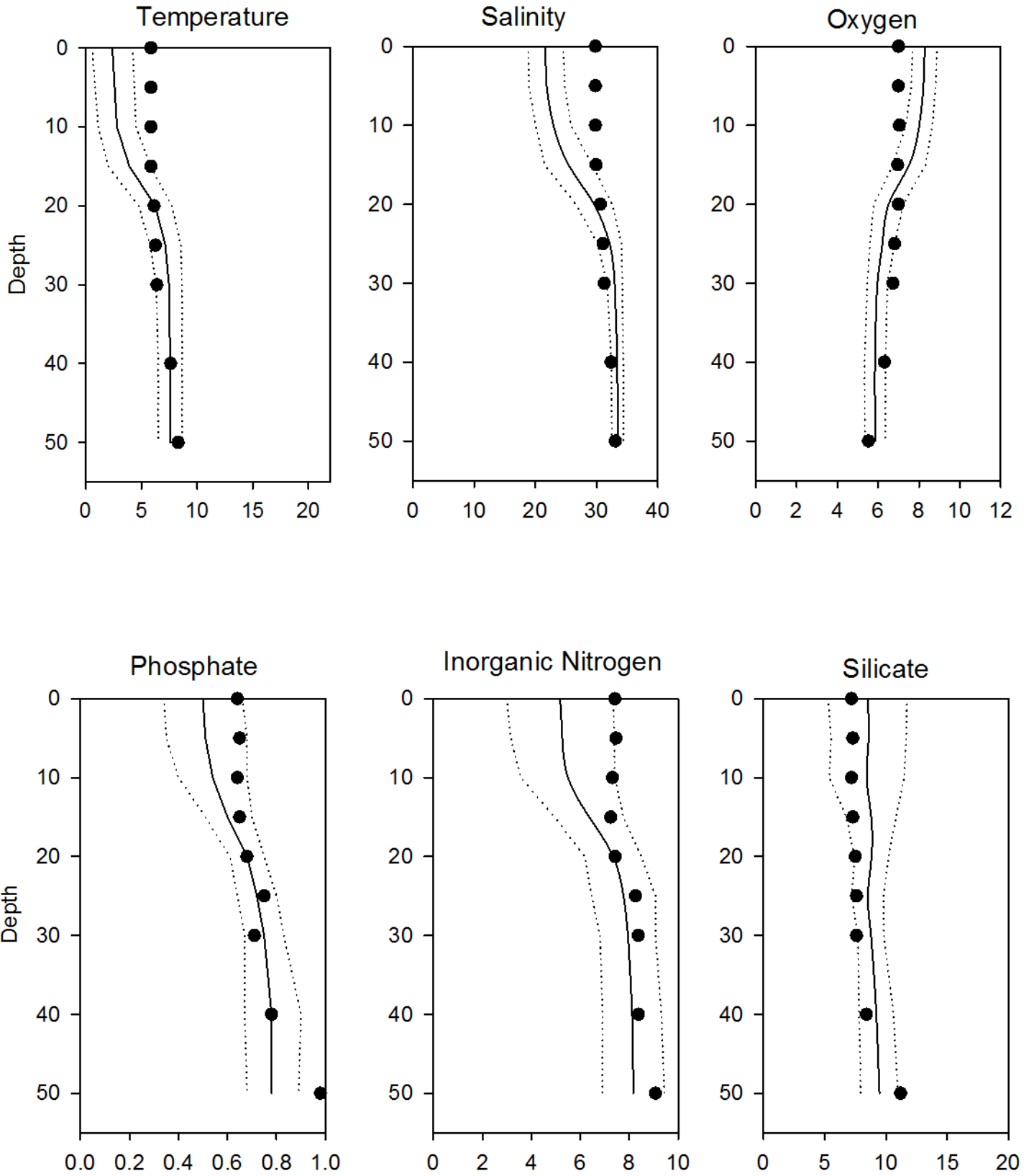


## OXYGEN IN BOTTOM WATER (depth > 50m)



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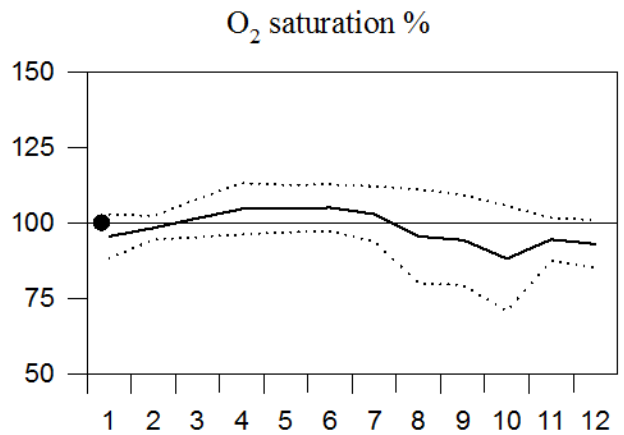
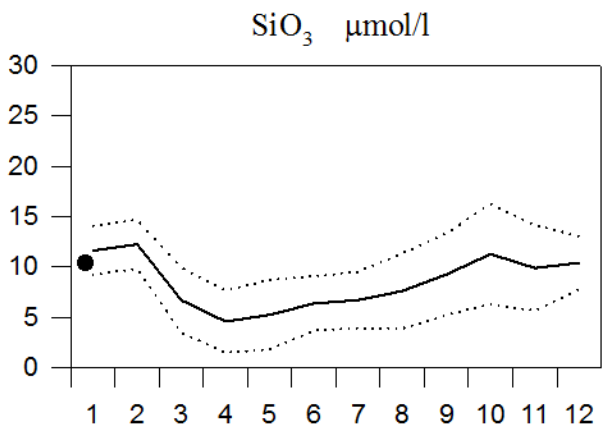
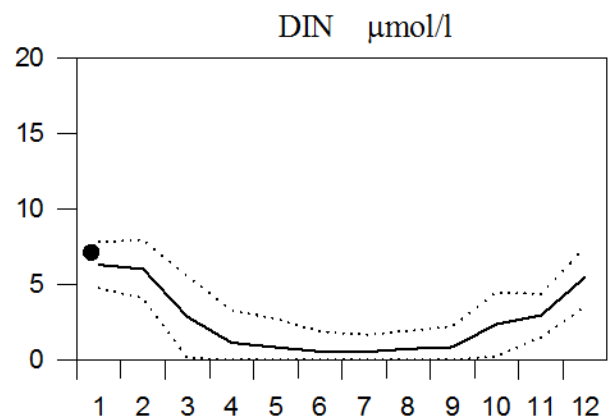
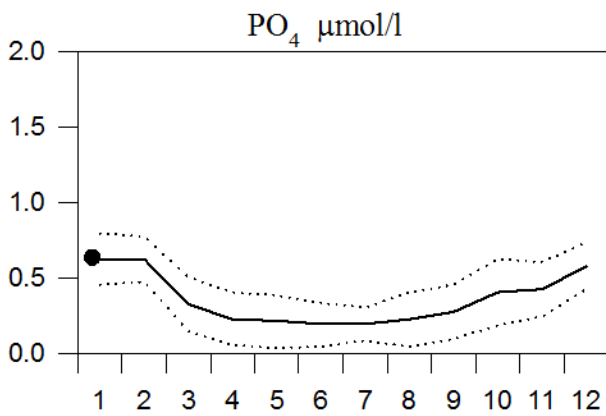
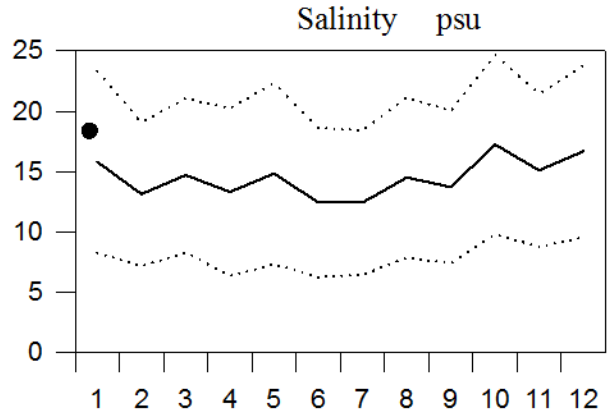
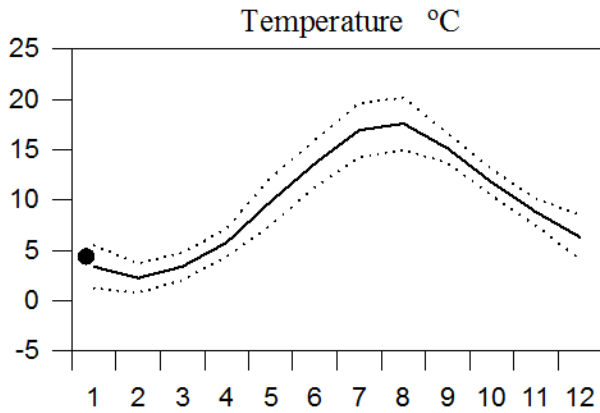
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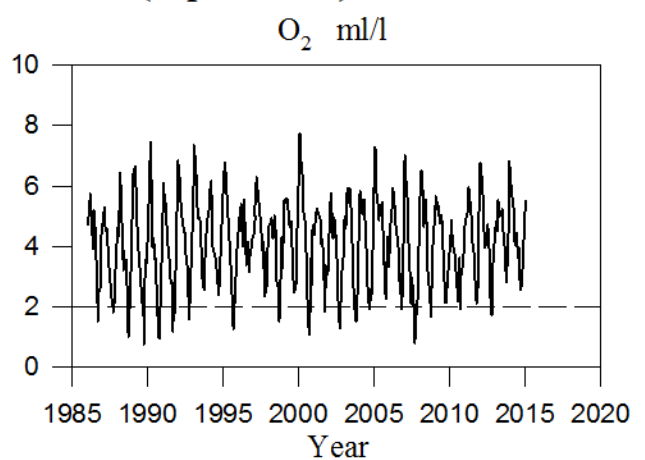
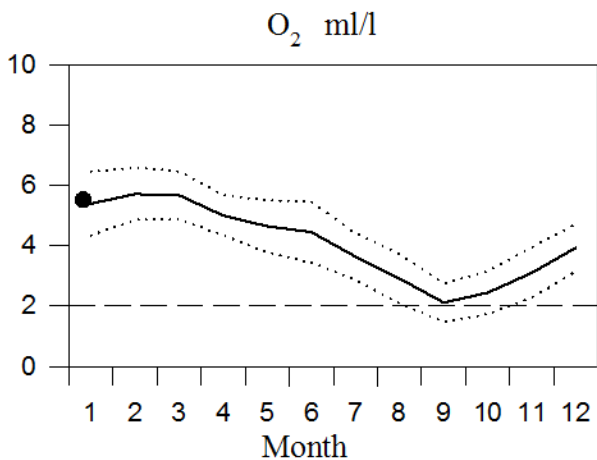
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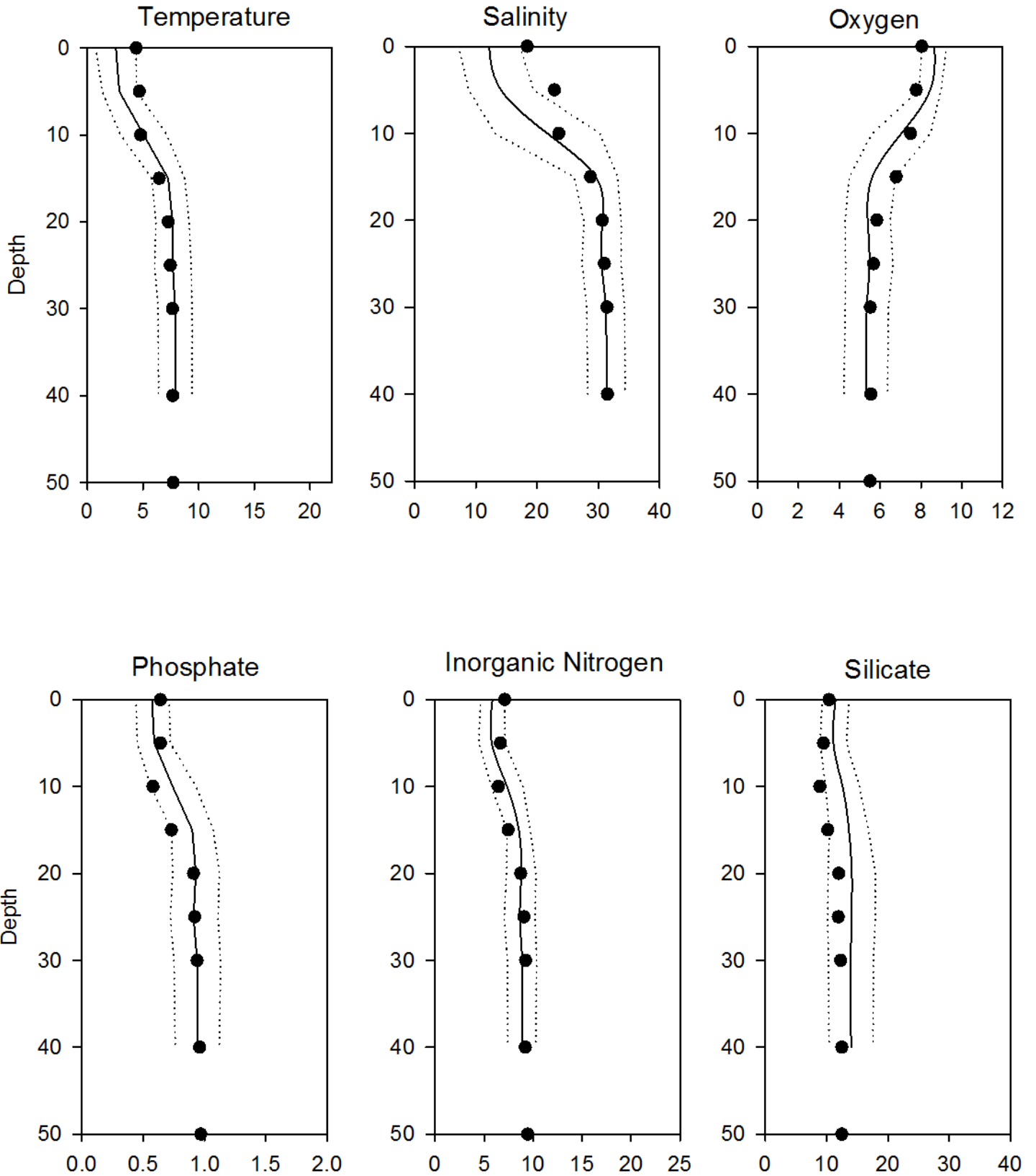


