

Report from the SMHI monitoring cruise with R/V Aranda



Survey period: 2015-03-16 - 2015-03-23
Survey area: Skagerrak, Kattegat, the Sound and the Baltic Proper
Principal: SMHI and the Swedish Agency for Marine and Water Management

SUMMARY

The expedition was part of the Swedish regular marine monitoring programme and covered Skagerrak, Kattegat, the Sound and the Baltic Proper. Data presented in this report have been subject to preliminary quality control procedures only.

The water temperatures in the surface layer were essentially normal for the season. In the Kattegat as well as in the coastal zone of Skagerrak the spring bloom was in full progress and nutrients showed low concentrations. In the Baltic Proper spring bloom had started in the Arkona while winter conditions prevailed in the rest of the area. High phosphate and silicate concentrations were recorded in the Western Gotland Basin.

The effect of the inflow during December 2014 was clearly seen in many parts of the Baltic Proper. In Western Gotland Basin, however, the oxygen situation remains serious, as acute hypoxia occurred at depths exceeding 70-80 meters and hydrogen sulphide was present from about 100 meters depth.

The next cruise is planned to start April 20, 2015.

PRELIMINARY RESULTS

The cruise, performed on board the Finnish research vessel Aranda, began in Helsinki on March 16 and ended in the same port on the 23rd. The winds during the expedition were mainly mild to moderate. During the last days, however, the wind increased and on a few occasions there were at gale force. Air temperatures ranged from -1 to 6 ° C.

Two researchers from the University of Helsinki took part in the expedition in order to study the formation of N₂O in hypoxic waters.

The Skagerrak

Surface water temperature was normal for the season and varied between 4.2 and 4.8° C. The salinity in the surface layer varied from 22 psu near the coast, well below normal, to 31 psu in the central parts, which is normal. The halocline reached from the surface down to a depth of about 20 m. A marked thermocline was found only at station Å17, furthest west, and was situated at 20 meters depth.

Surface nutrients were almost consumed close to the coast, while they showed higher levels further west. Phosphate concentrations in the surface water ranged 0.05 and 0.13 µmol/l, nitrite + nitrate varied from below the detection limit (<0.10 µmol/l) to 2.1 µmol/l, while the concentrations of silicate ranged between 0.3 and 0.7 µmol/l.

Fluorescence measurements together with oxygen saturation showed an ongoing spring bloom and some fluorescence peaks were found at depths between 10 and 20 meters.

The Kattegat and the Sound

The temperature of the surface water, normal for the season varied between 4 and 5° C. In the northern Kattegat surface salinity was normal 21.5 psu. In the south it fell from a normal value of 19.2 down to 16.6 psu, which is well below average, during one and a half day. In the Sound, the temperature was 4.5° C and salinity 9.4 psu. Halocline and thermocline were found between 15 and 20 meters depth, however, the thermocline was weakly developed. A very sharp halocline was recorded in the Sound at a depth of 15 meters.

Concentrations of nutrients in surface water had fallen since the previous visit in February. The spring bloom was still ongoing and high fluorescence values were measured adjacent to the halocline. The phosphate concentrations were between 0.05 and 0.11 µmol/l, silicate in the range of 1 - 2 µmol/l. In the Sound the corresponding values were 0.29 for phosphate and 4 for silicate. Inorganic nitrogen was below the detection limit throughout the area.

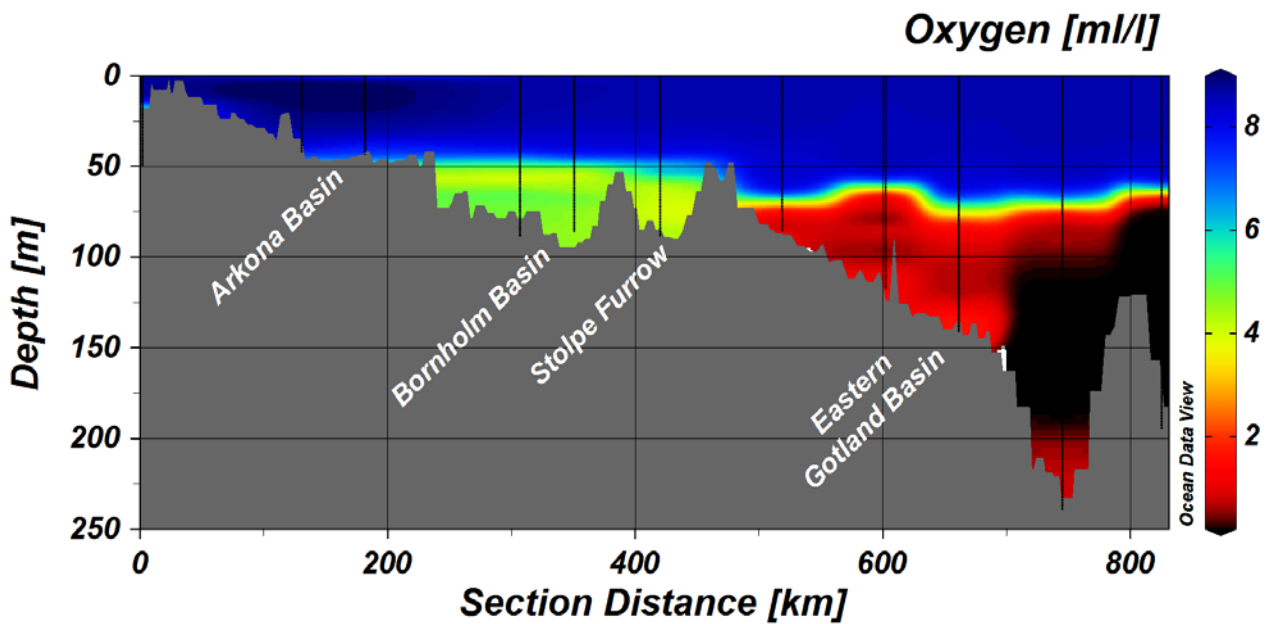
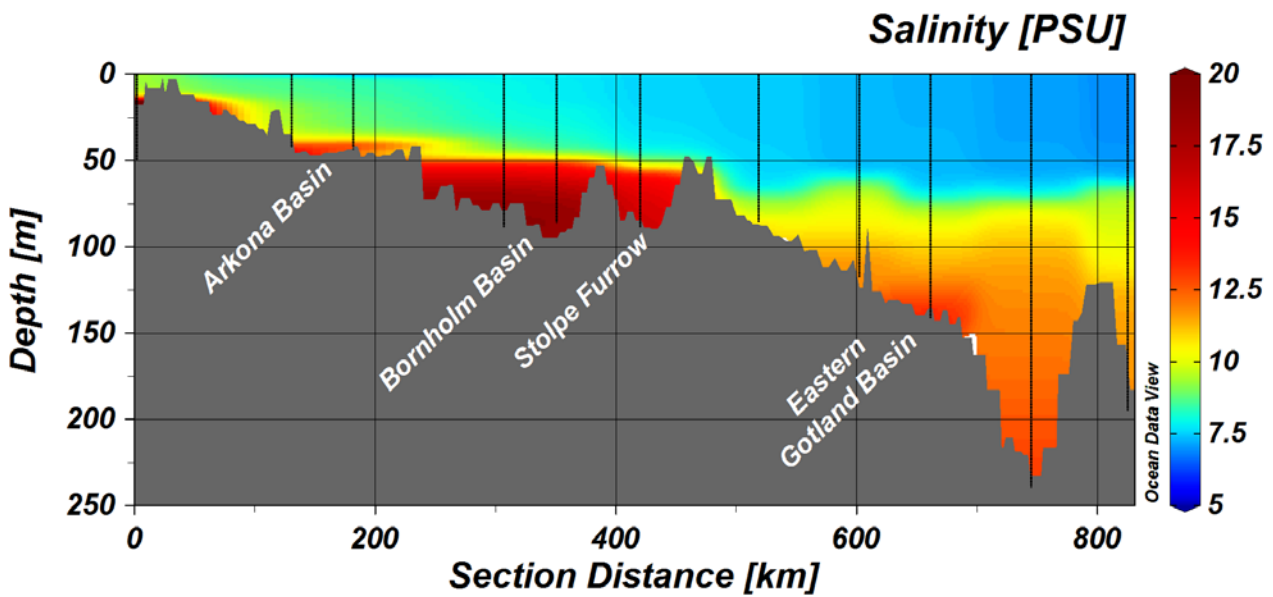
The lowest oxygen concentrations in the deep water were measured at Anholt E in the Kattegat, 5.9 ml/l and at W Landskrona in the Sound, 5.6 ml/l.

The Baltic Proper

The water temperature in the surface layer was slightly above mean for the season and ranged from 3.5° C in the north to 4.4° C in the southwest. Surface salinity was slightly above normal in the Arkona Basin, 8.8 psu, and slightly below mean, 7.1 psu in the Eastern Gotland Basin, otherwise it was normal increasing from 6.9 psu in the north to 7.9 psu in the south. The halocline was found at 60 to 80 m depth in the Western and Eastern Gotland Basins, while it was located shallower in the south, at depths between 40 and 50 meters.

The nutrients, in the surface layer, showed almost normal levels for the season, with the exception of the Western Gotland Basin where phosphate and silicate were significantly elevated, phosphate concentrations were here 0.9 µmol/l and silicate 18 µmol/l. In other areas concentrations varied within the following ranges, phosphate 0.2 - 0.8 µmol/l, nitrite + nitrate <0.10 - 3.4 µmol/l and silicate 4-15 µmol/l, with the lowest values in the Arkona Basin where the spring bloom was ongoing. In other areas phytoplankton activity was low.