## OXYGEN IN BOTTOM WATER (depth >40m)



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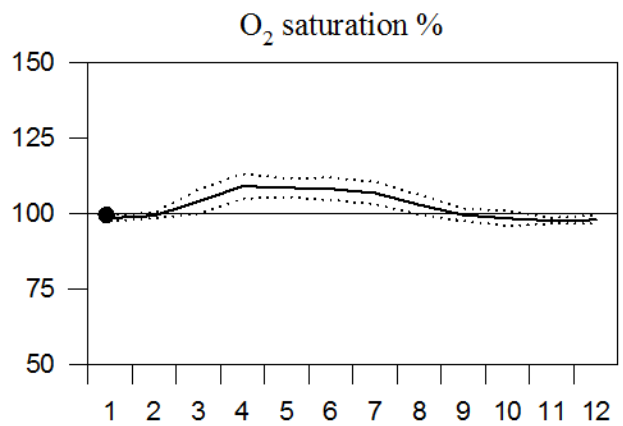
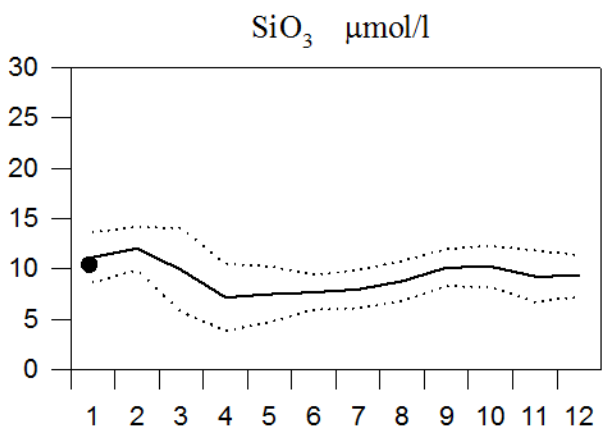
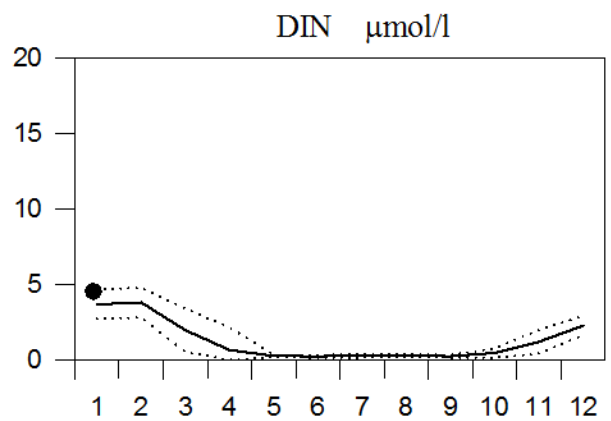
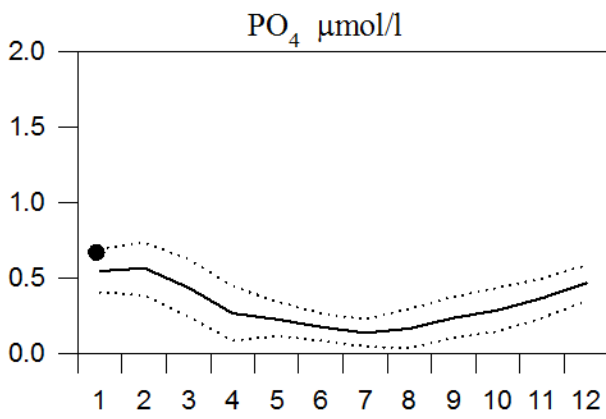
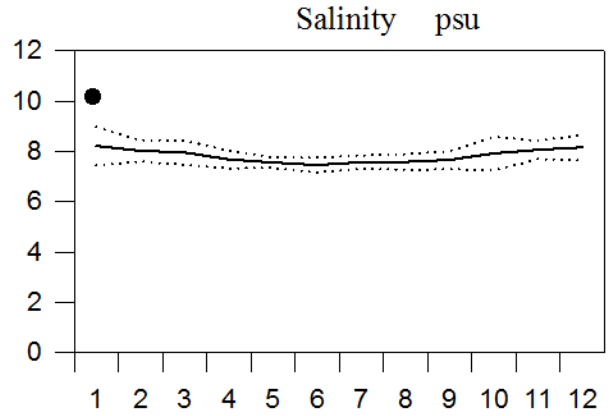
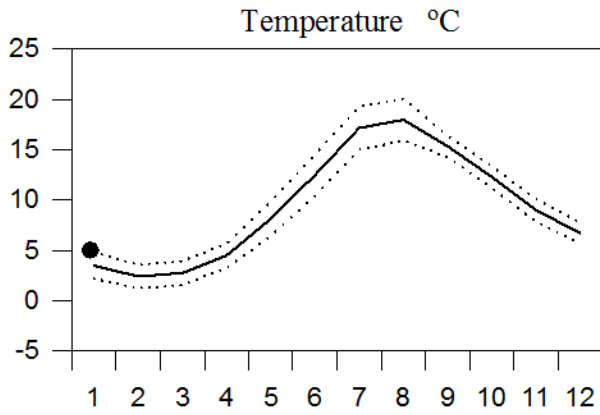
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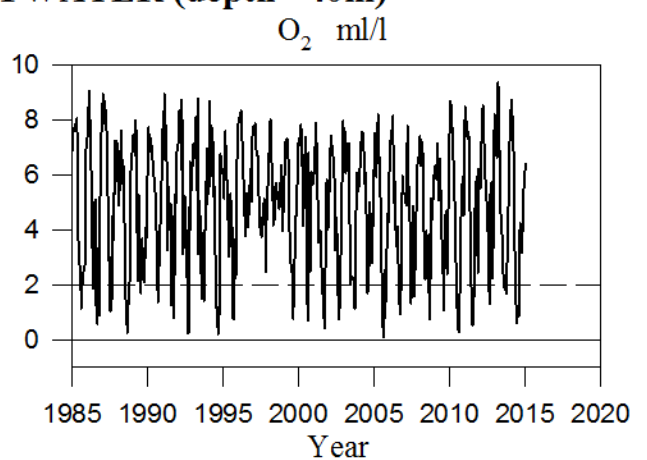
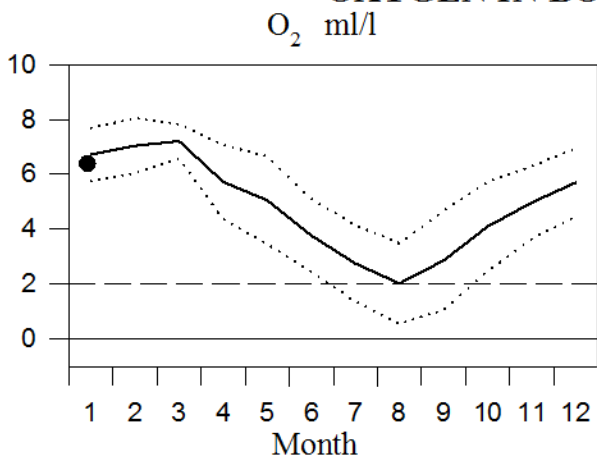
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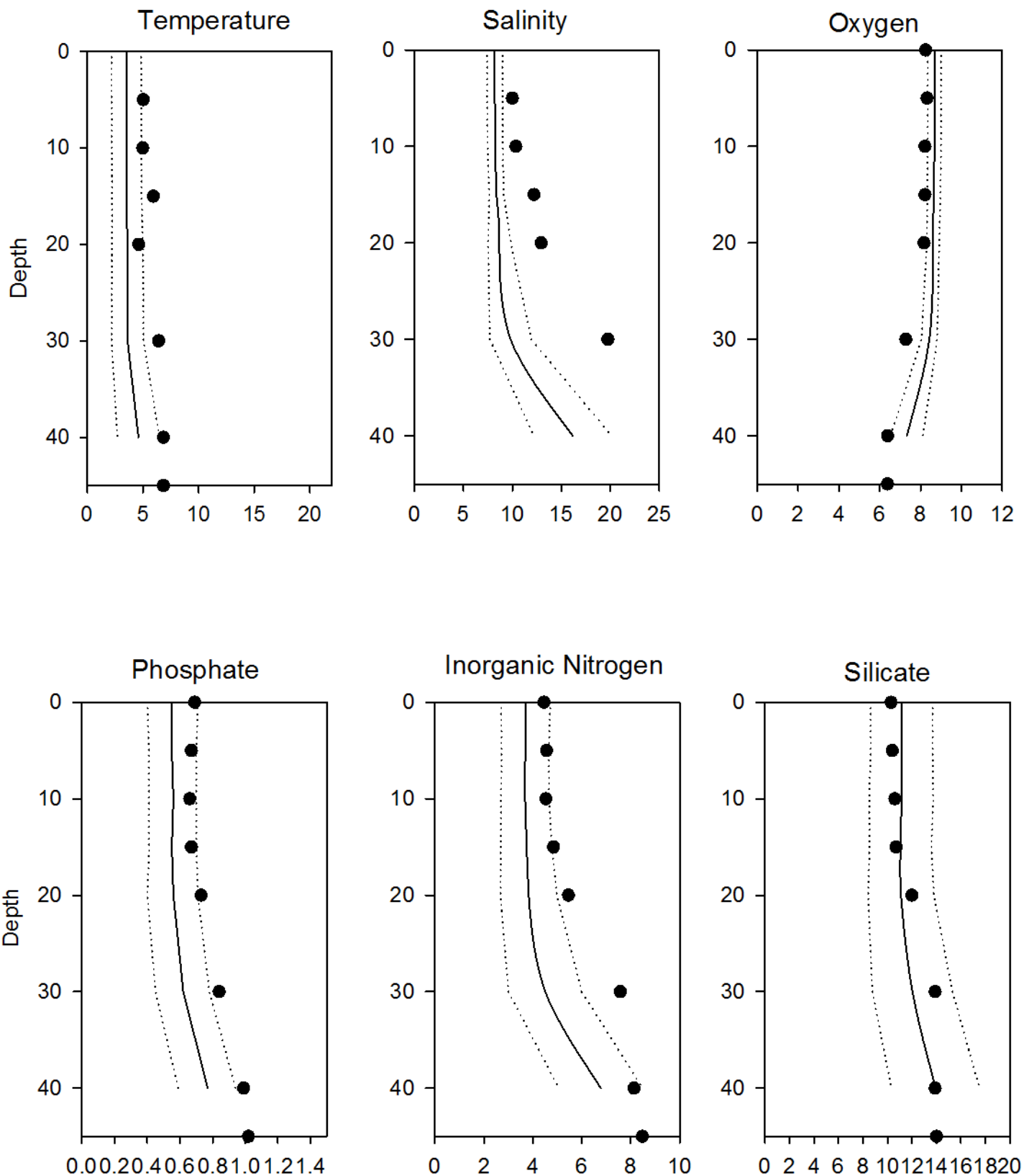


## OXYGEN IN BOTTOM WATER (depth >40m)



# Vertical profiles BY1 January

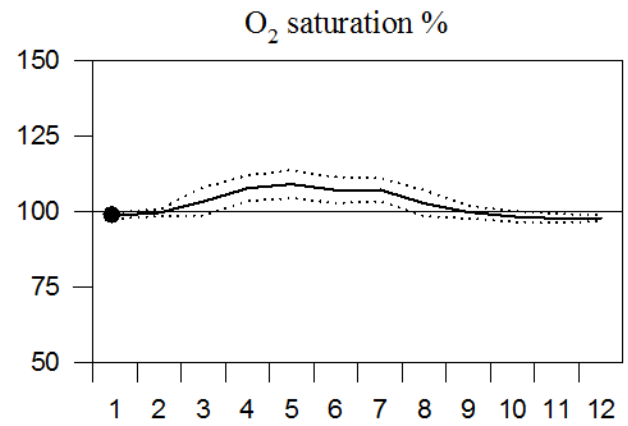
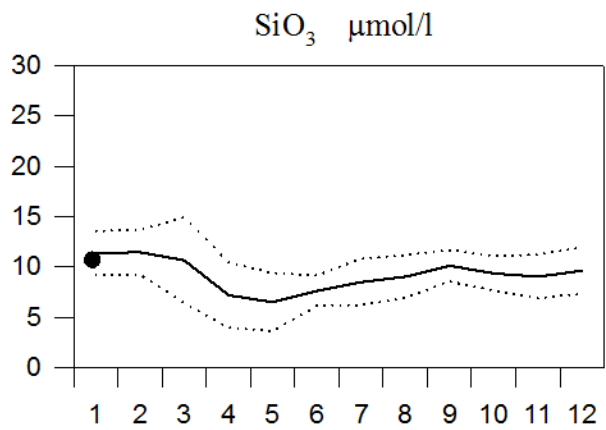
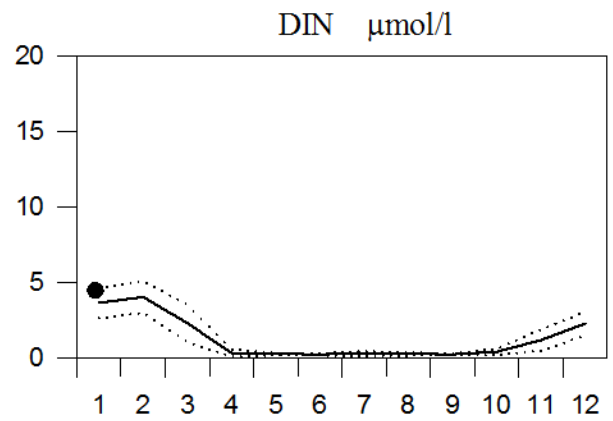
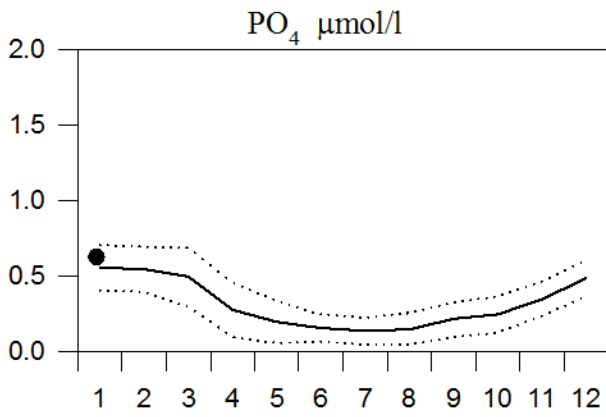
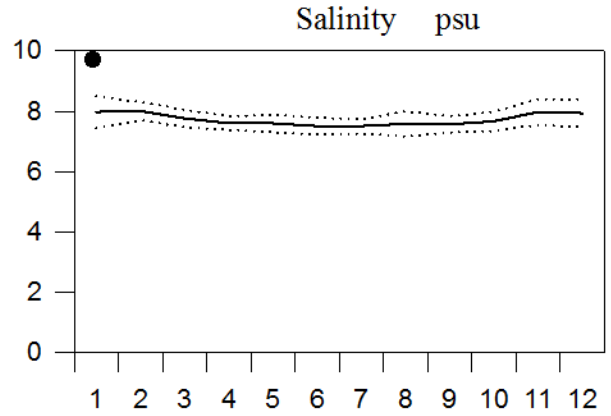
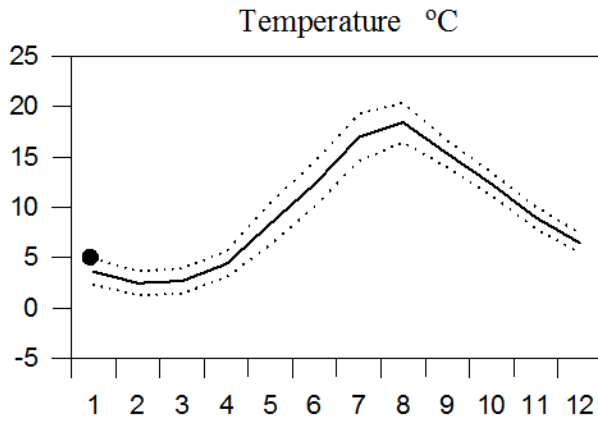
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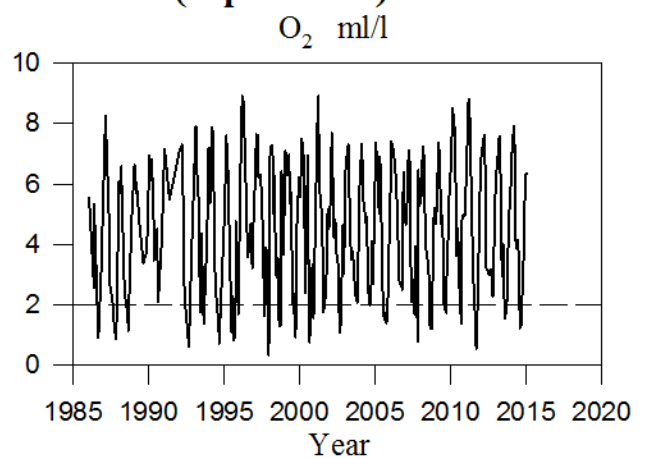
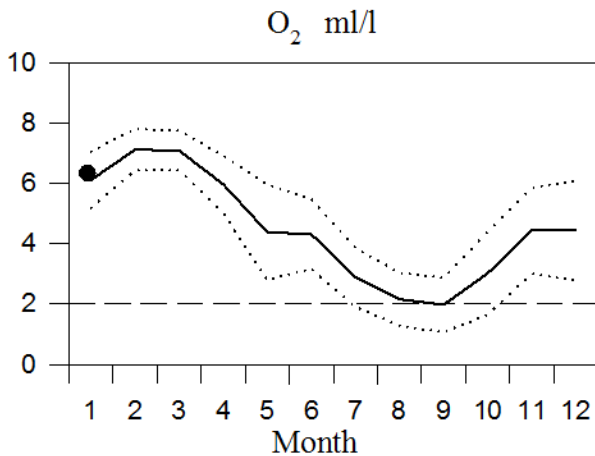
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## Annual Cycles

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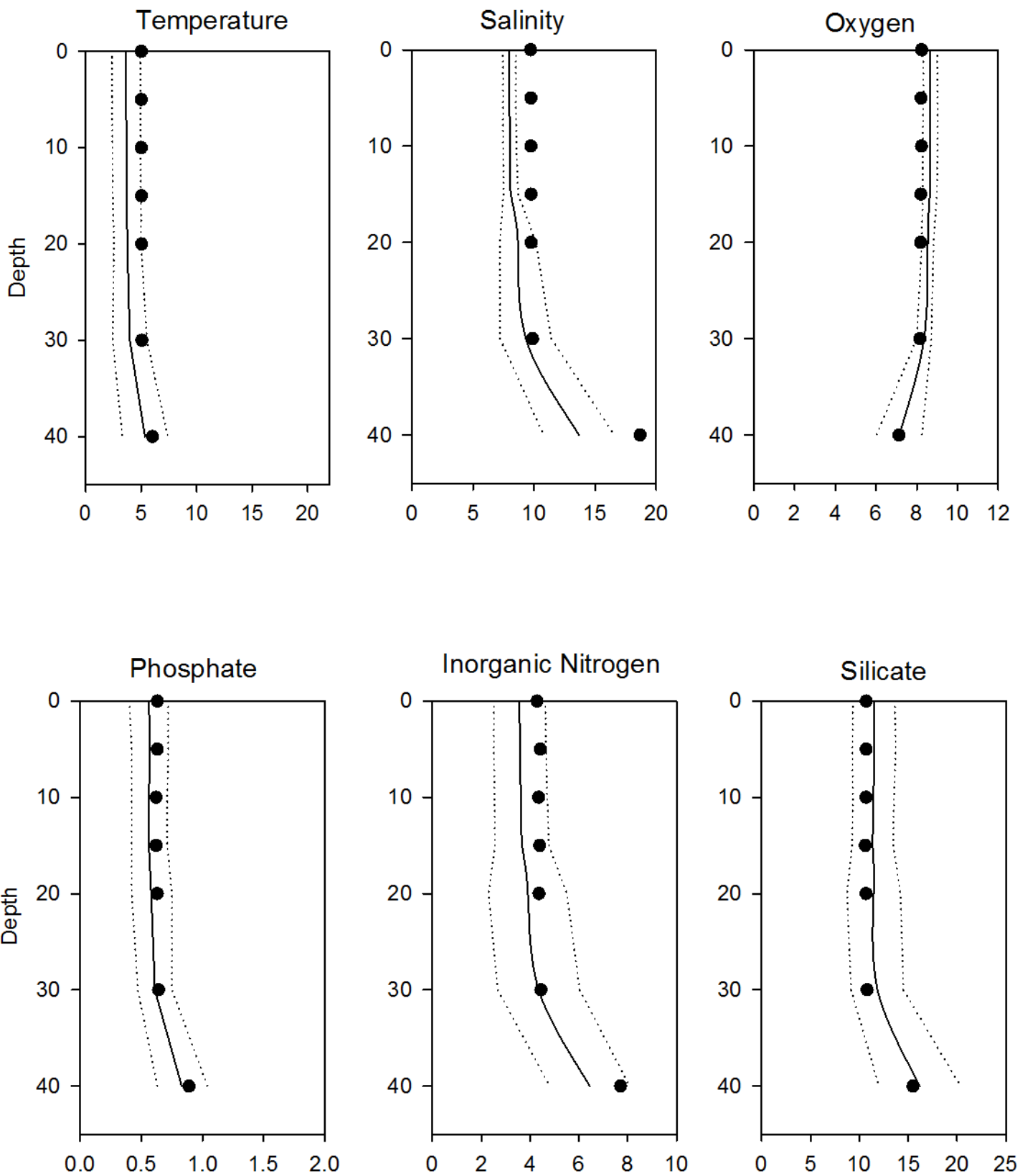
## OXYGEN IN BOTTOM WATER (depth >40m)





# Vertical profiles BY2 January

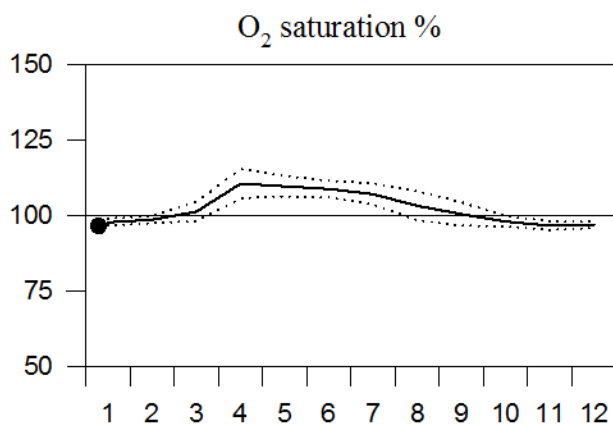
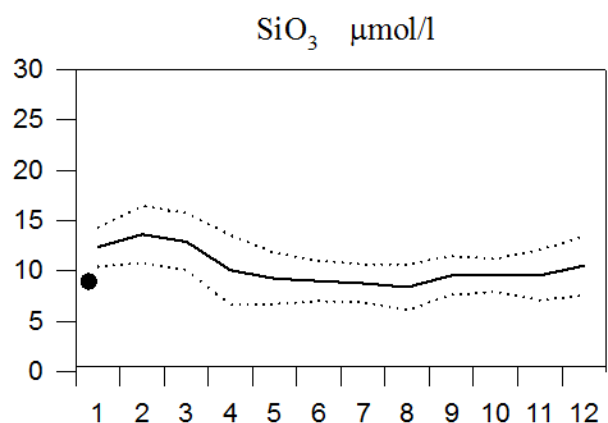
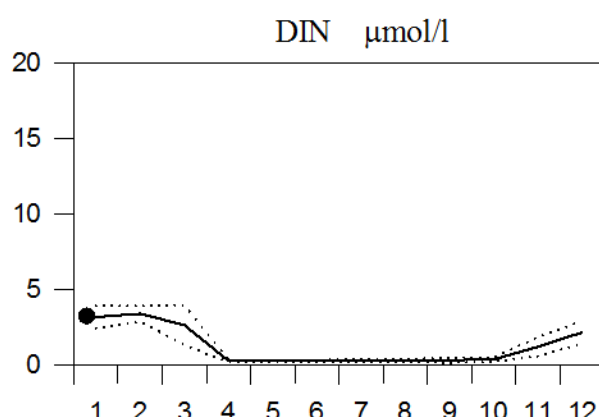
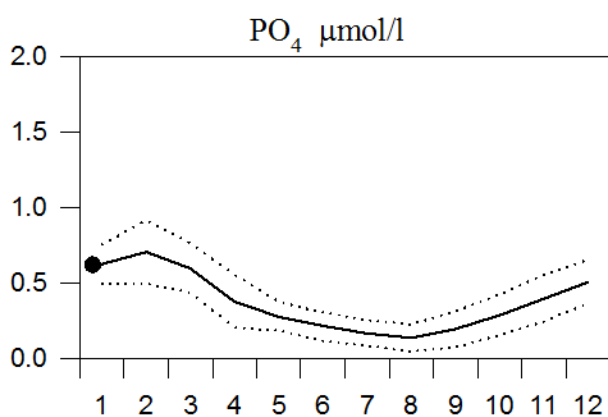
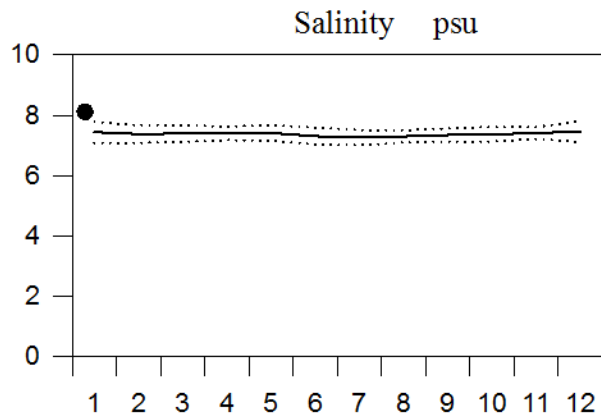
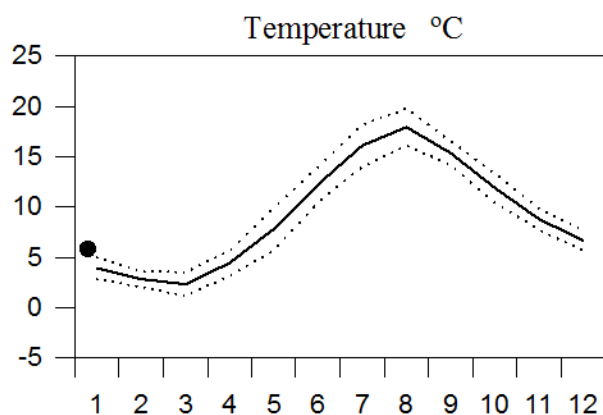
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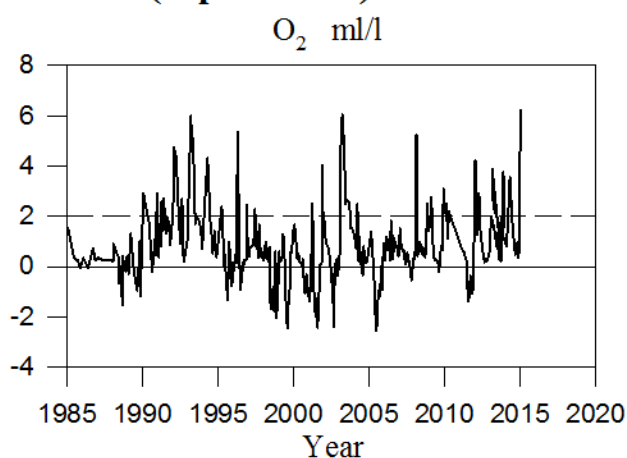
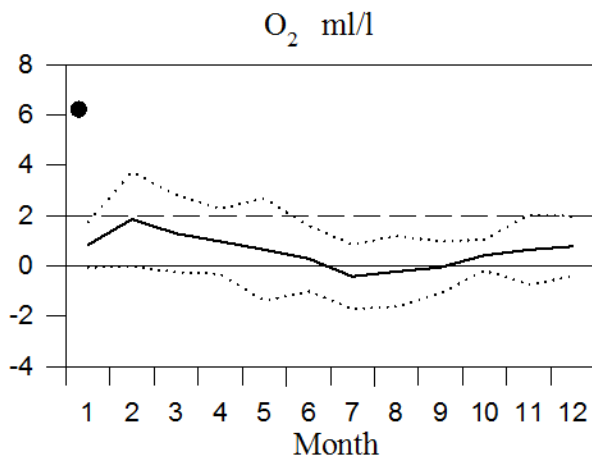
# STATION HANÖBUKTEN SURFACE WATER

## Annual Cycles

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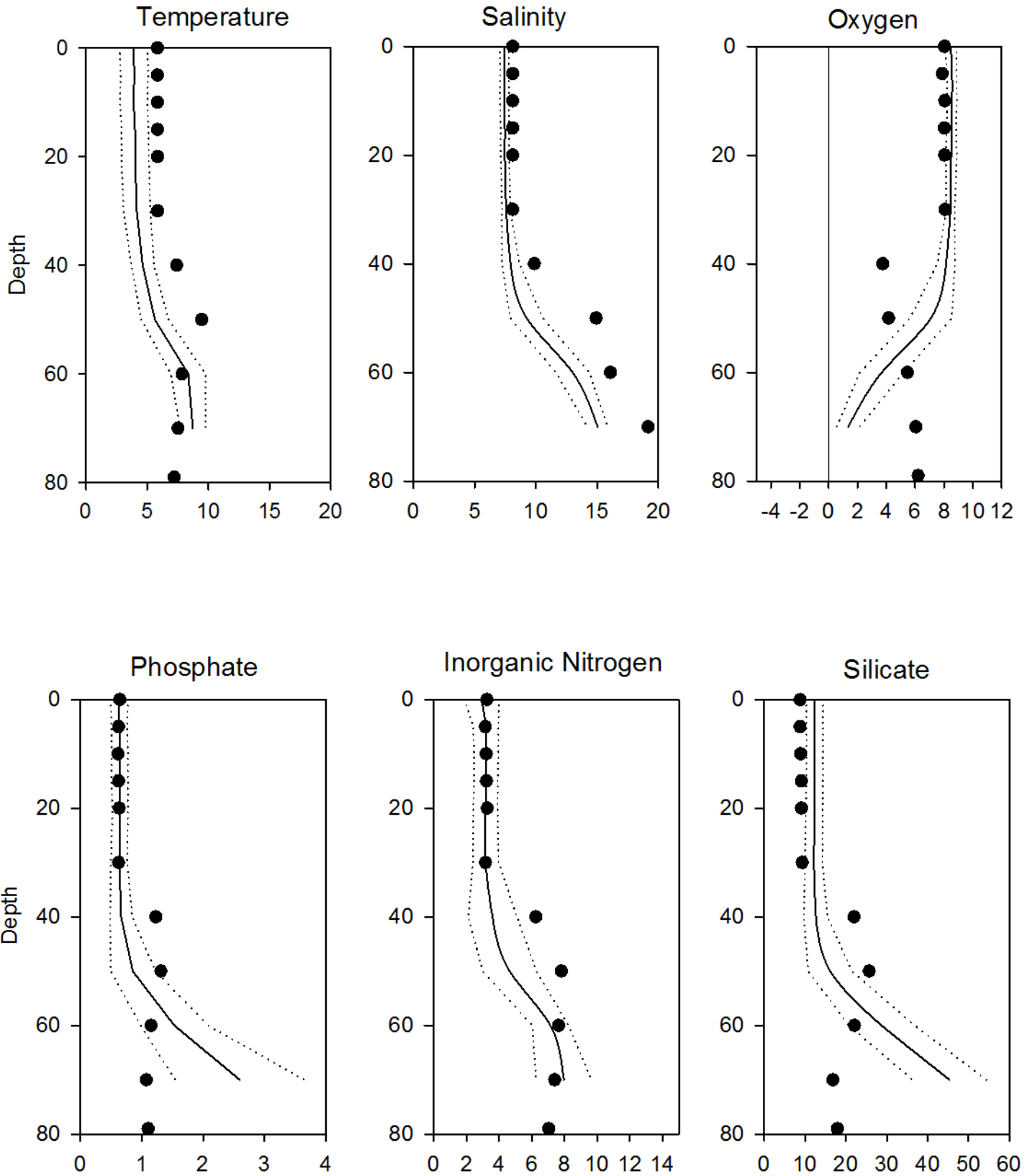


## OXYGEN IN BOTTOM WATER (depth > 70m)



# Vertical profiles Hanöbukten January

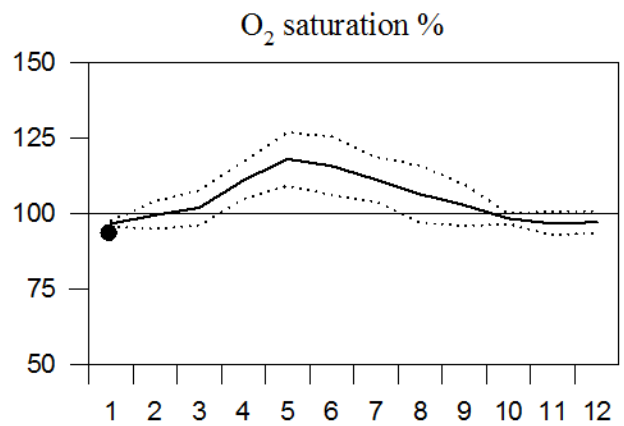
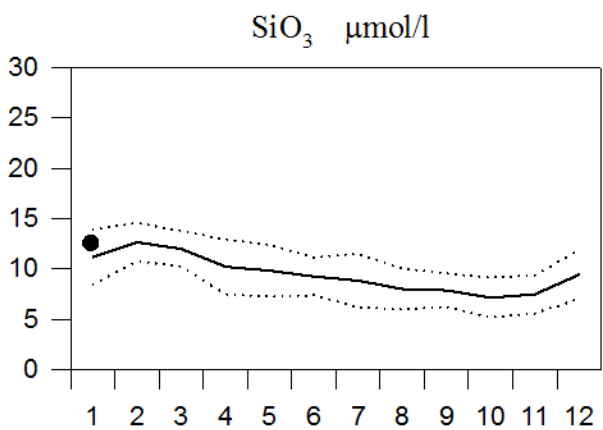
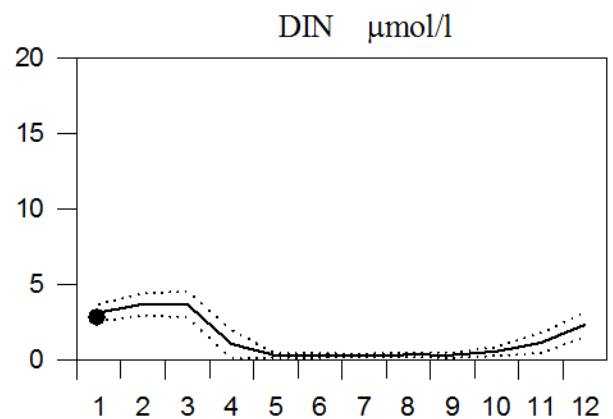
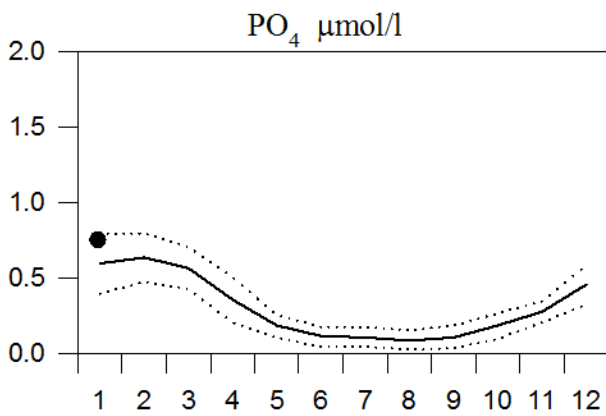
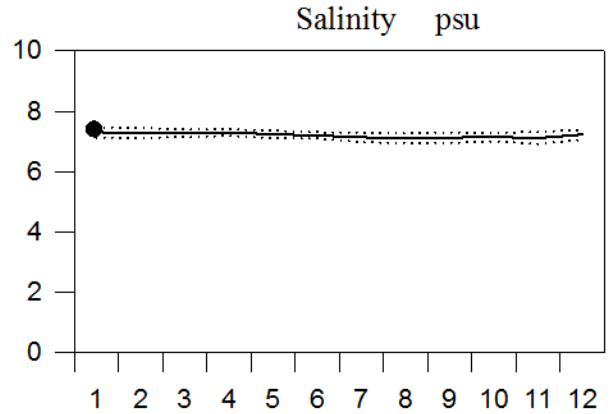
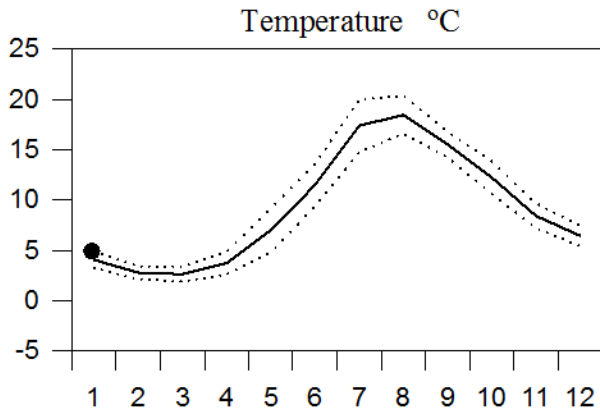
— Mean 1996-2010      ..... St.Dev.      ● 2015



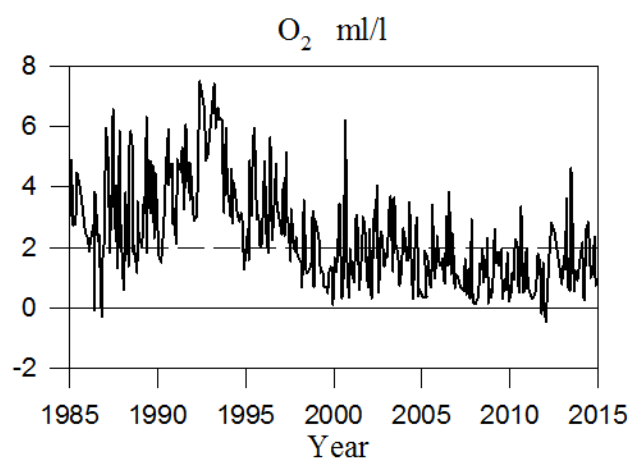
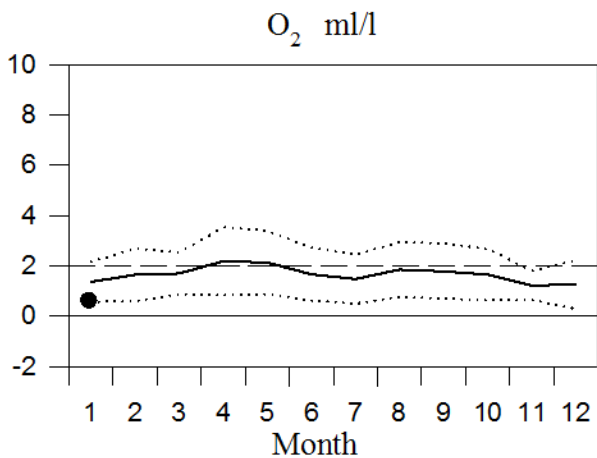
# STATION BCS III-10 SURFACE WATER