The effects of the inflows that took place at the end of 2014, especially the large inflow during December, was now clearly seen in the southeast and in the Eastern Gotland Basin. The Bornholm Basin was filled up to the sill depth with water having a salinity of about 18 psu and an oxygen content of about 5 ml/l. In the Stolpe Furrow, water with a salinity of 16 psu and an oxygen content of 4 ml/l was recorded at depths exceeding 60 meters. Also in the Eastern Gotland Basin the effects of the major inflow was visible, although the deep waters that now reached that area rather stems from the earlier inflows in 2014. At the station BY15, the Gotland Deep, hydrogen sulphide were now present in an intermediate level between 120 and 190 meters depth, while the bottom water was oxygenated with an oxygen concentration of about 1 ml / l. The salinity of the bottom water had increased from 12.4 psu at the visit in February to 13.2 psu.



The Arkona- and Bornholm Basins as well as the Hanö Bight were well oxygenated. Generally,



acute hypoxia was present below a depth of 70-80 meters. Hydrogen sulphide was present in the northern part of the Eastern Gotland Basin from, 90 meters depth, and in the Western Gotland Basin at depths exceeding 100 meters.

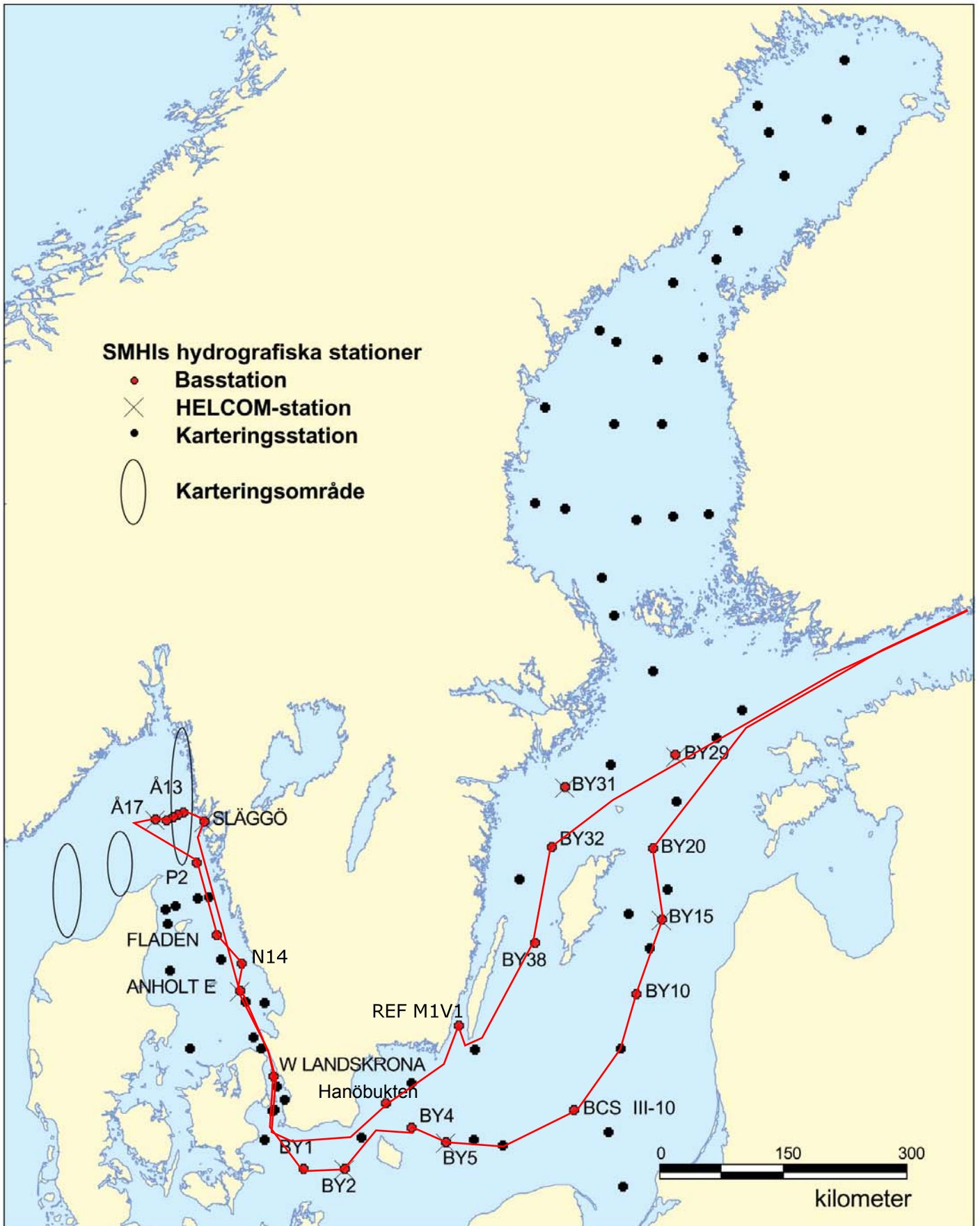
PARTICIPANTS

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

APPENDICES

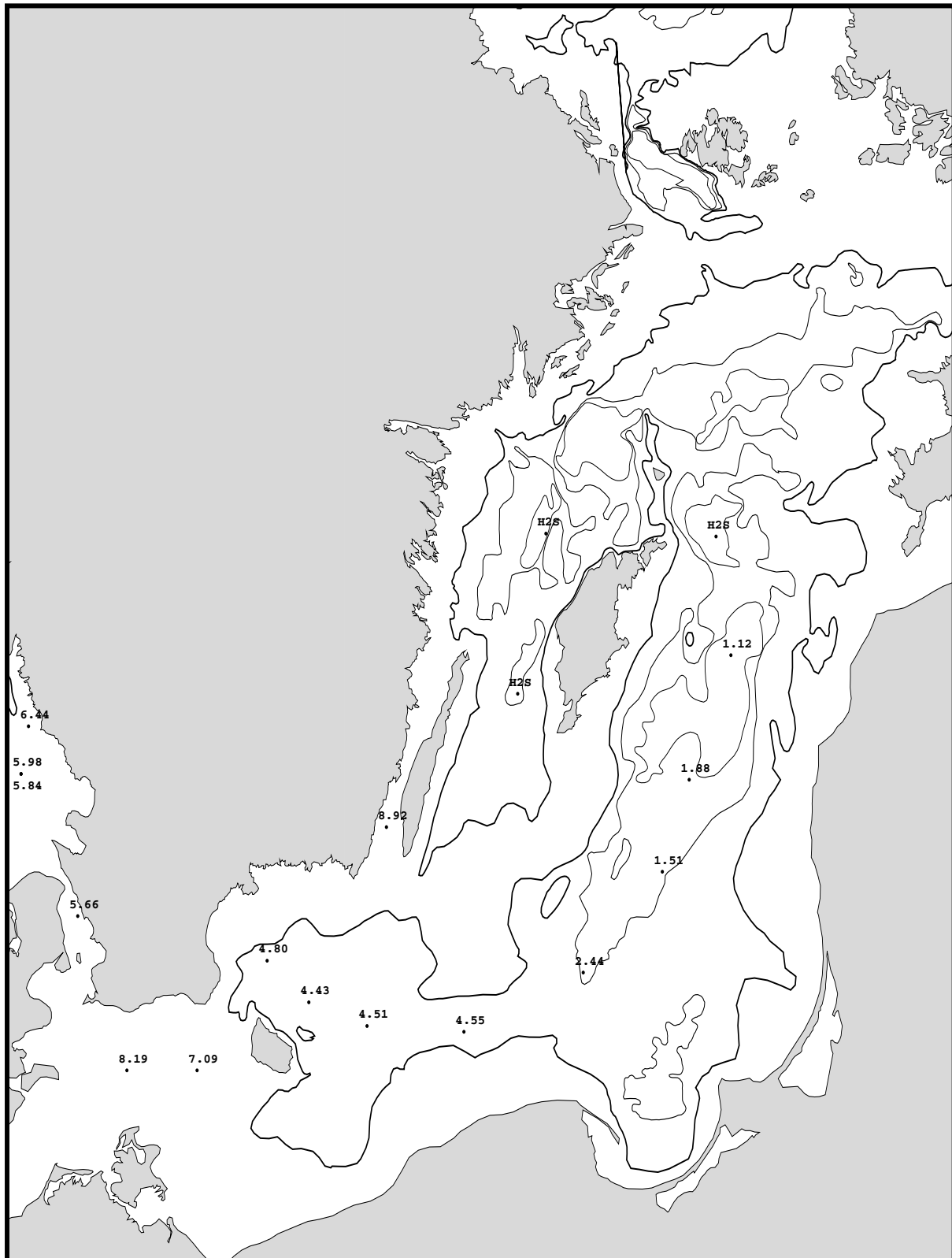
- Track chart
- Table over stations, parameters and sampling depths
- Map showing bottom oxygen concentrations
- Monthly average surface water plots for selected stations
- Vertical profiles for selected stations

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Date: 20150316-20150323
Series: 0145-0176



Bottom water oxygen concentration (ml/l)