## Annual Cycles

— Mean 1996-2010    ..... St.Dev.    ● 2015

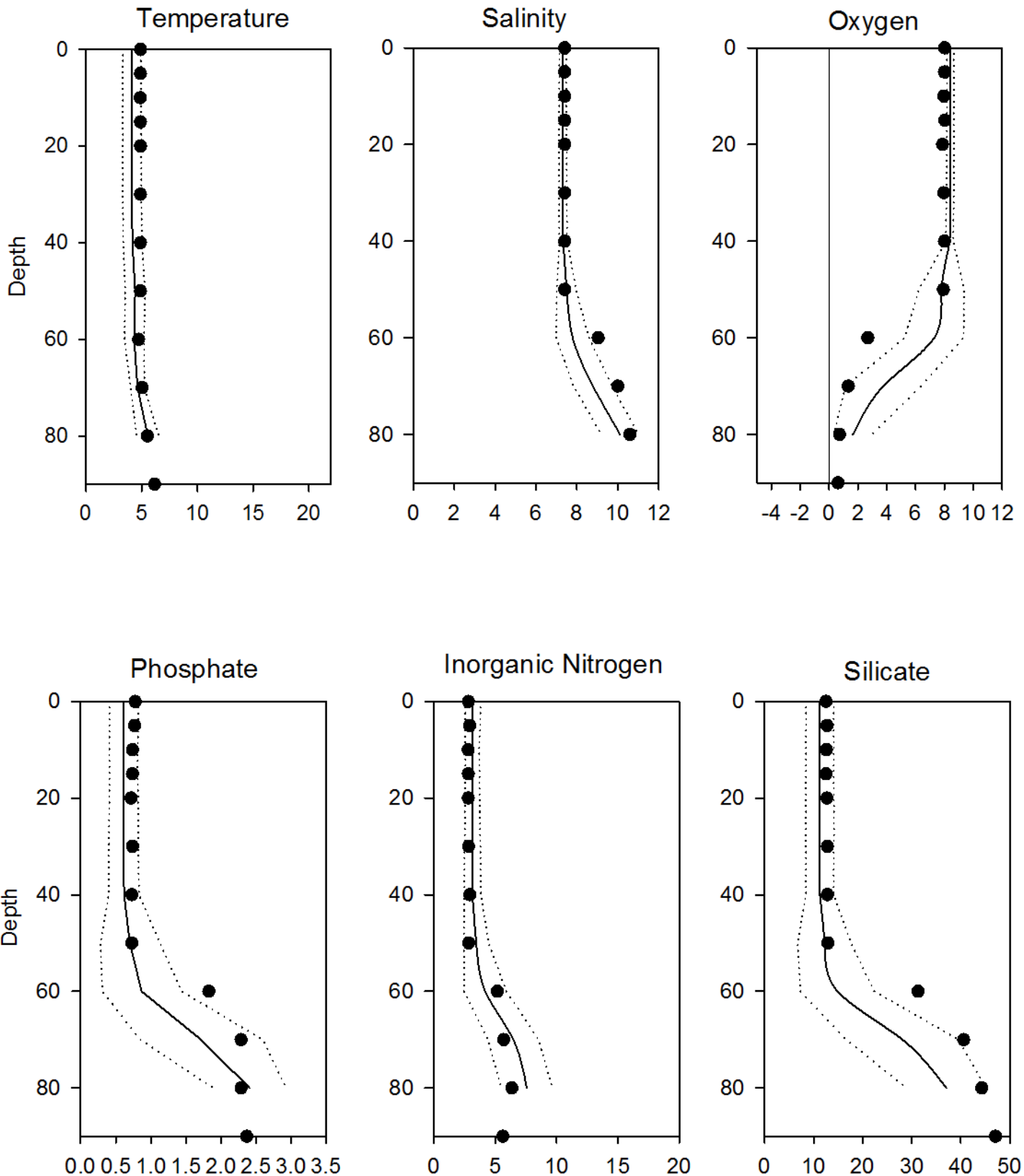


## OXYGEN IN BOTTOM WATER (depth > 80m)



# Vertical profiles BCS III-10 January

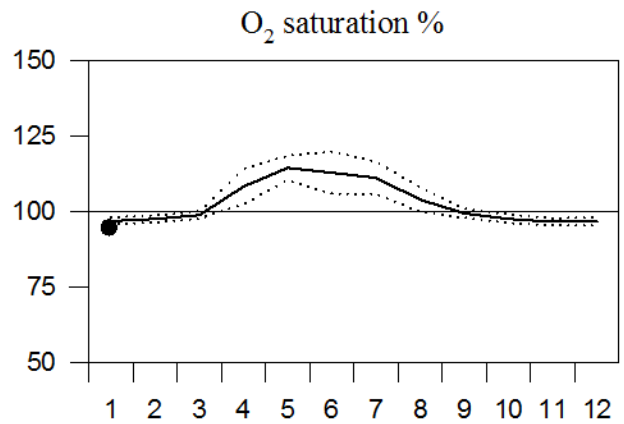
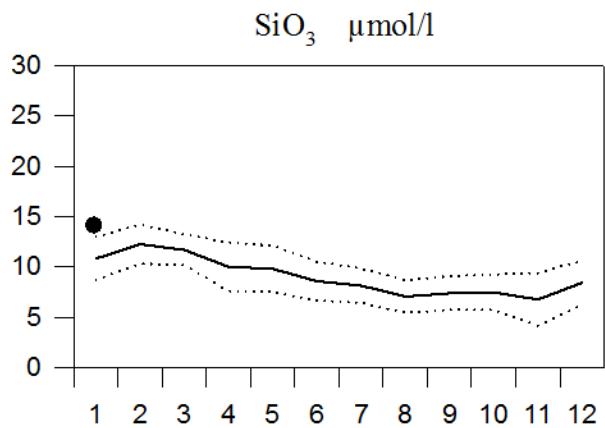
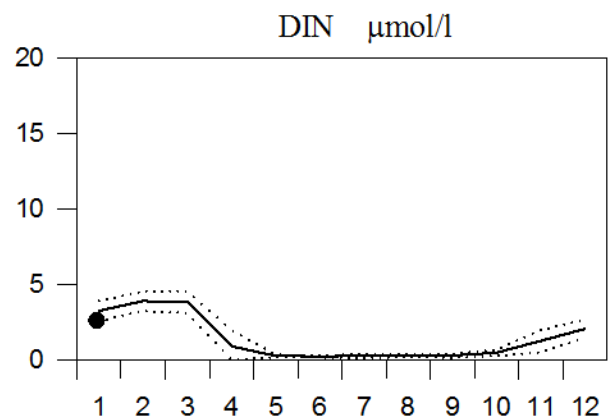
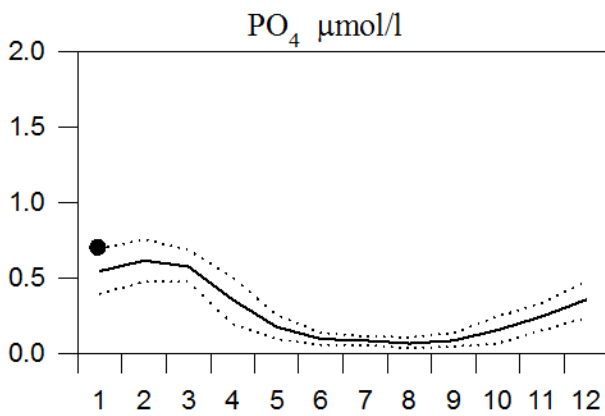
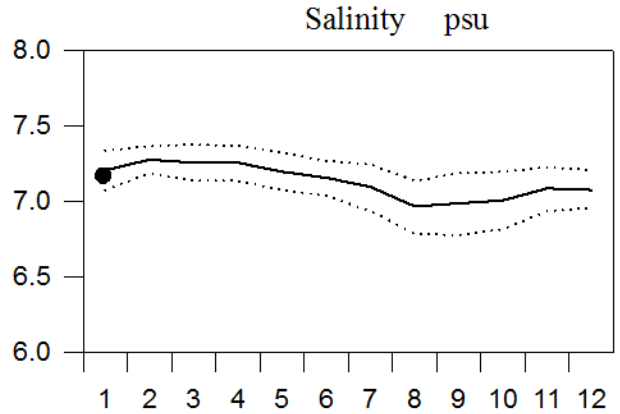
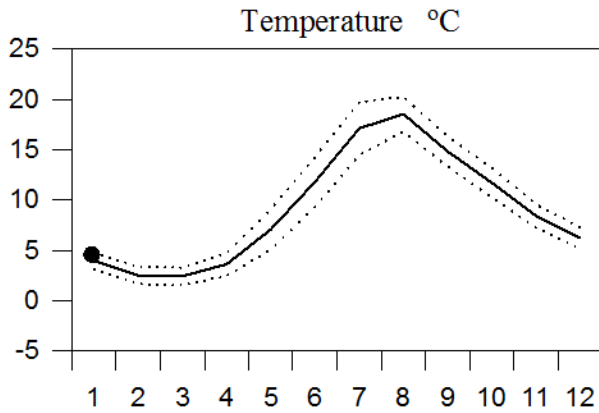
— Mean 1996-2010      ..... St.Dev.      ● 2015



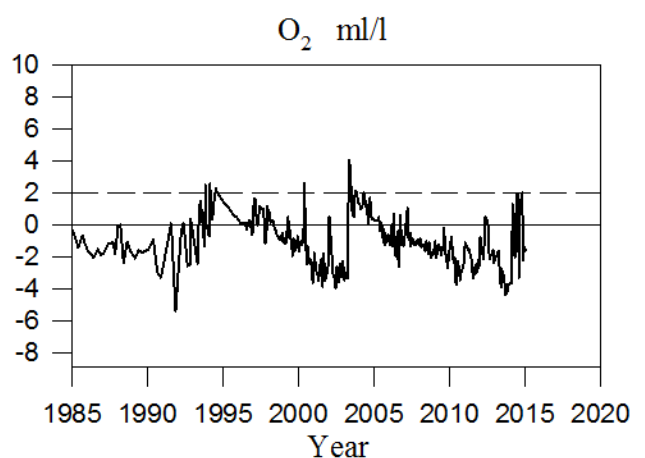
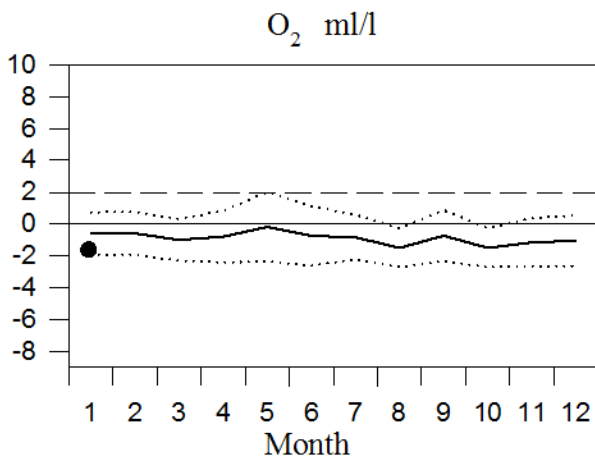
# STATION BY10 SURFACE WATER

## Annual Cycles

— Mean 1996-2010      ····· St.Dev.      ● 2015

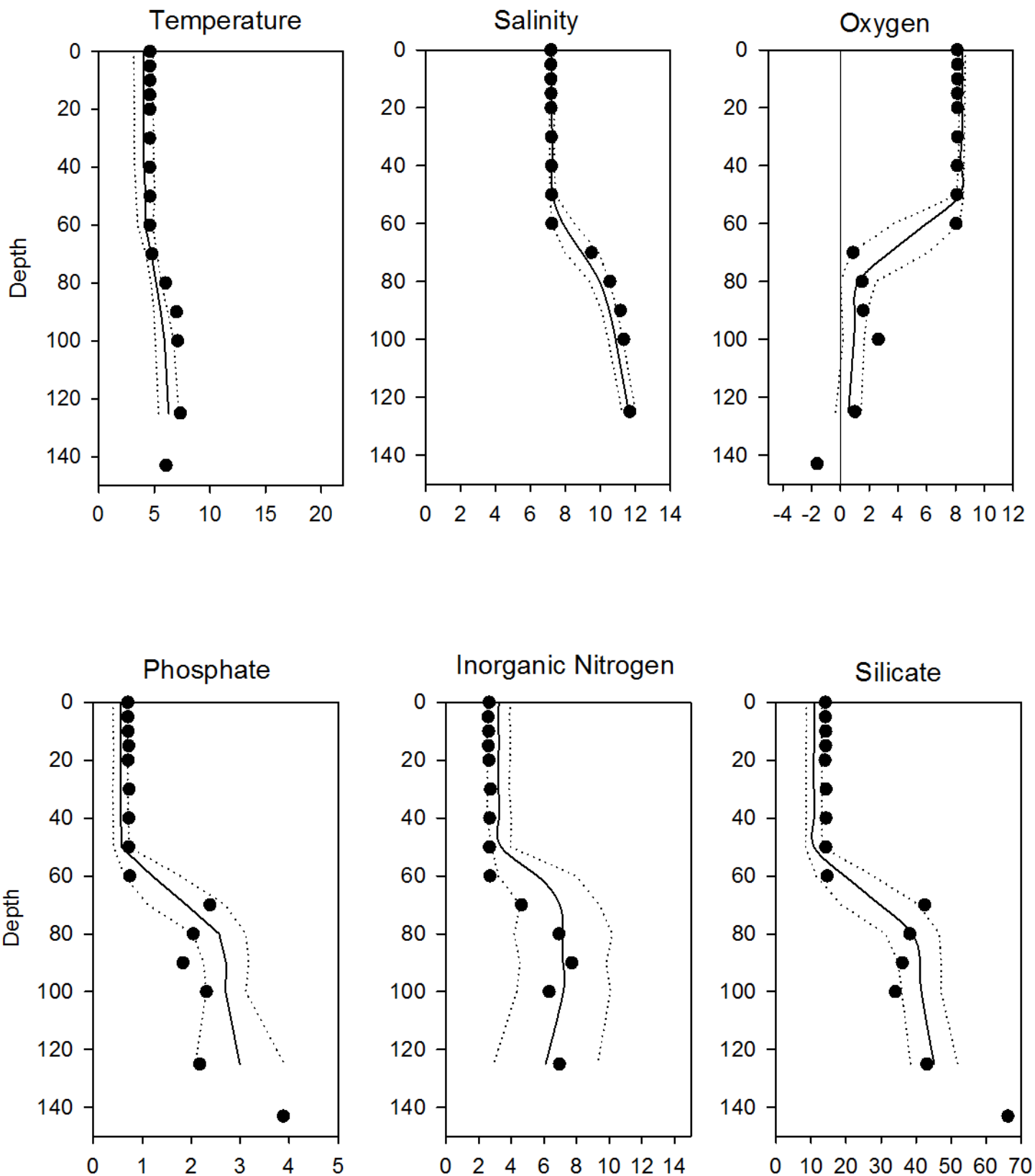


## OXYGEN IN BOTTOM WATER (depth >125m)



# Vertical profiles BY10 January

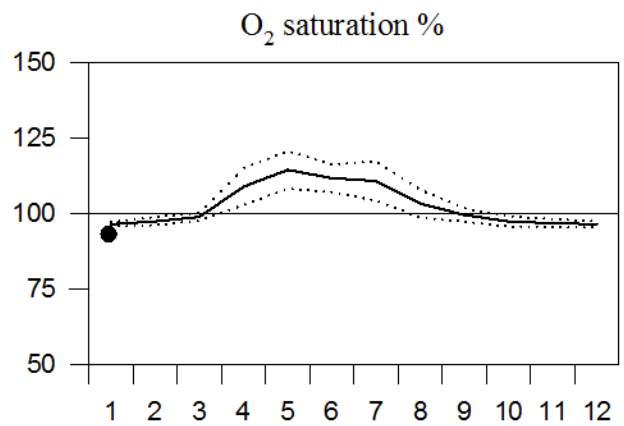
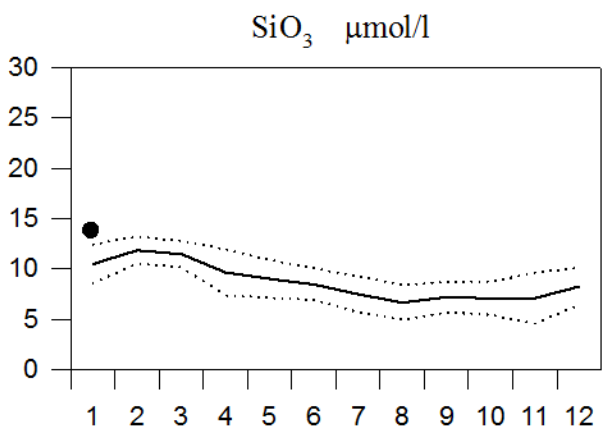
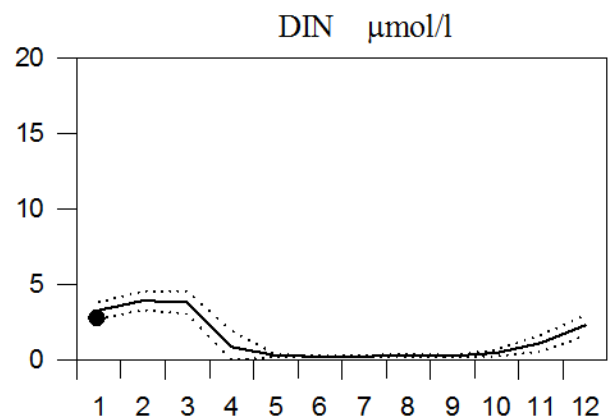
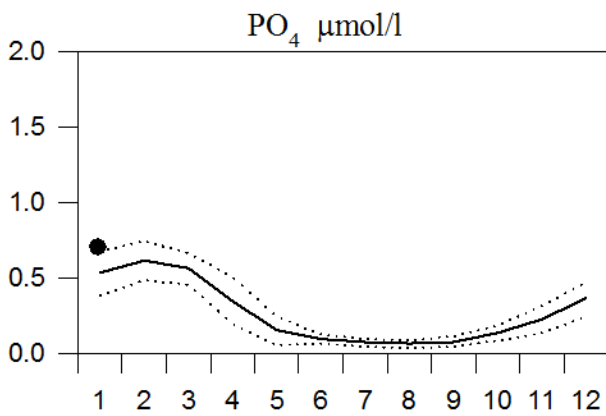
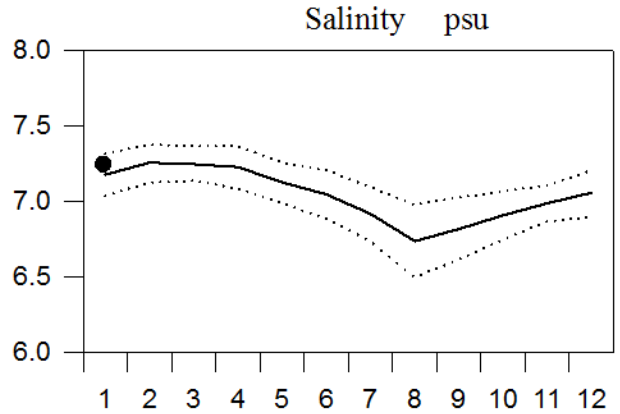
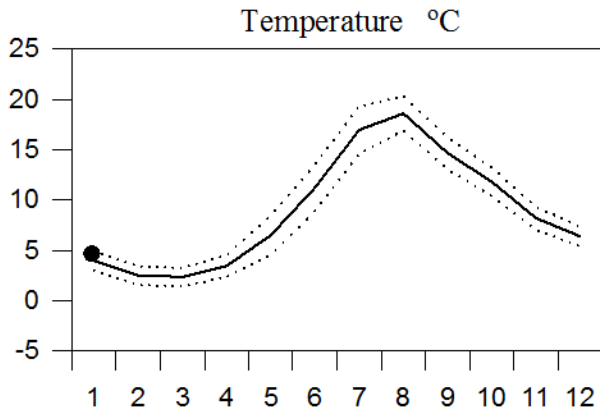
— Mean 1996-2010      ..... St.Dev.      ● 2015



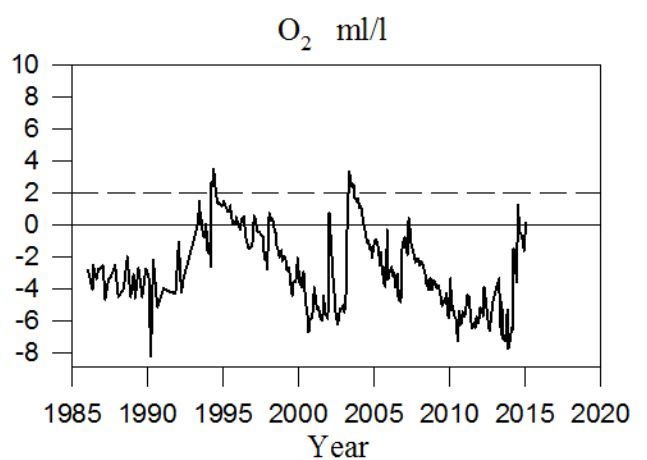
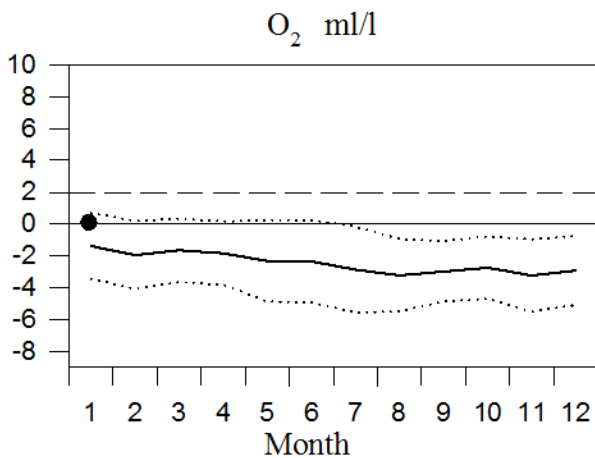
# STATION BY15 SURFACE WATER

## Annual Cycles

— Mean 1996-2010      ..... St.Dev.      ● 2015



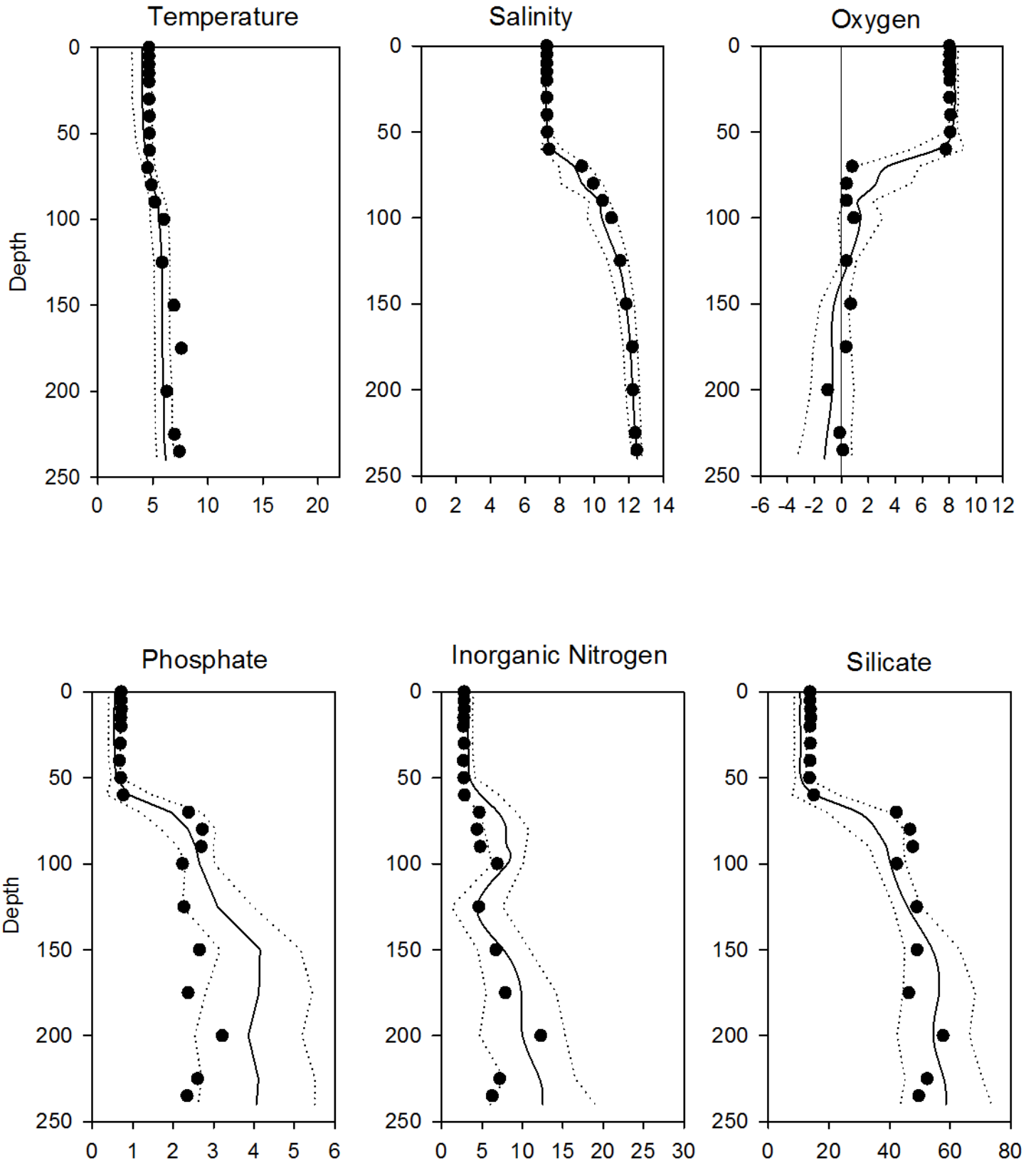
## OXYGEN IN BOTTOM WATER (depth >225m)





# Vertical profiles BY15 January

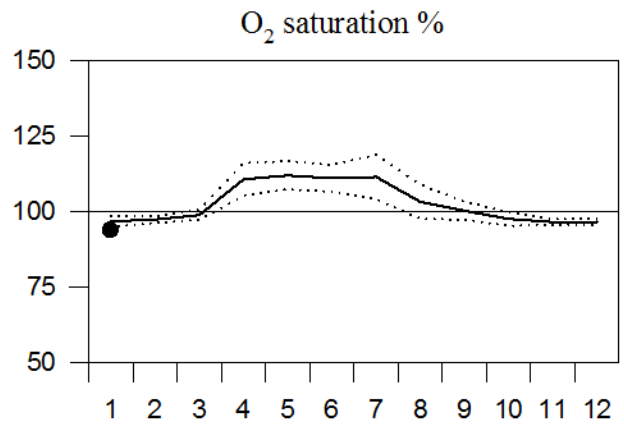
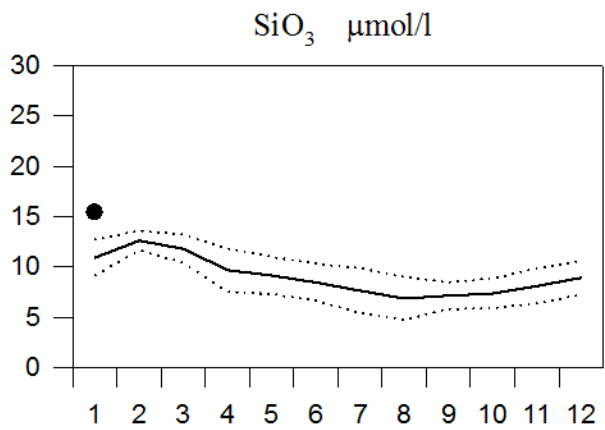
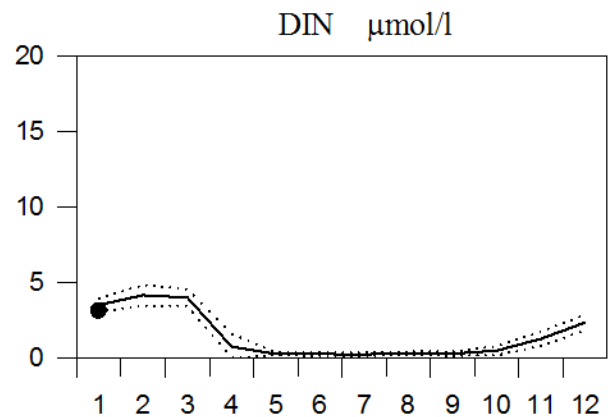
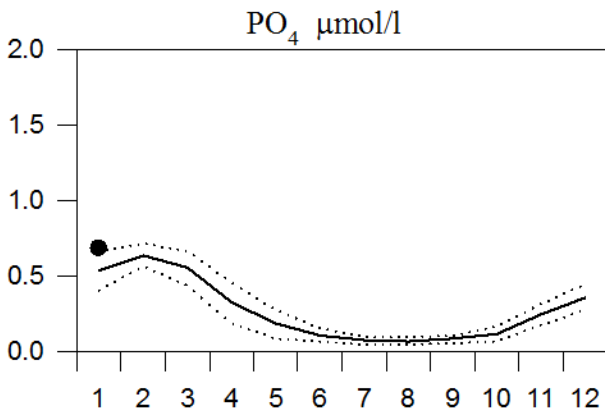
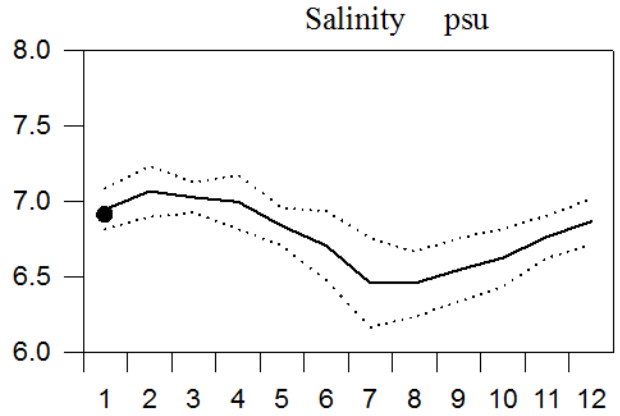
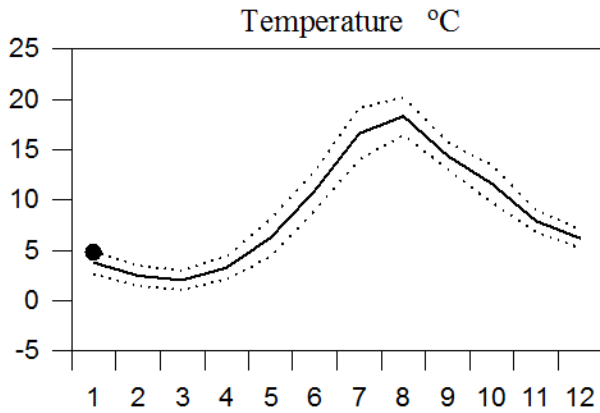
— Mean 1996-2010      ..... St.Dev.      ● 2015



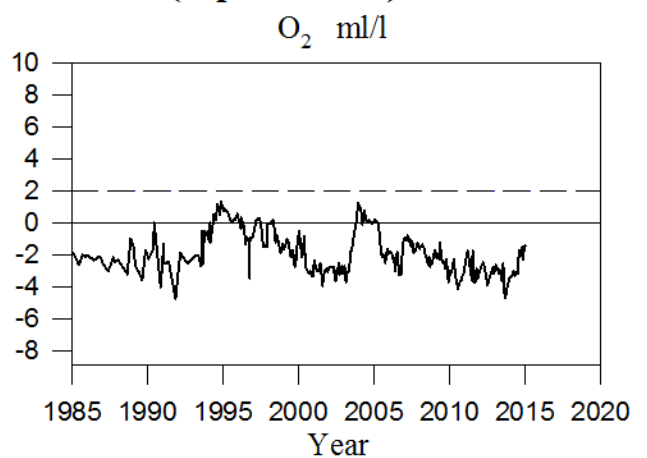
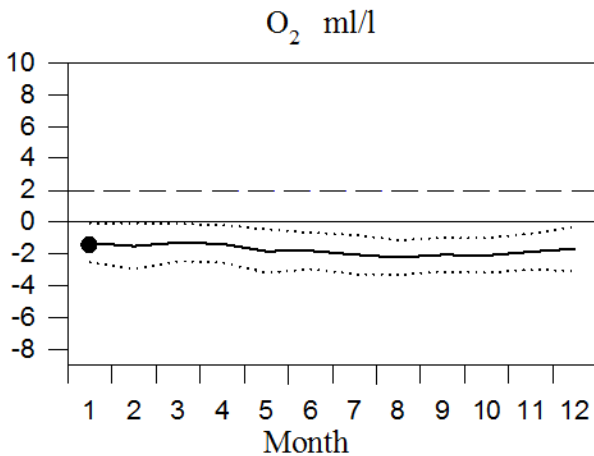
# STATION BY20 SURFACE WATER