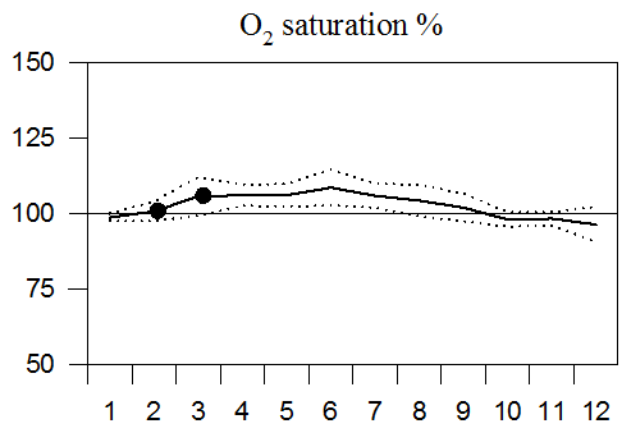
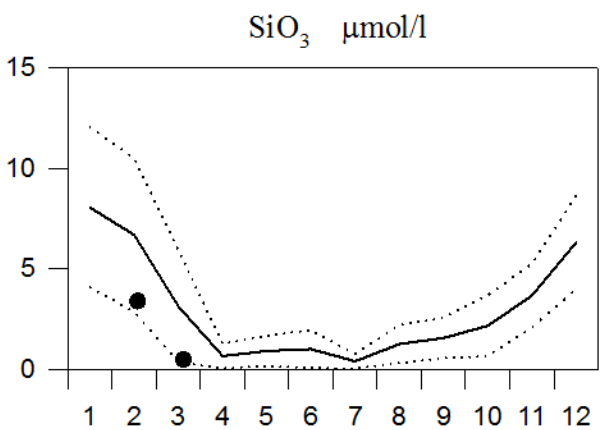
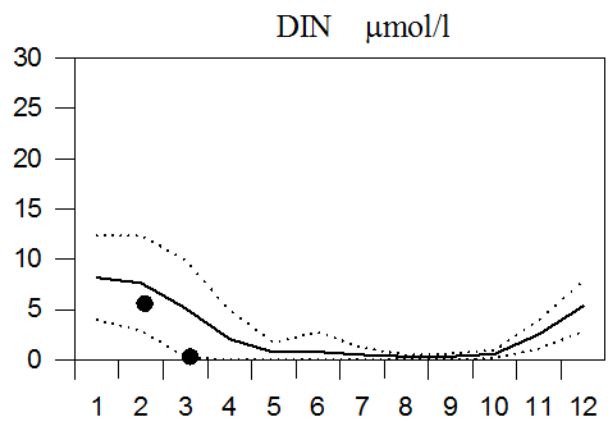
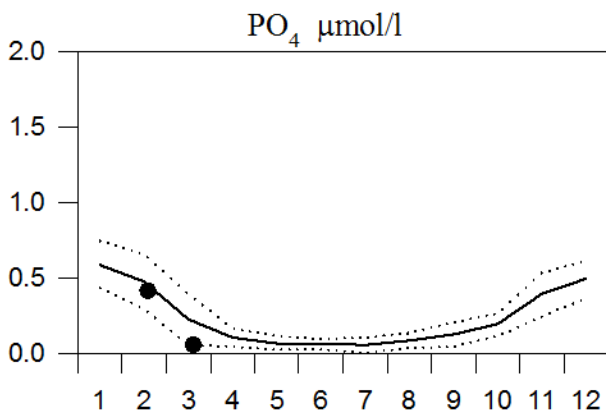
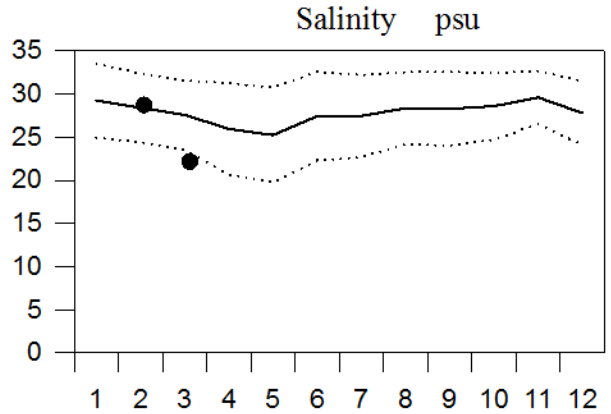
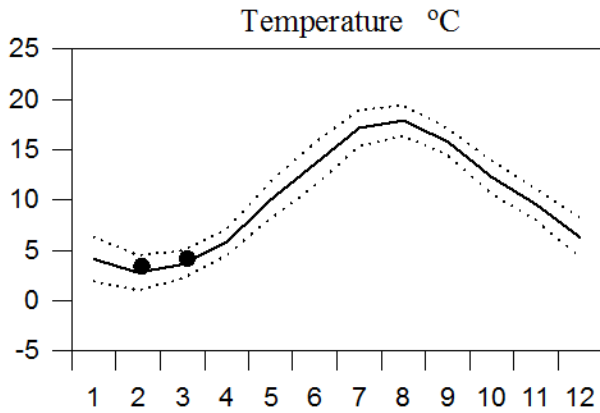
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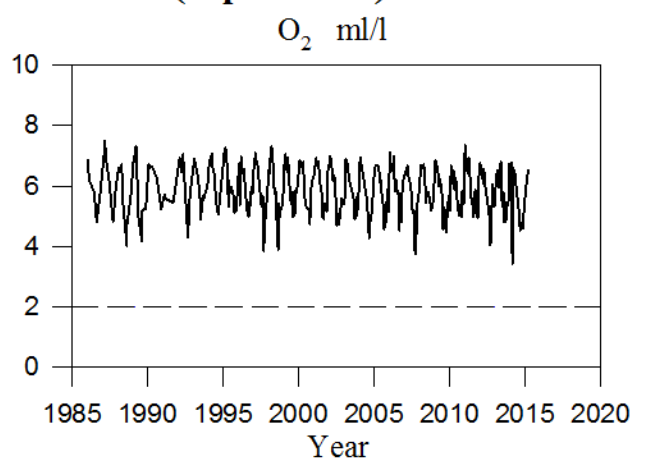
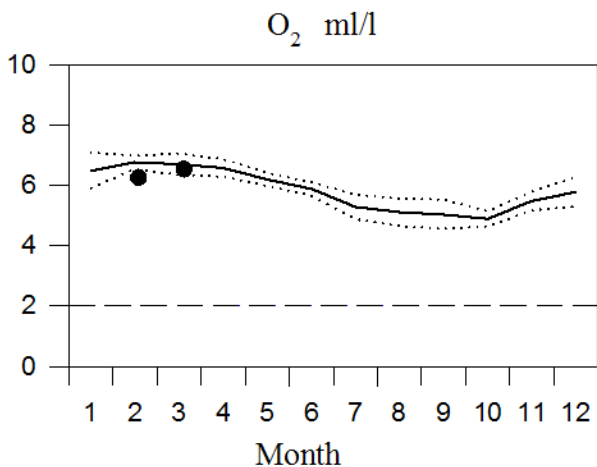
STATION P2 SURFACE WATER

Annual Cycles

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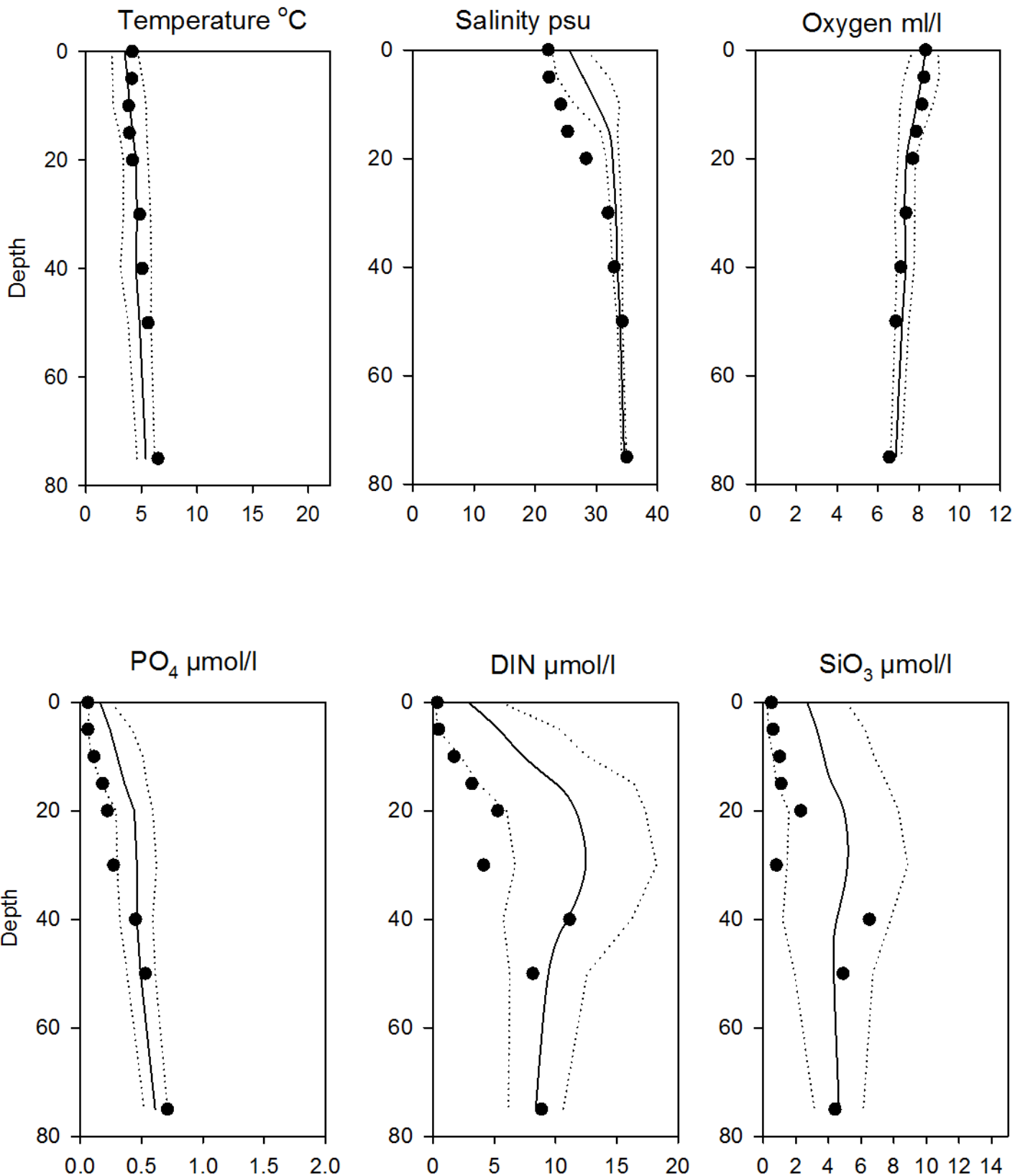


OXYGEN IN BOTTOM WATER (depth >75m)