## Annual Cycles

— Mean 1996-2010      ..... St.Dev.      ● 2015

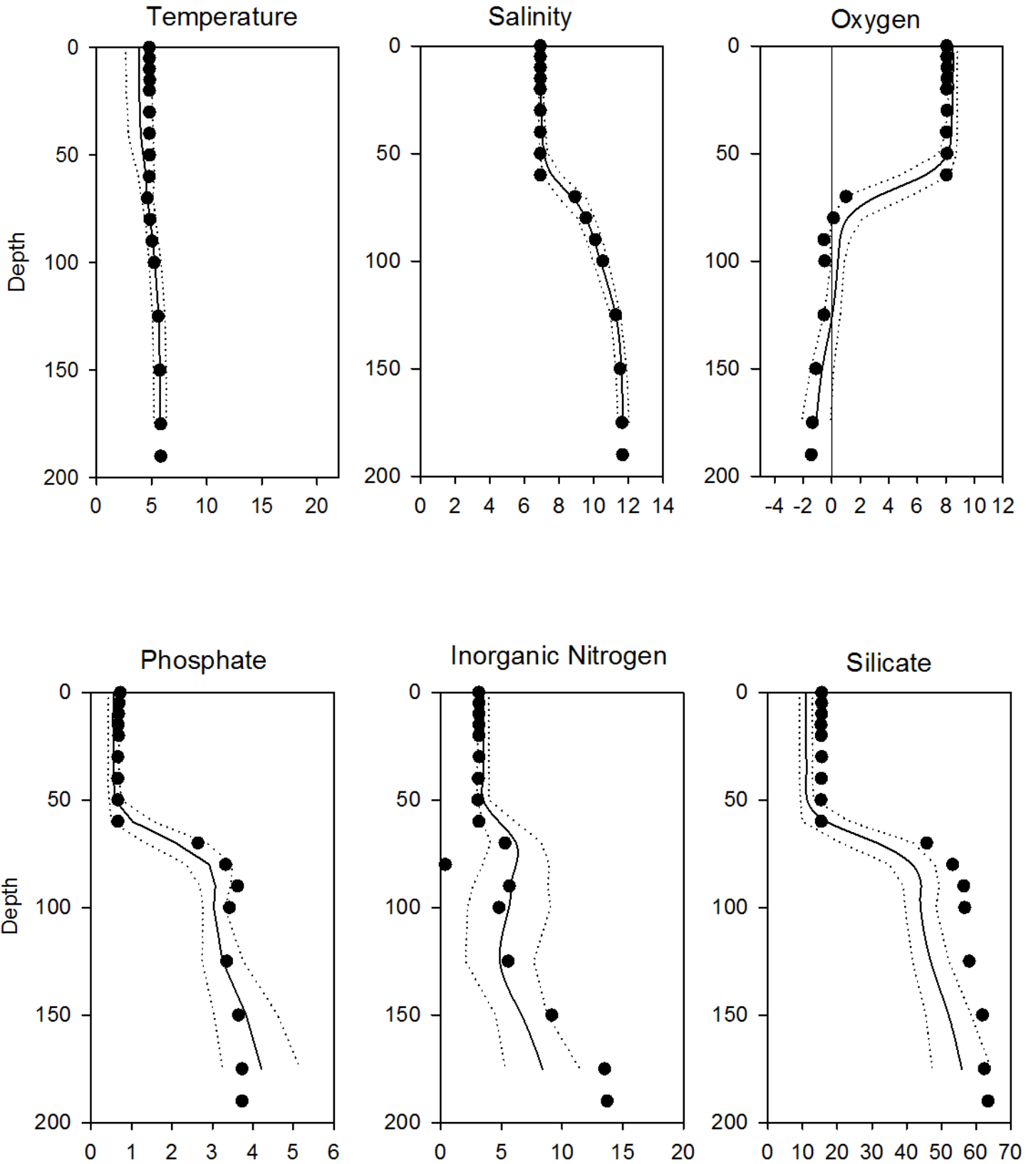


## OXYGEN IN BOTTOM WATER (depth >175m)



# Vertical profiles BY20 January

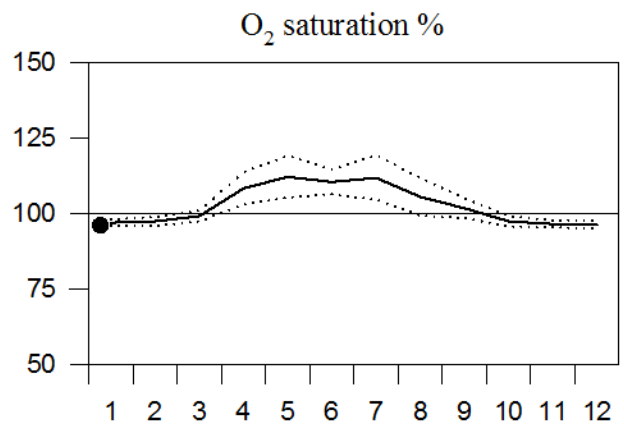
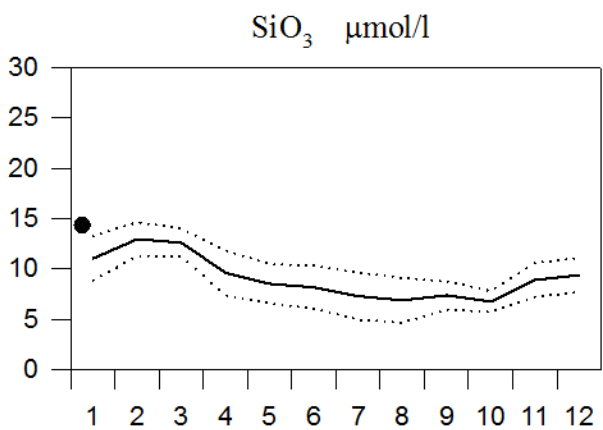
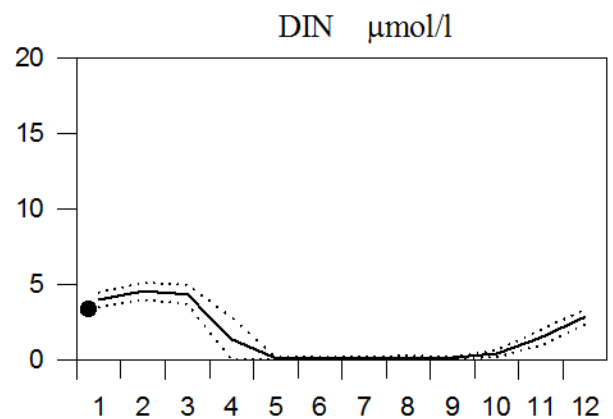
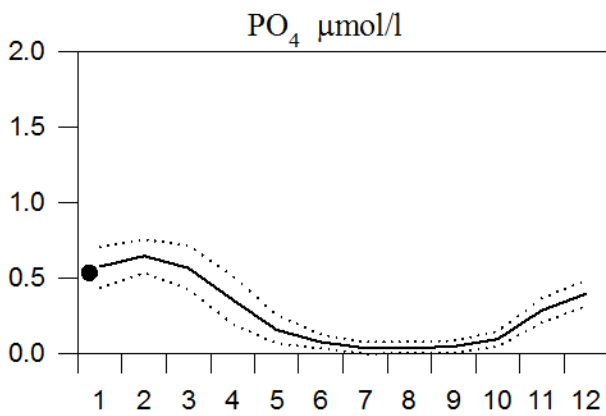
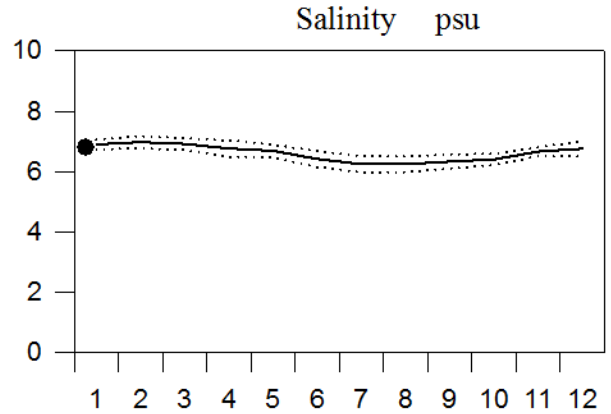
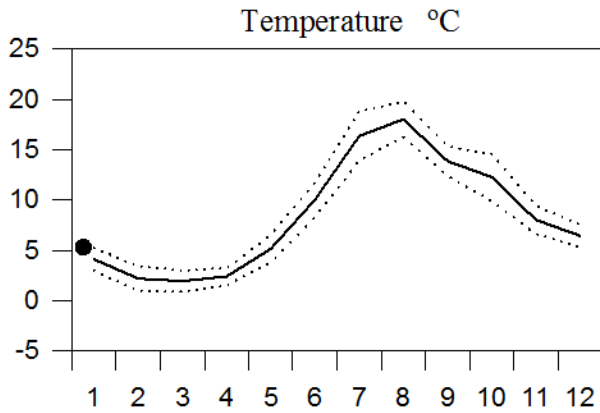
— Mean 1996-2010      ..... St.Dev.      ● 2015



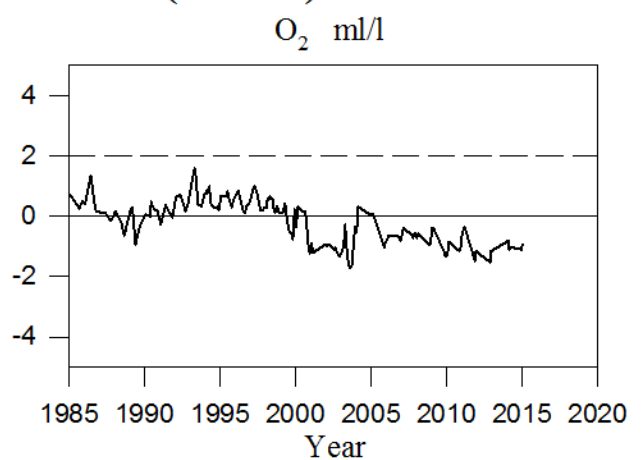
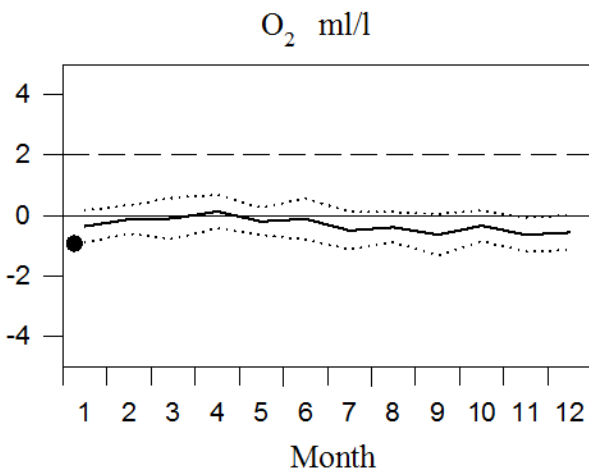
# STATION BY29 SURFACE WATER

## Annual Cycles

— Mean 1996-2010      ..... St.Dev.      ● 2015

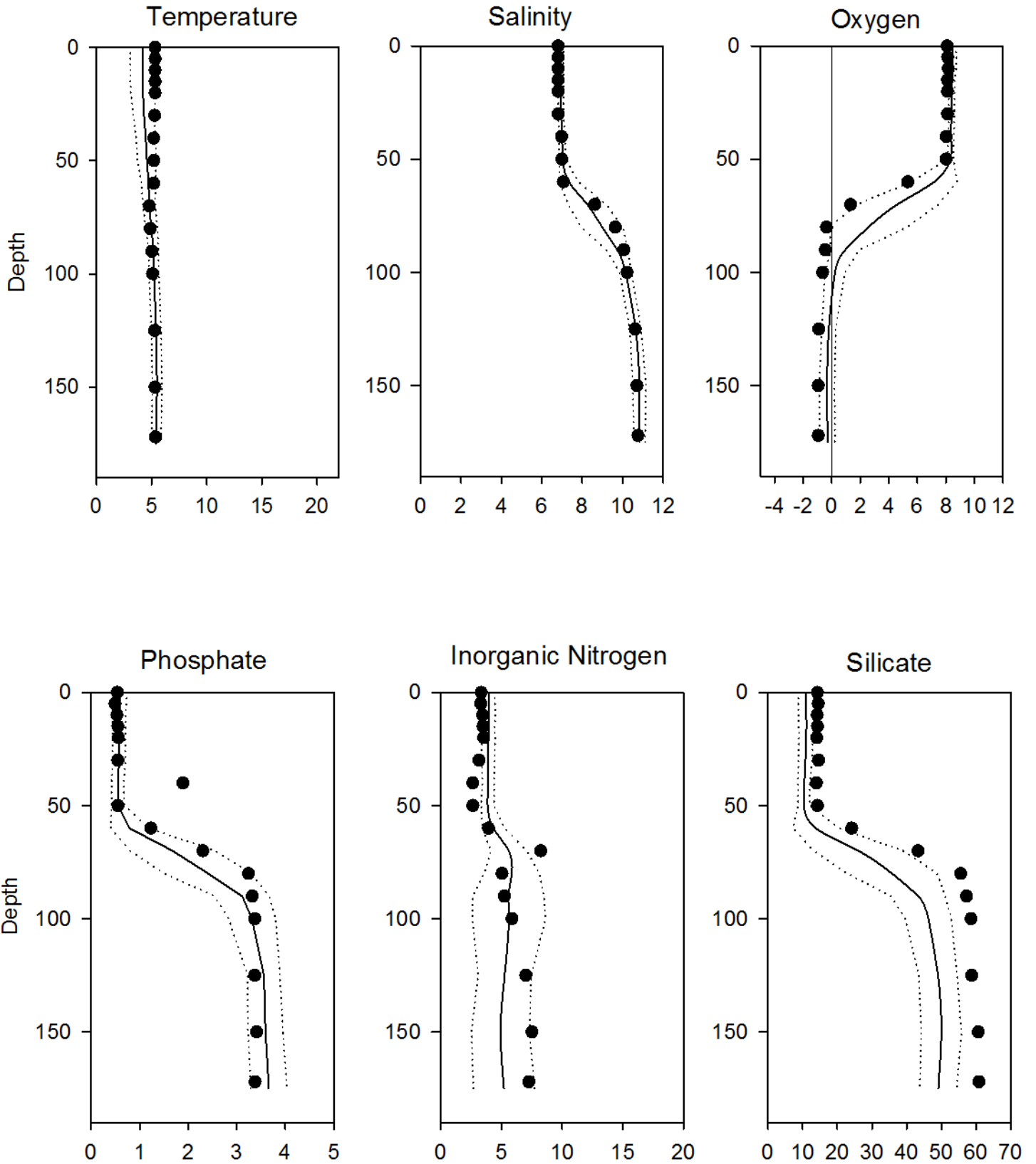


## OXYGEN IN BOTTOM WATER (>=150m)



# Vertical profiles BY29 January

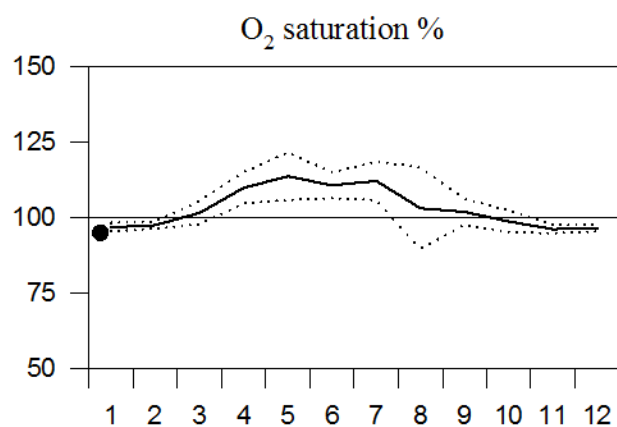
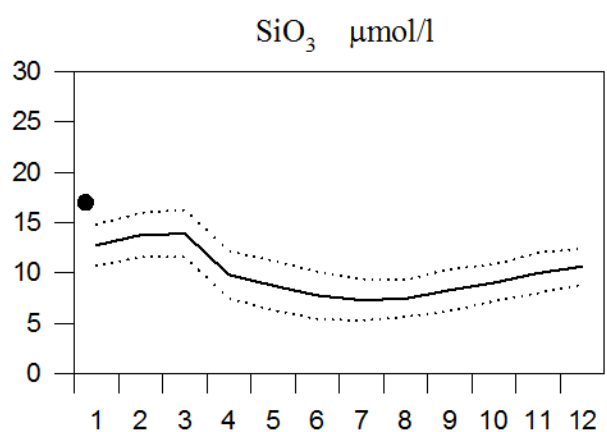
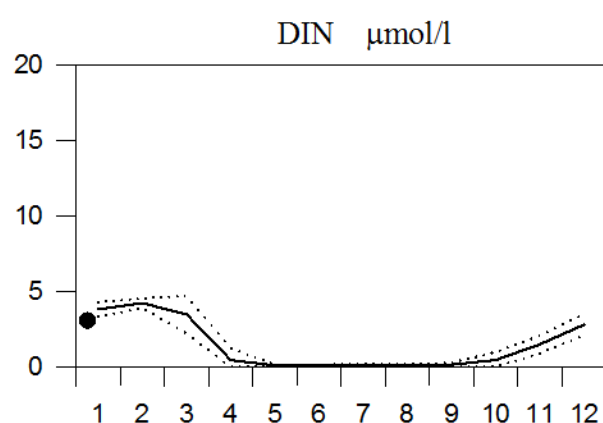
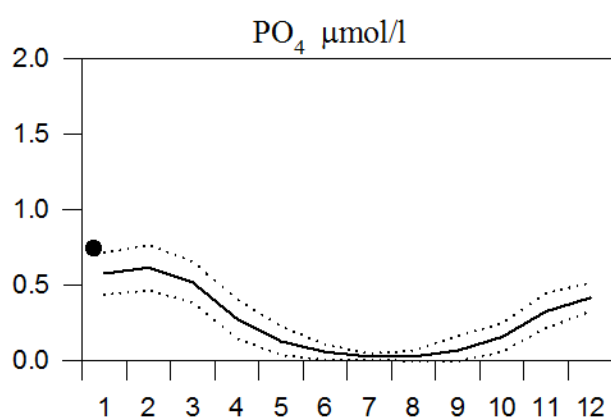
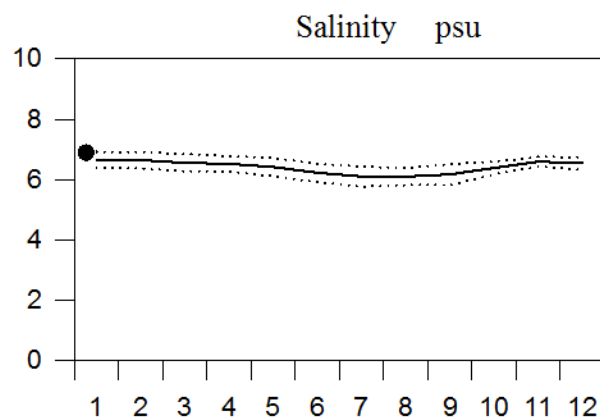
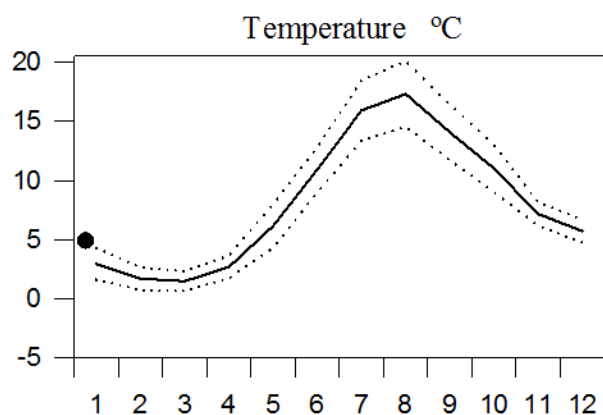
— Mean 1996-2010      ..... St.Dev.      ● 2015