Vertical profiles P2 March

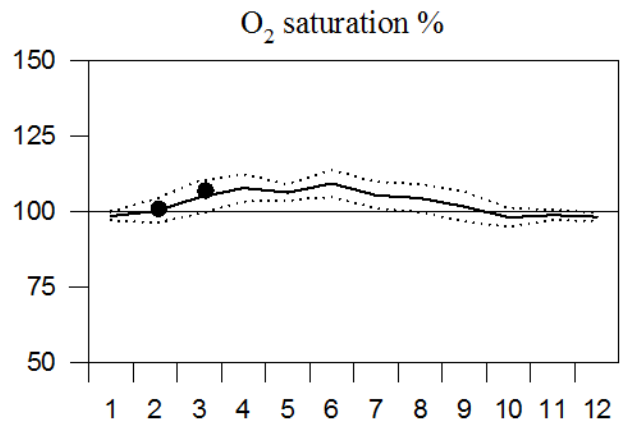
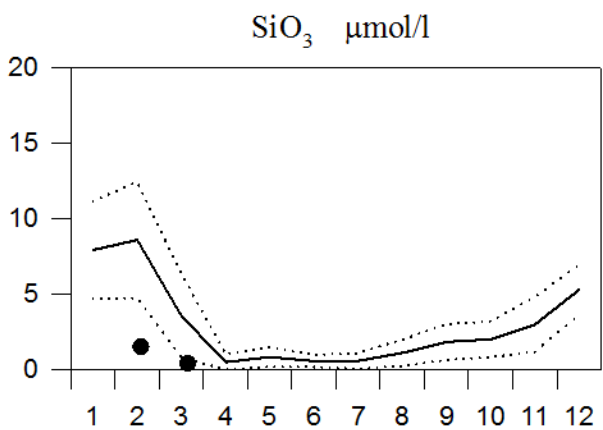
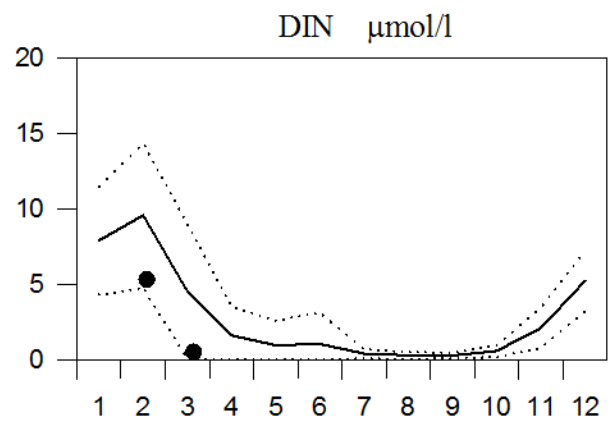
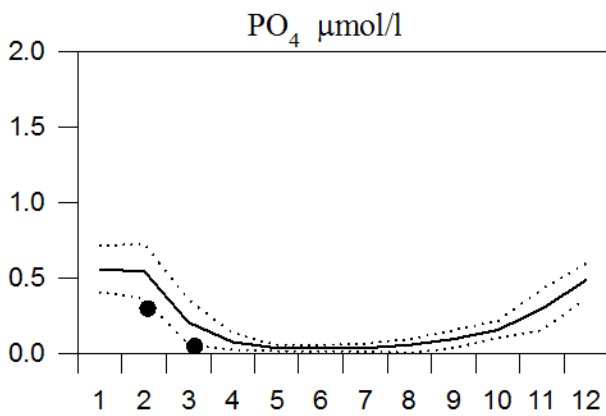
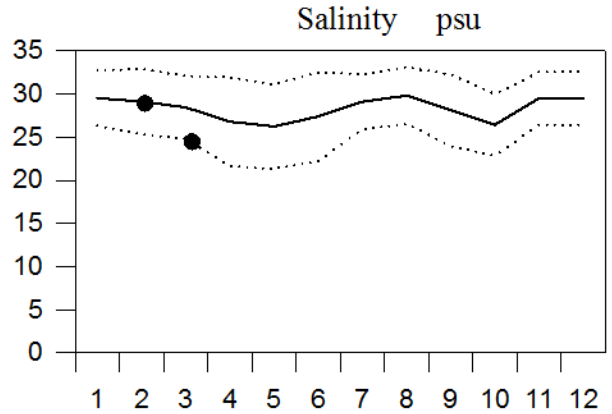
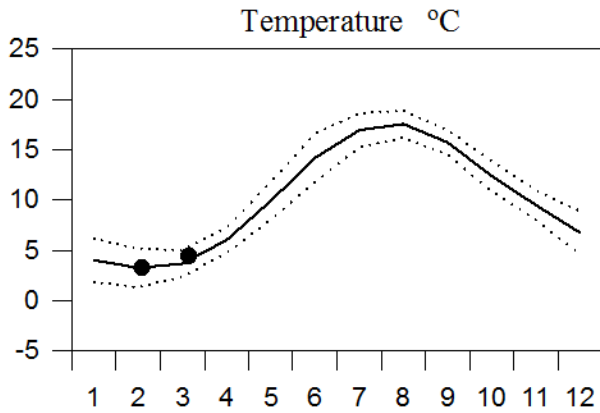
— Mean 1996-2010 St.Dev. ● 2015



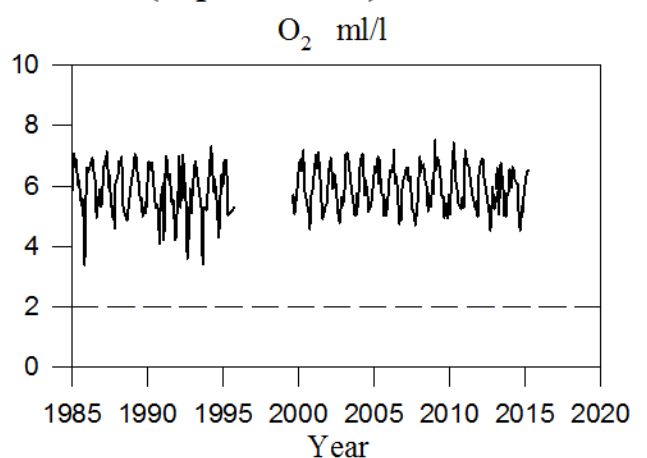
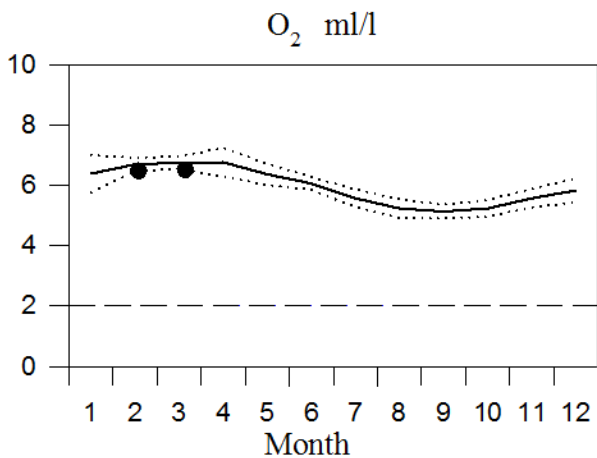
STATION Å13 SURFACE WATER

Annual Cycles

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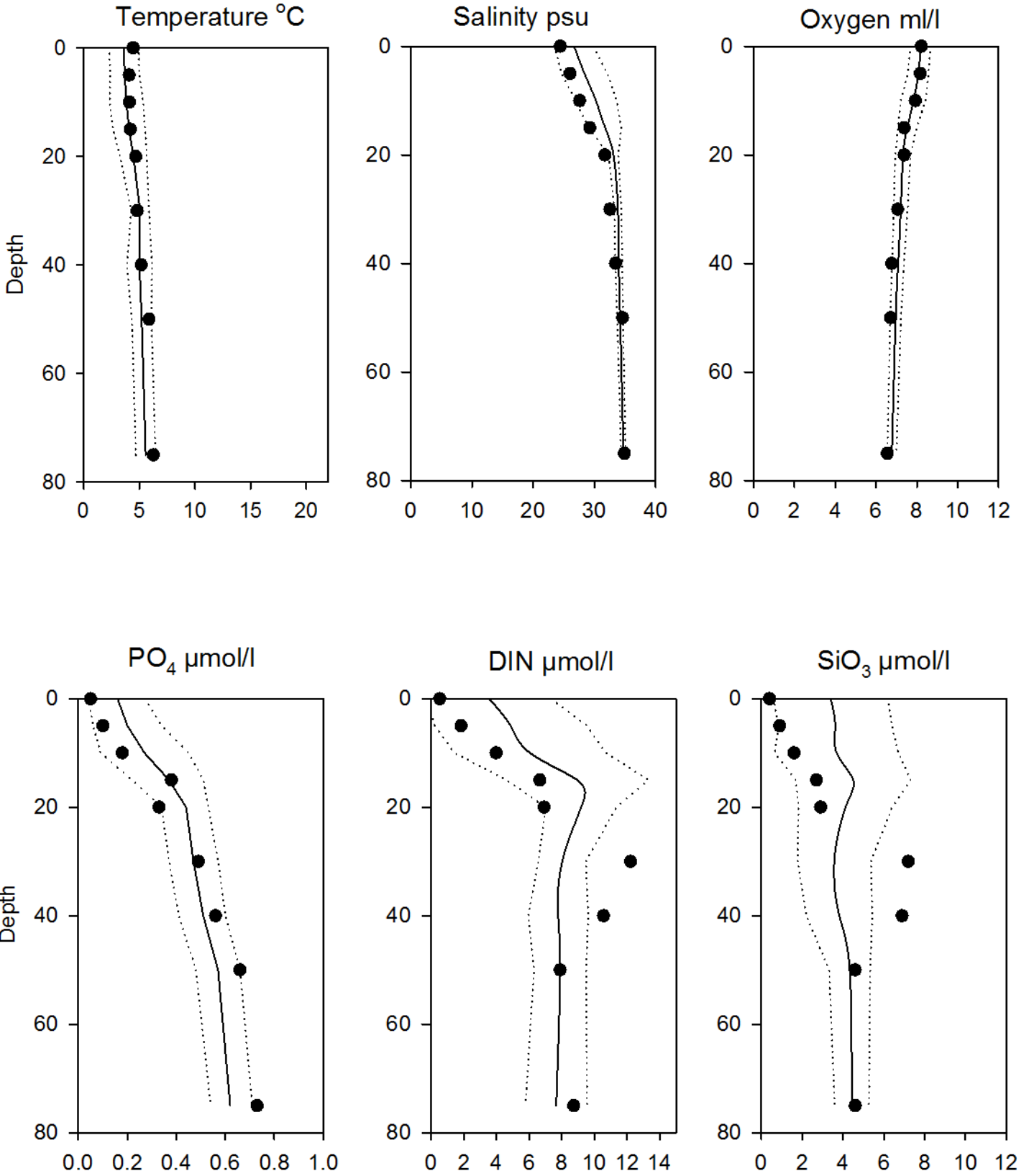


OXYGEN IN BOTTOM WATER (depth >=75m)



Vertical profiles Å13 March

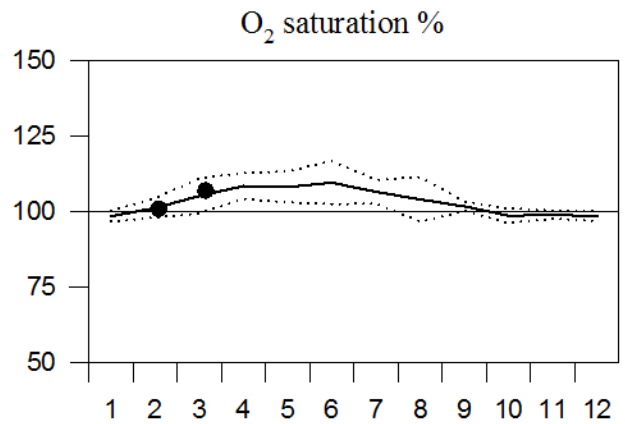
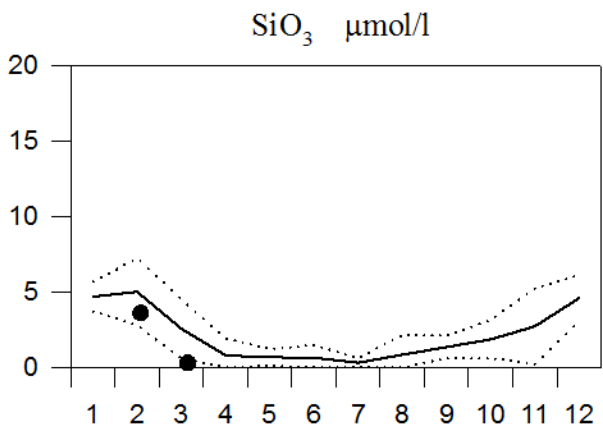
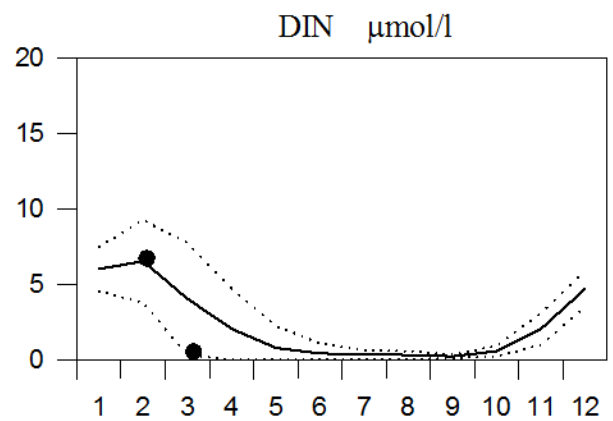
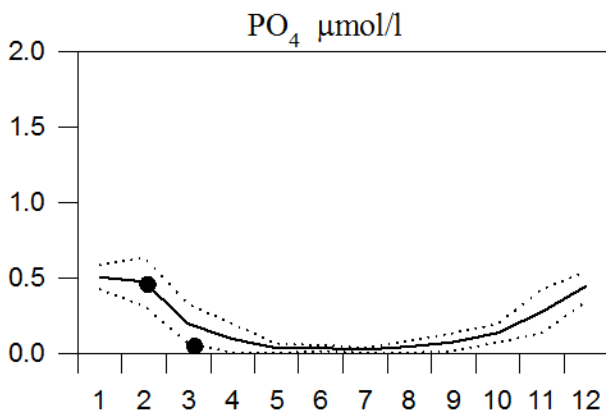
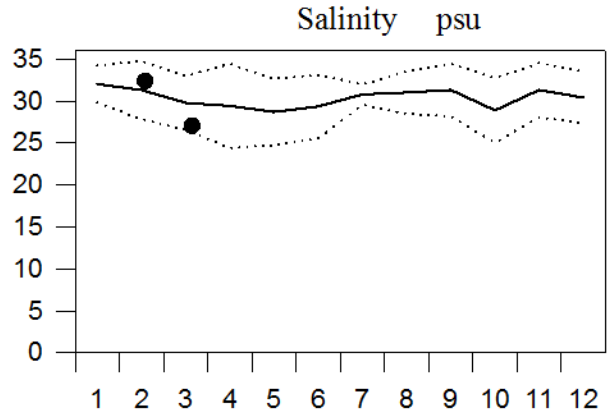
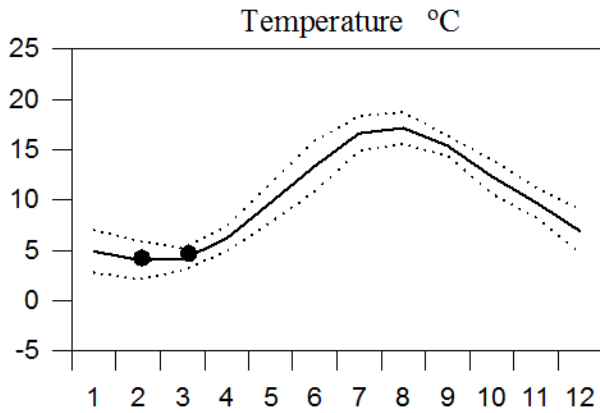
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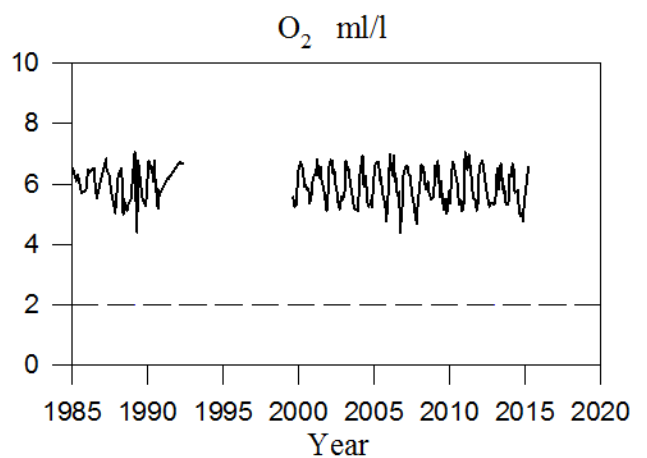
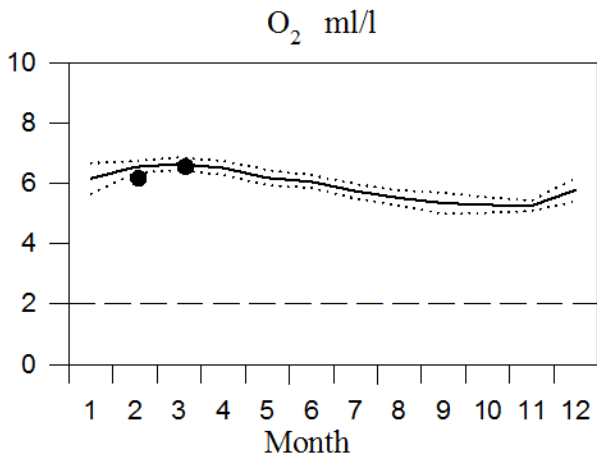
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Annual Cycles

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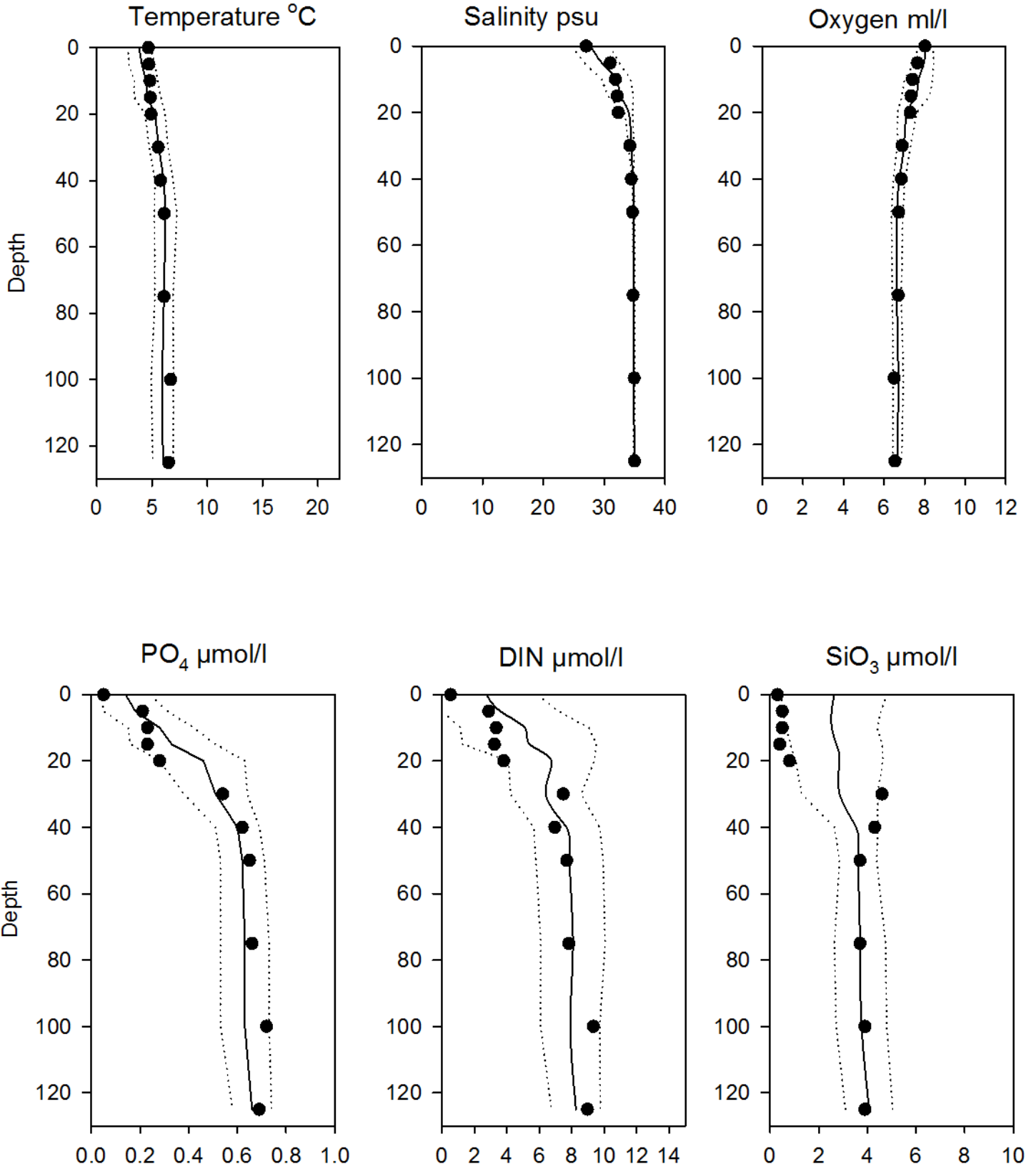