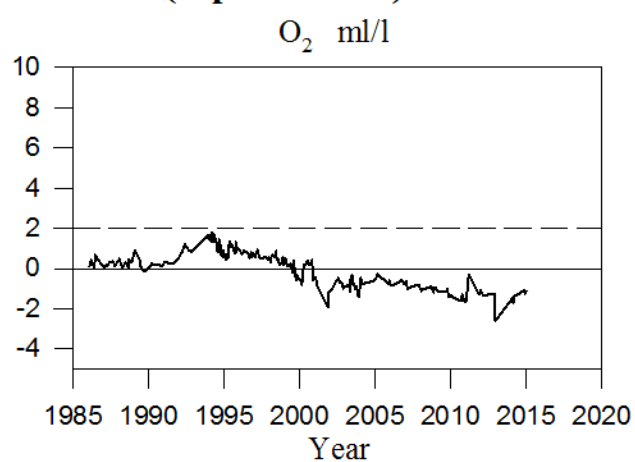
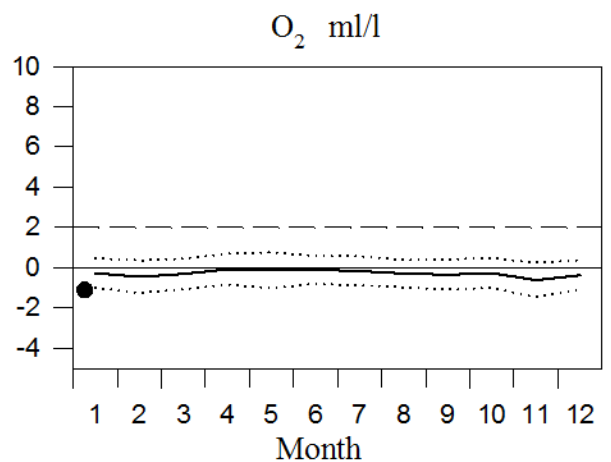
# STATION BY31 SURFACE WATER

## Annual Cycles

— Mean 1996-2010    ..... St.Dev.    ● 2015

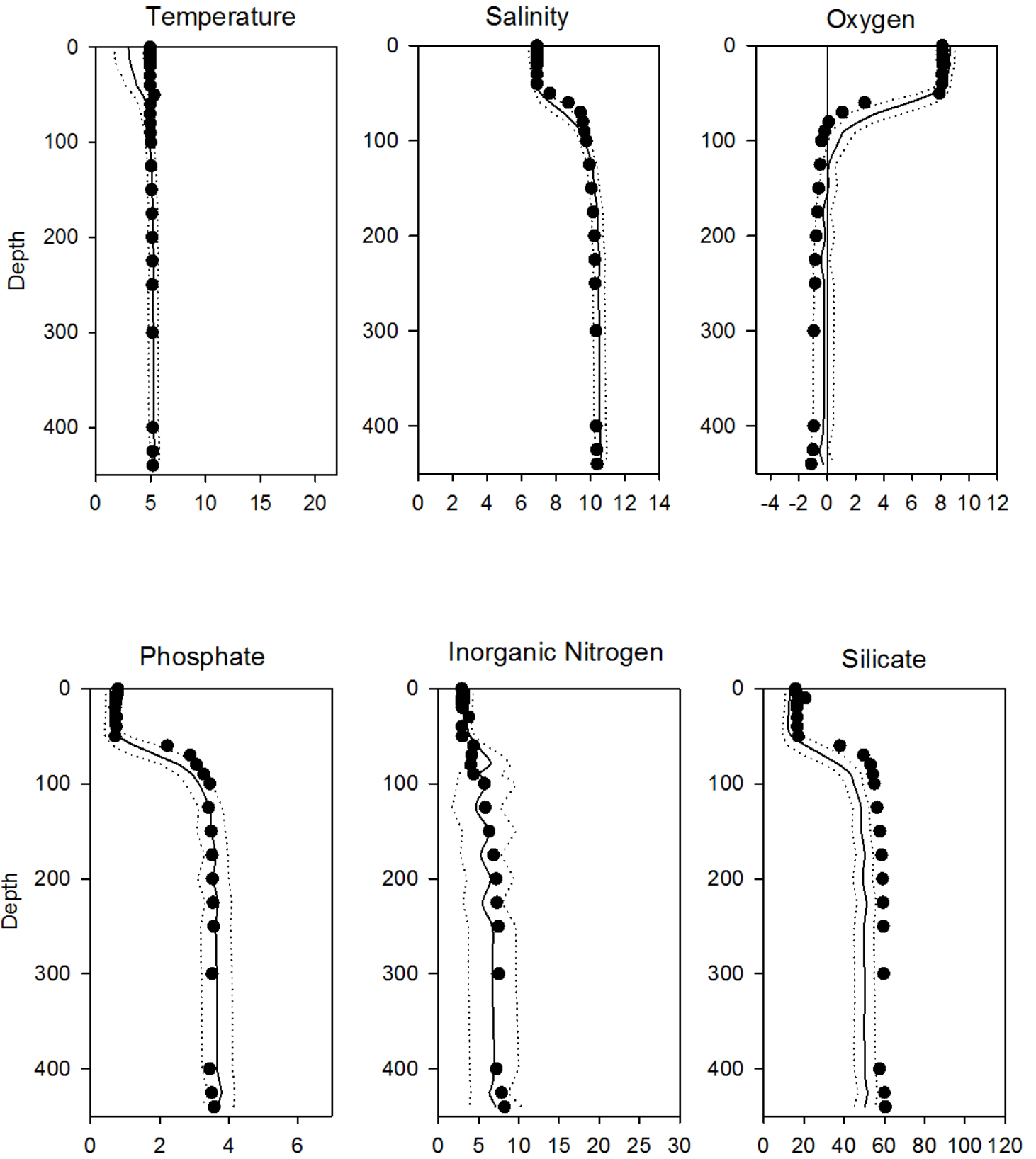


## OXYGEN IN BOTTOM WATER (depth = 440m)



# Vertical profiles BY31 January

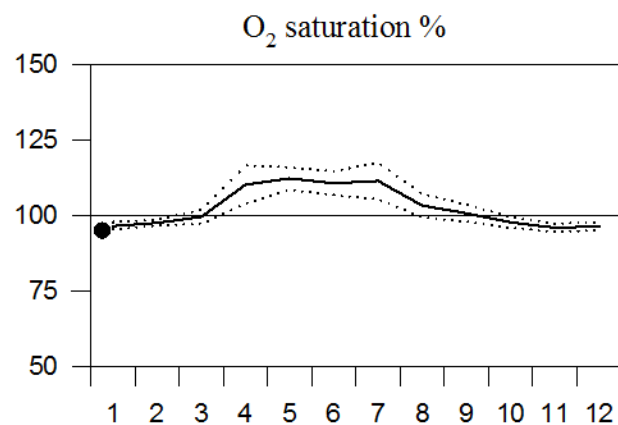
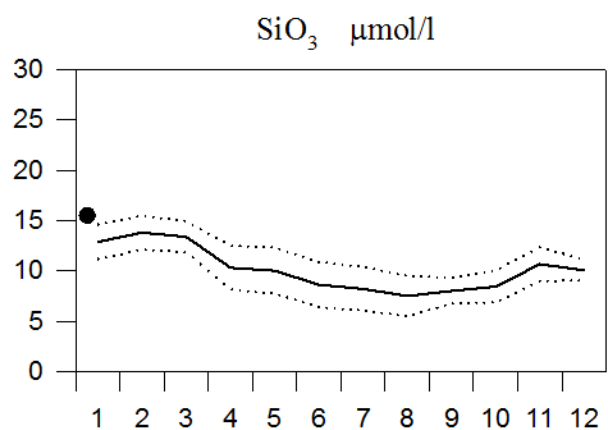
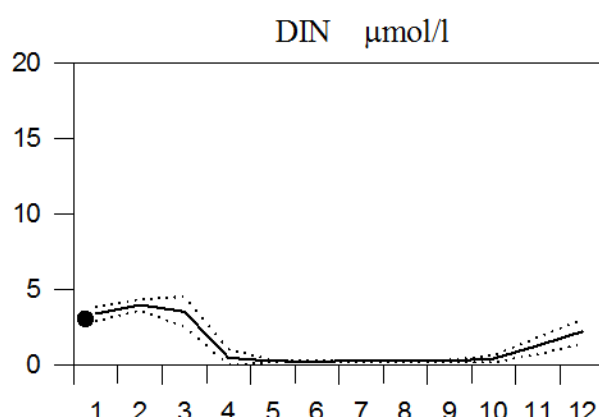
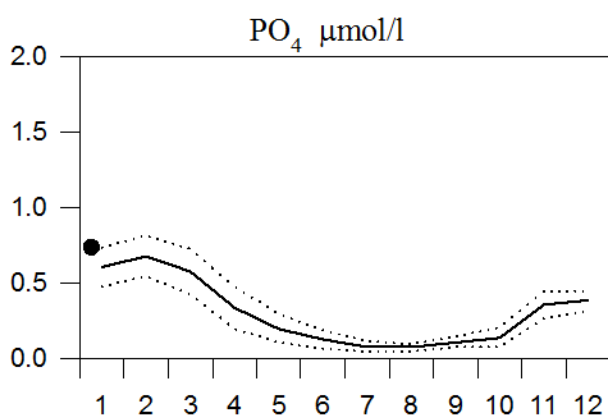
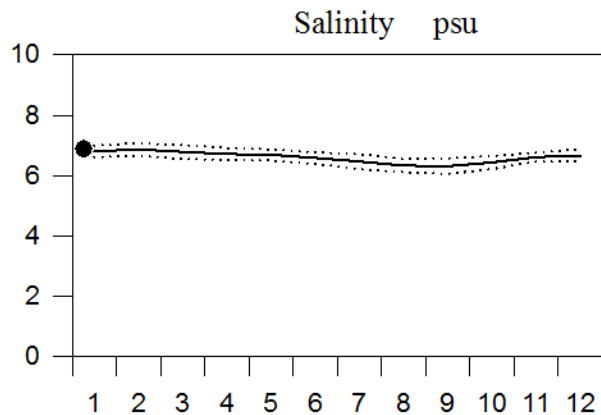
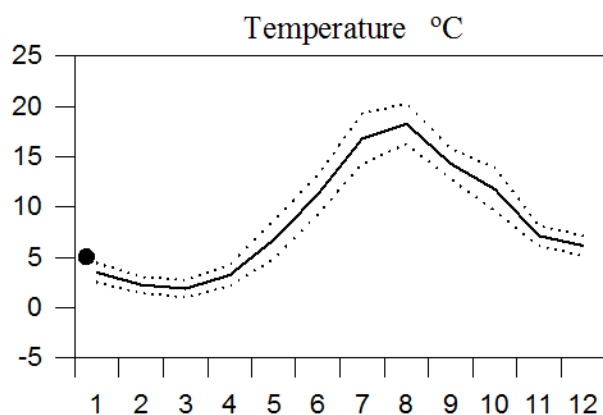
— Mean 1996-2010      ····· St.Dev.      ● 2015



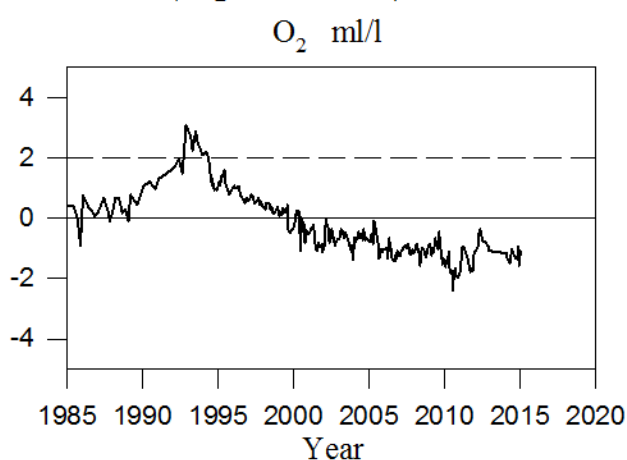
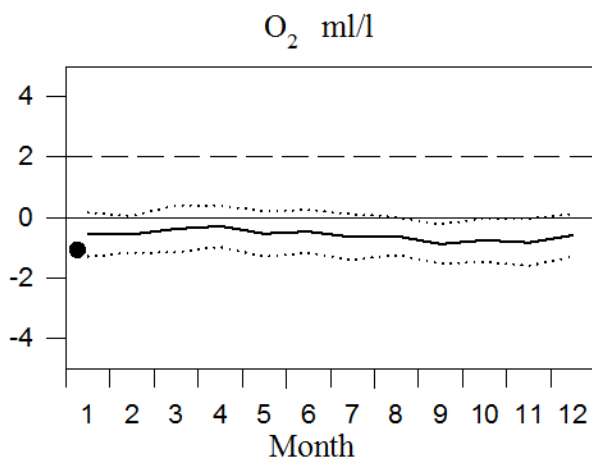
# STATION BY32 SURFACE WATER

## Annual Cycles

— Mean 1996-2010      ..... St.Dev.      ● 2015



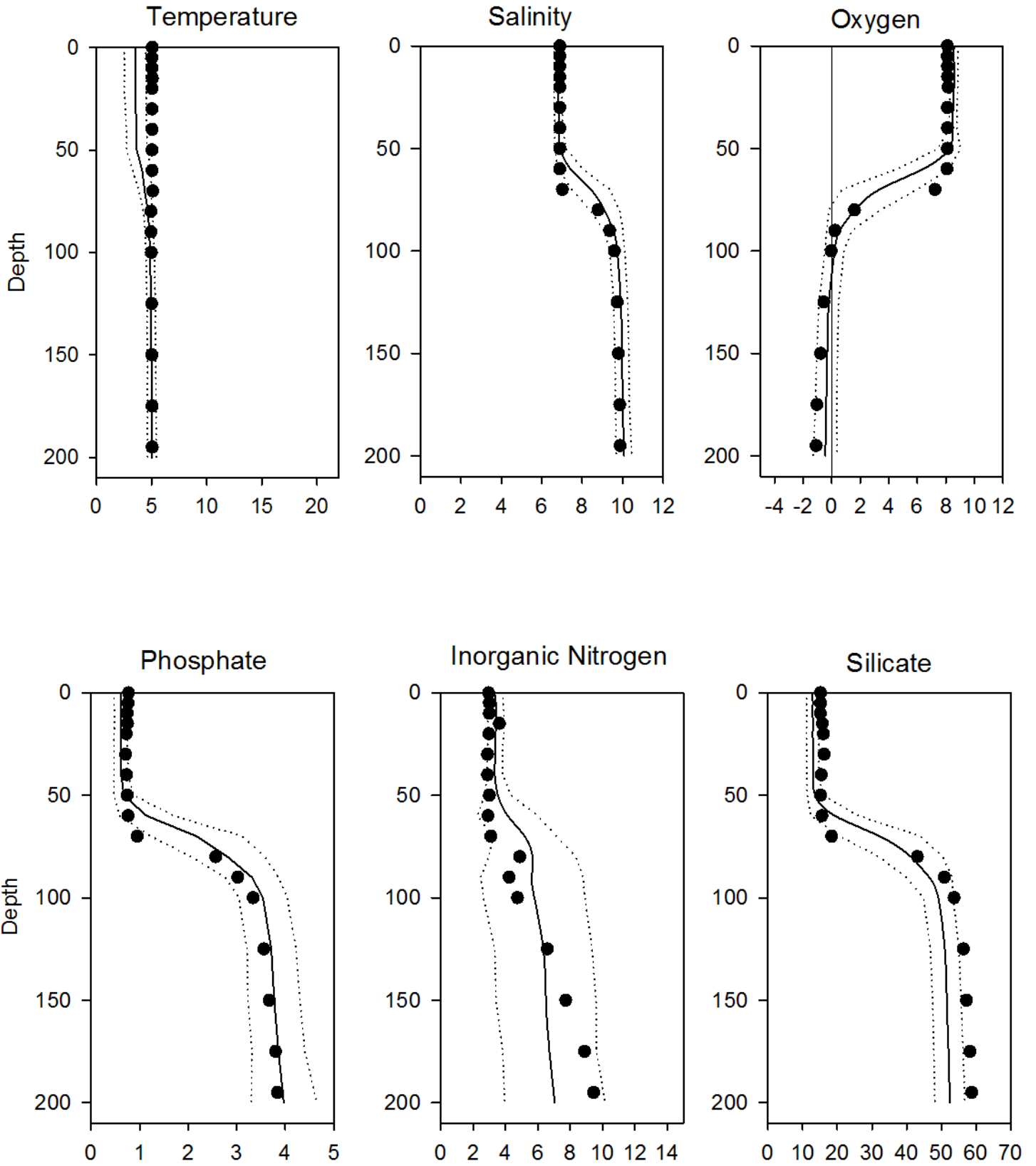
## OXYGEN IN BOTTOM WATER (depth > 175m)