OXYGEN IN BOTTOM WATER (depth >=125m)



Vertical profiles Å15 March

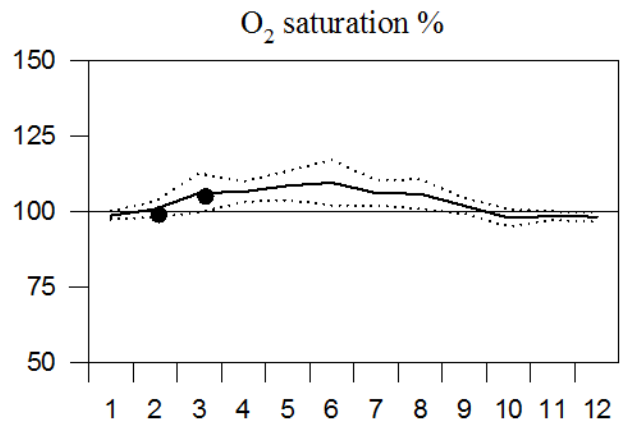
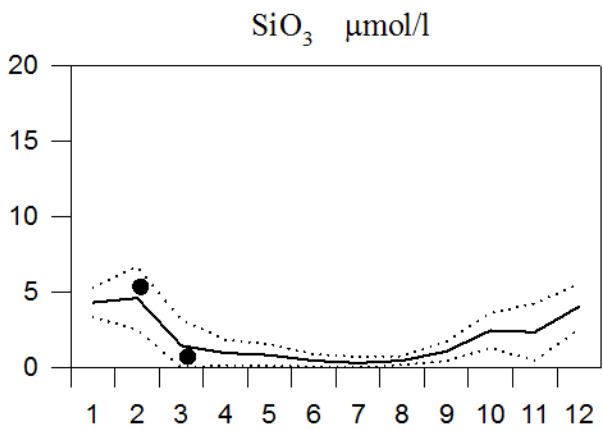
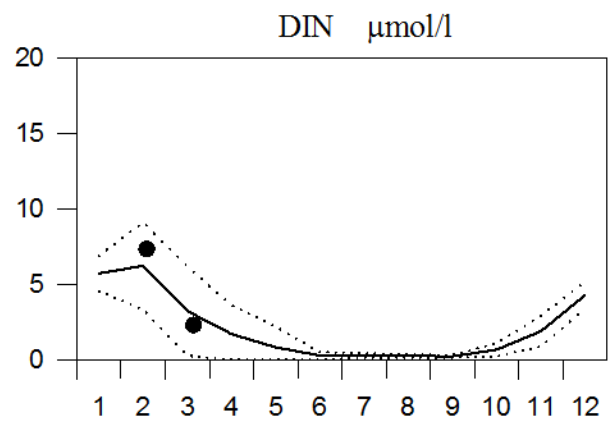
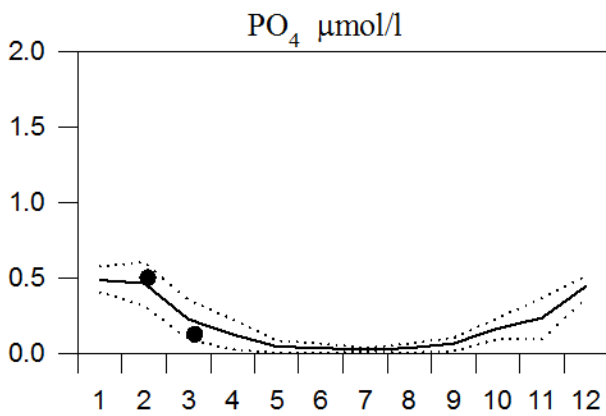
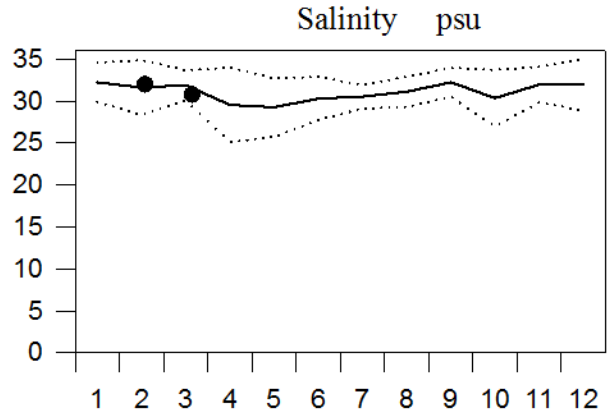
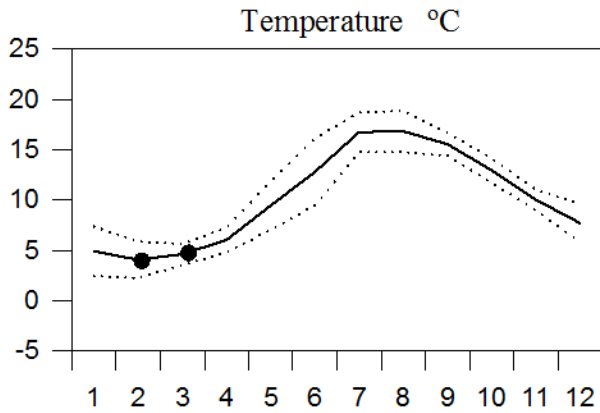
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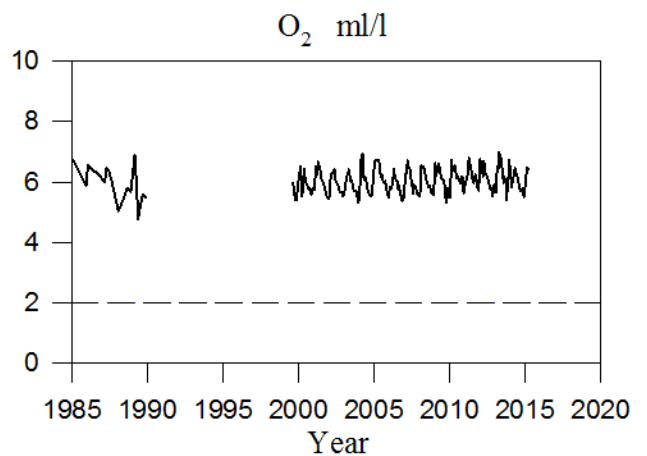
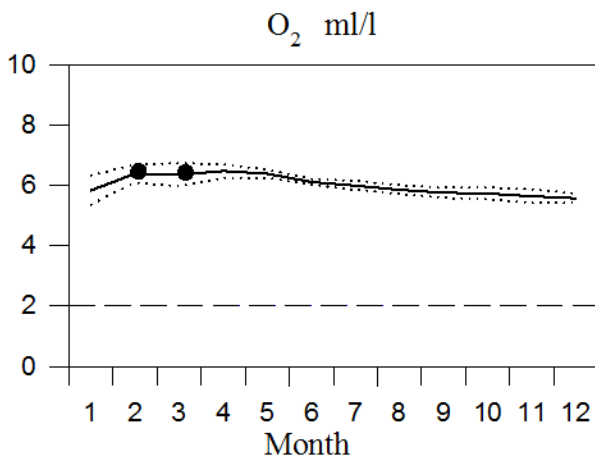
STATION Å17 SURFACE WATER

Annual Cycles

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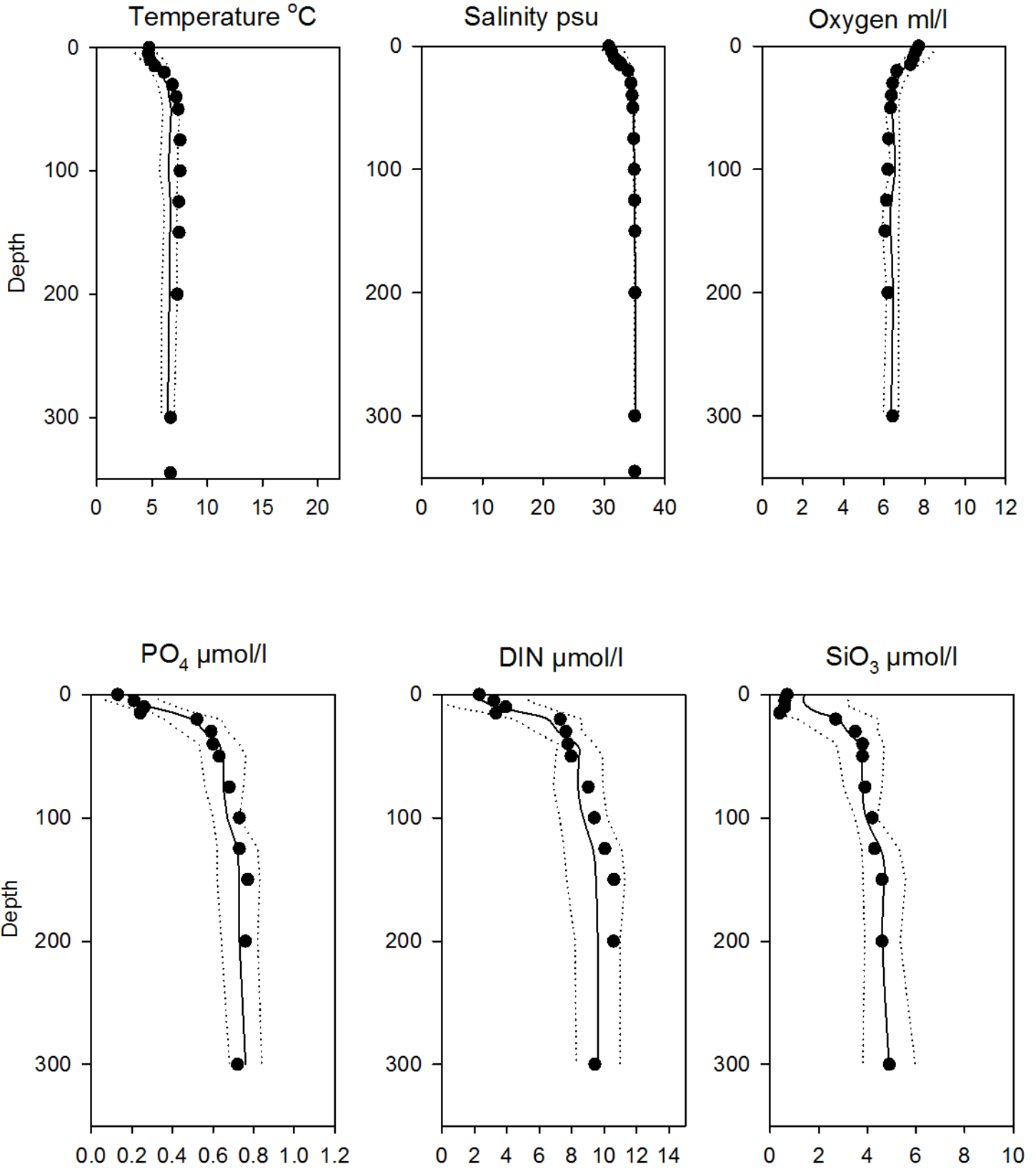


OXYGEN IN BOTTOM WATER (depth = 300m)



Vertical profiles Å17 March

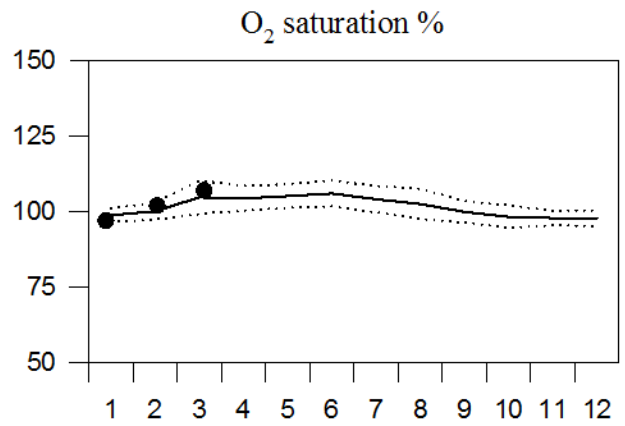
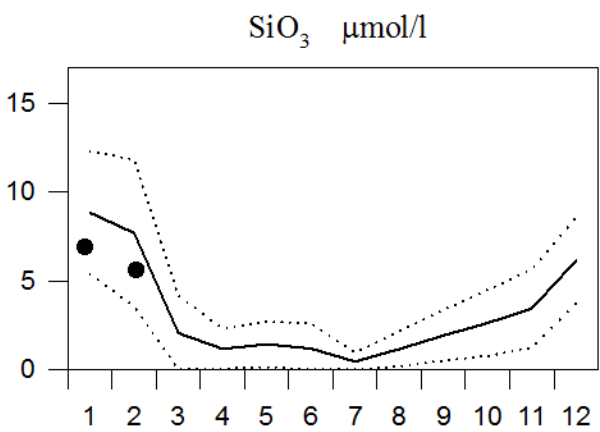
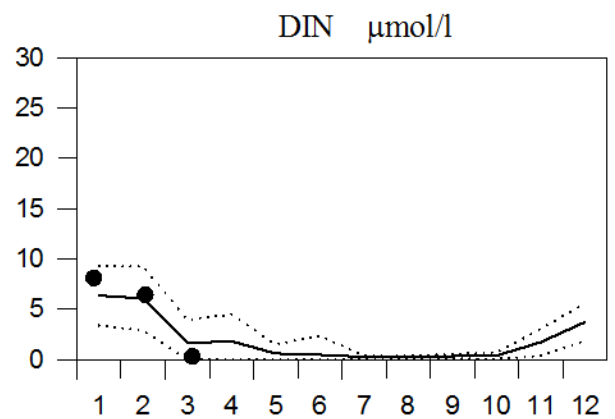
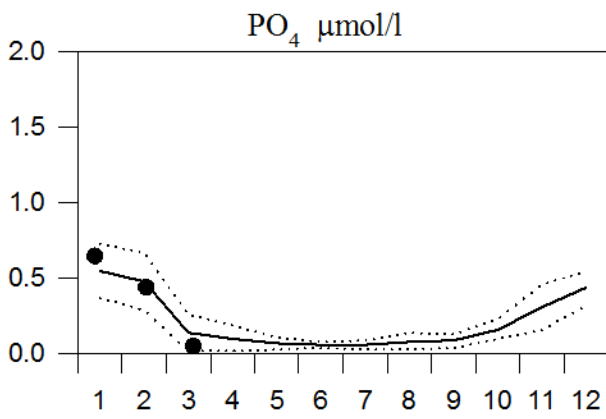
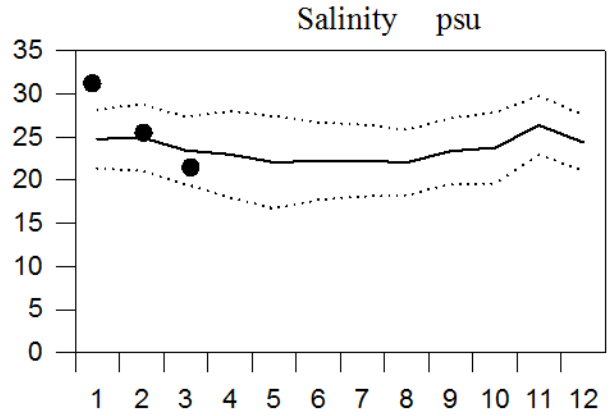
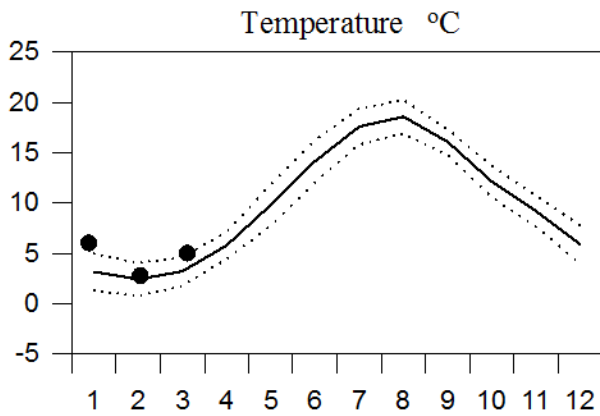
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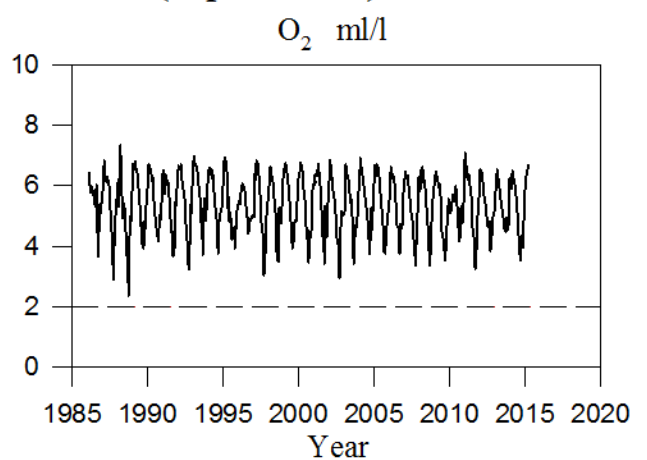
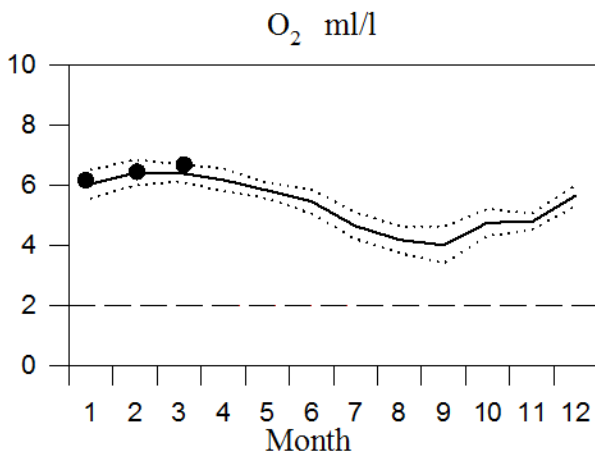
STATION FLADEN SURFACE WATER