# Vertical profiles BY32 January

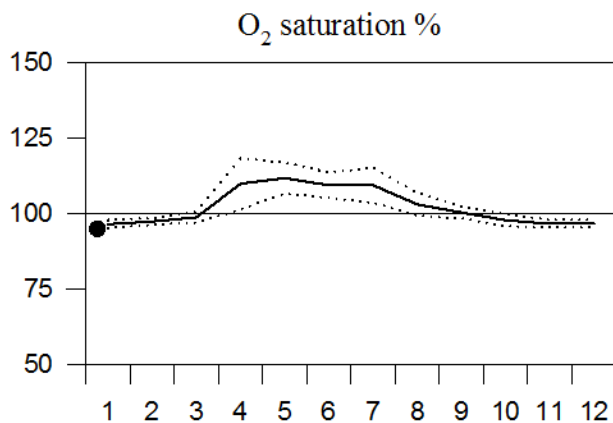
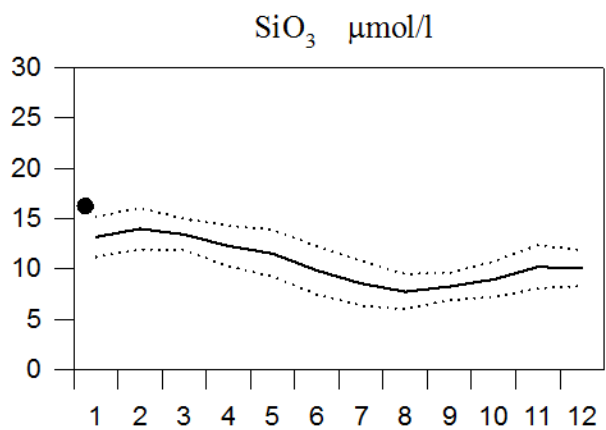
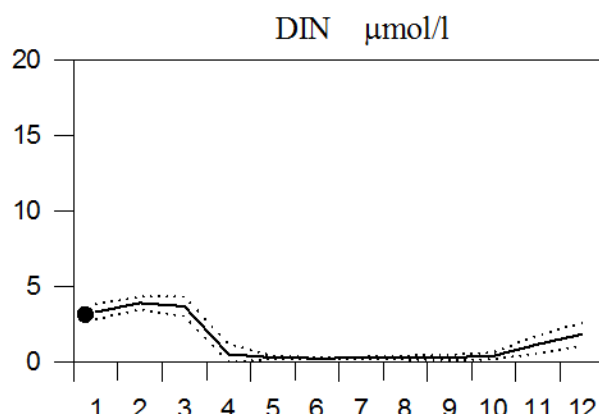
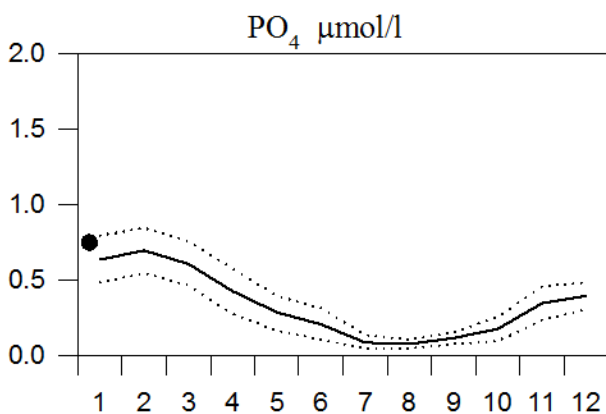
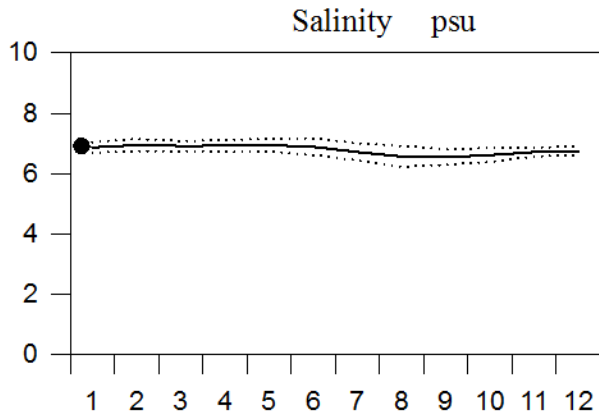
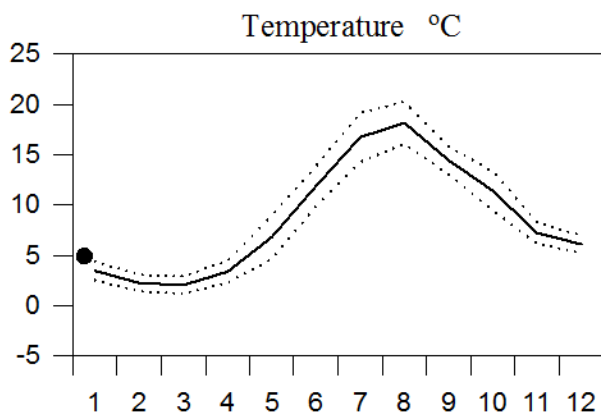
— Mean 1996-2010      ..... St.Dev.      ● 2015



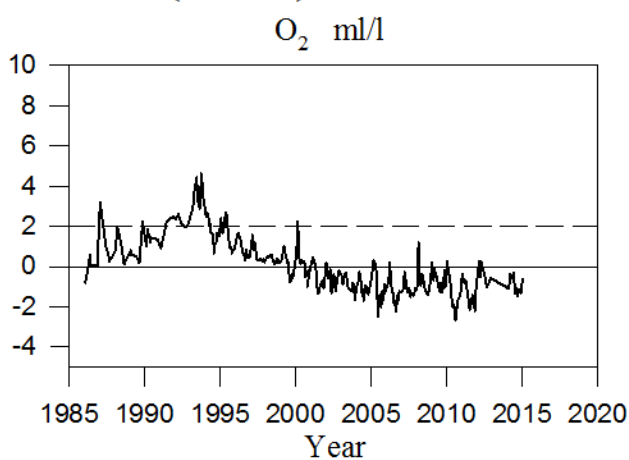
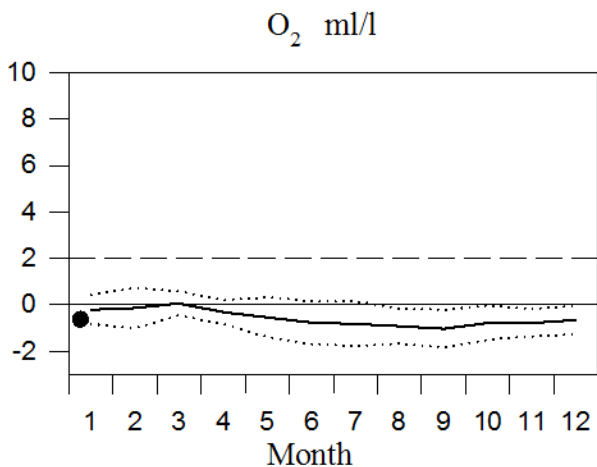
# STATION BY38 SURFACE WATER

## Annual Cycles

— Mean 1996-2010      ..... St.Dev.      ● 2015

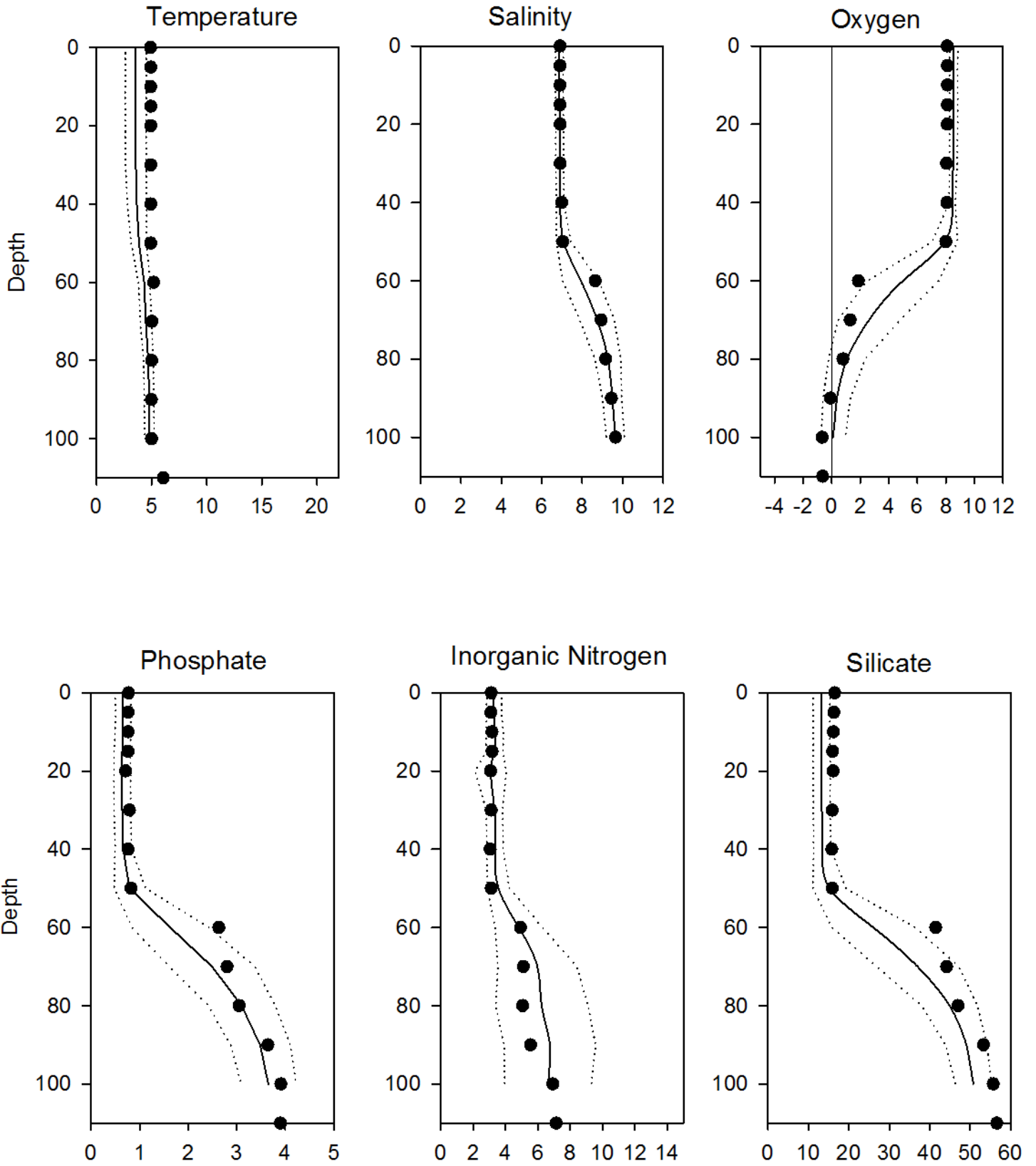


## OXYGEN IN BOTTOM WATER (> 100m)



# Vertical profiles BY38 January

— Mean 1996-2010      ····· St.Dev.      ● 2015



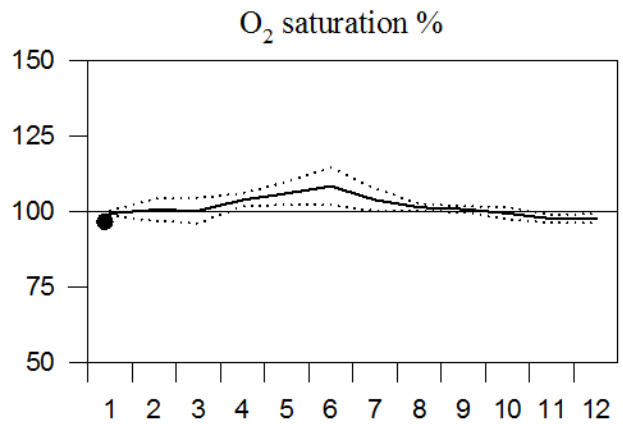
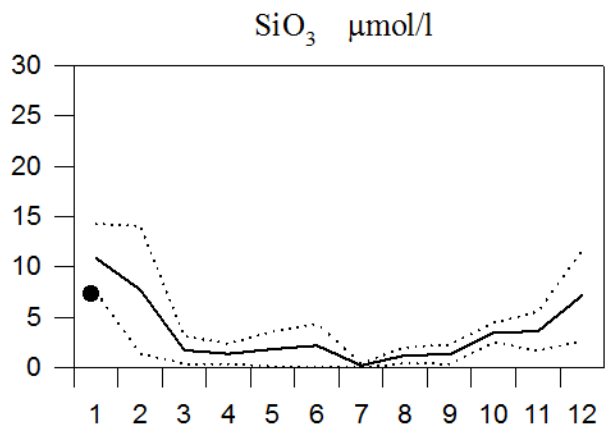
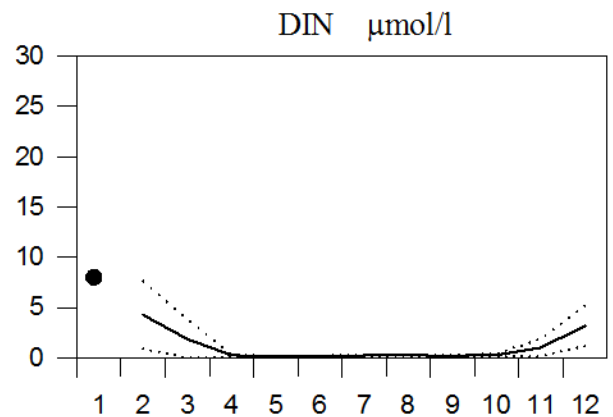
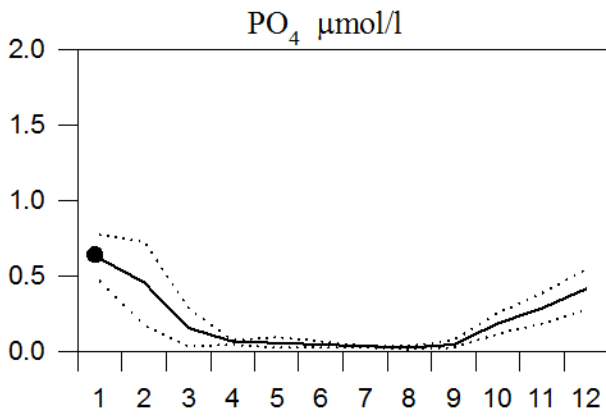
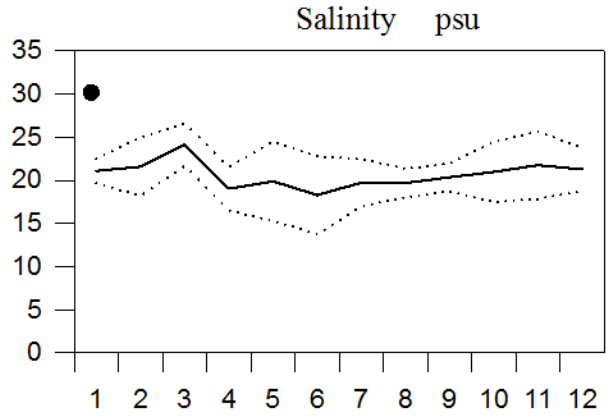
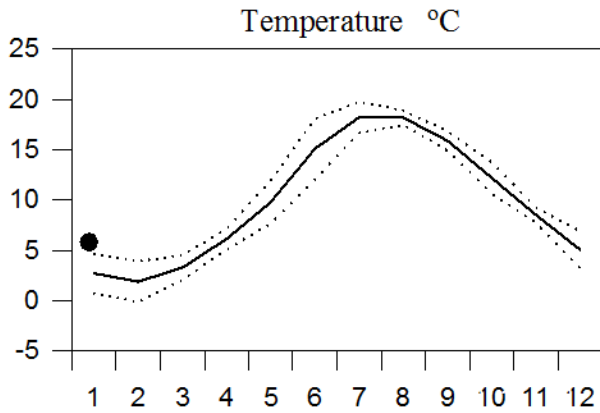
# STATION N14 Falkenberg SURFACE WATER

## Annual Cycles

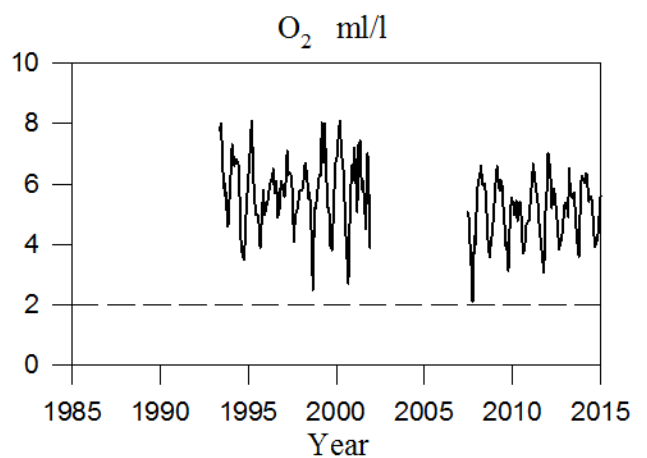
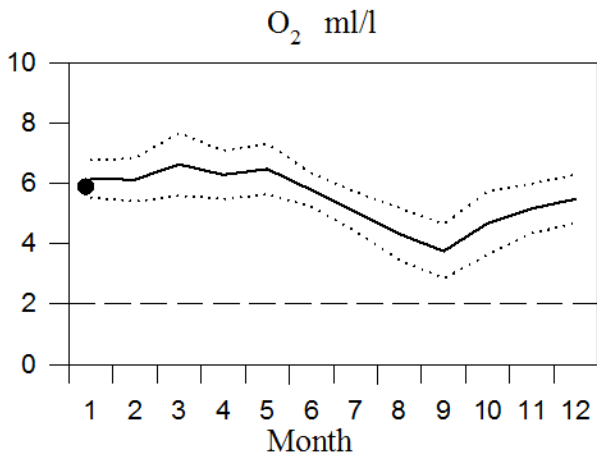
— Mean 2007-2010

..... St.Dev.

● 2015



## OXYGEN IN BOTTOM WATER (depth > 25m)



# Vertical profiles N14 Falkenberg January

— Mean 1996-2010      ..... St.Dev.      ● 2015