Annual Cycles

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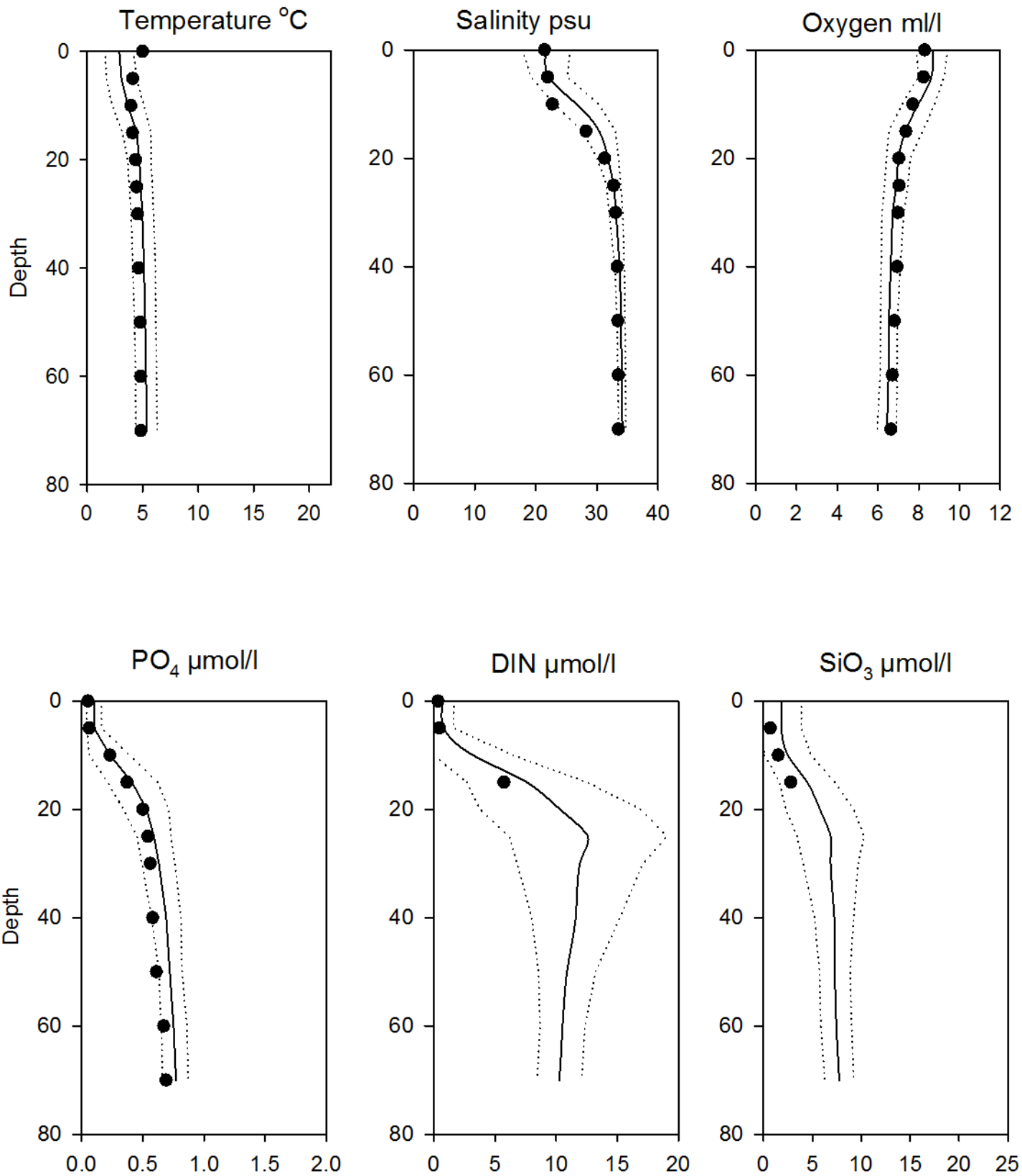


OXYGEN IN BOTTOM WATER (depth > 70m)



Vertical profiles Fladen March

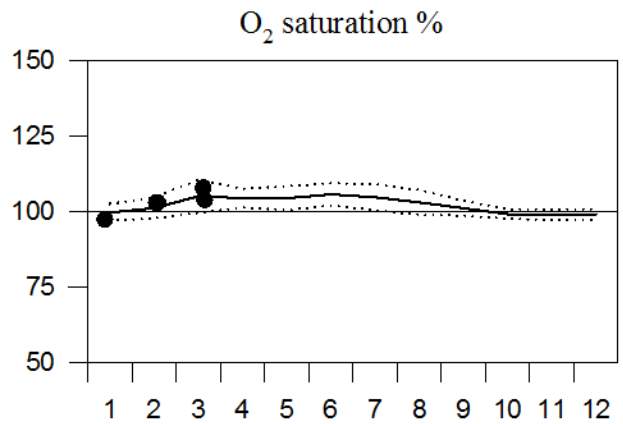
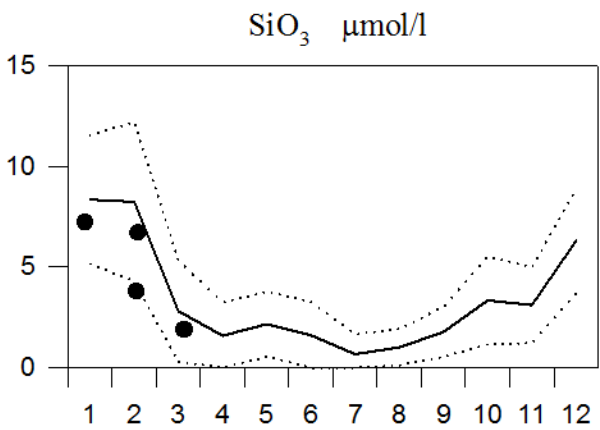
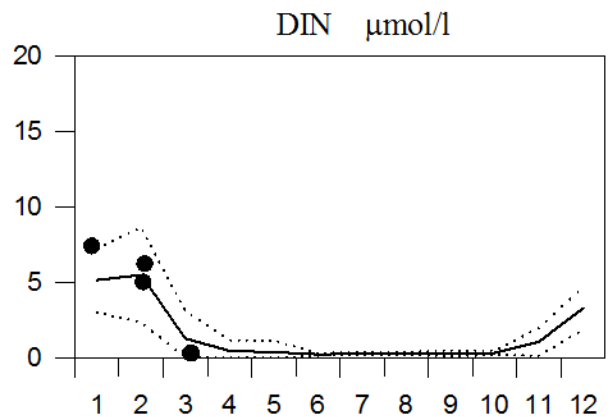
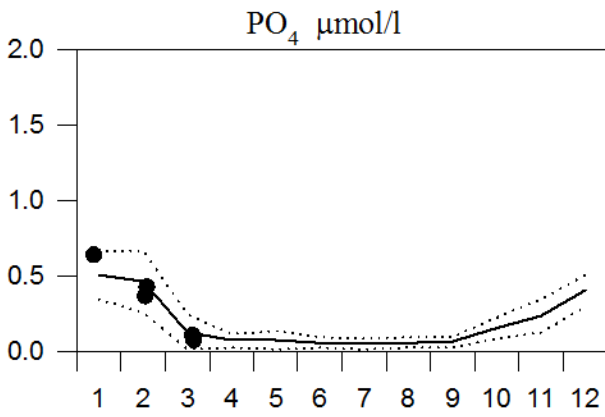
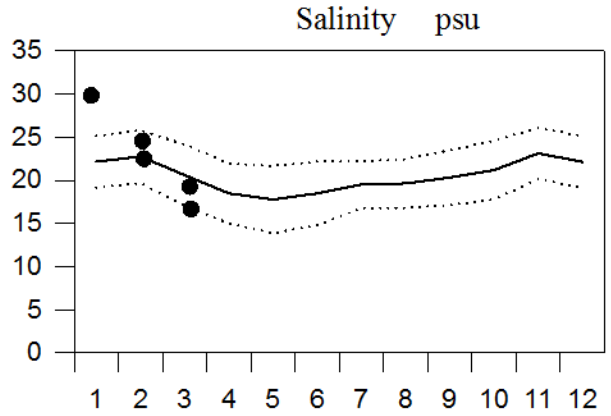
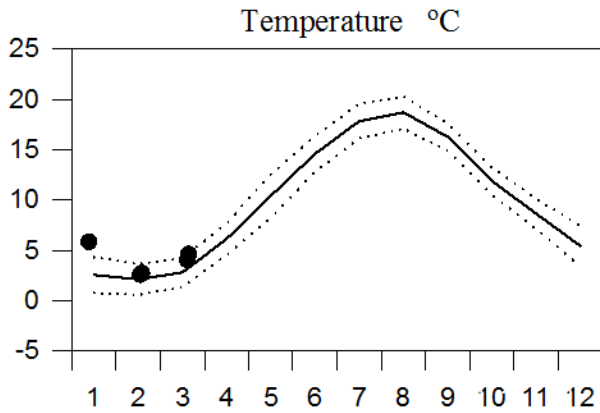
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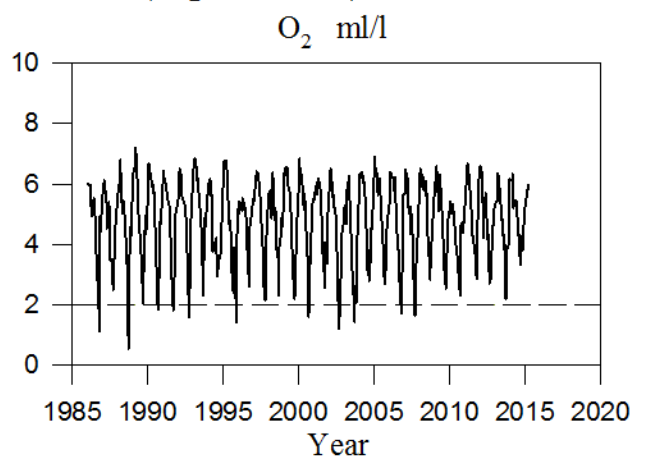
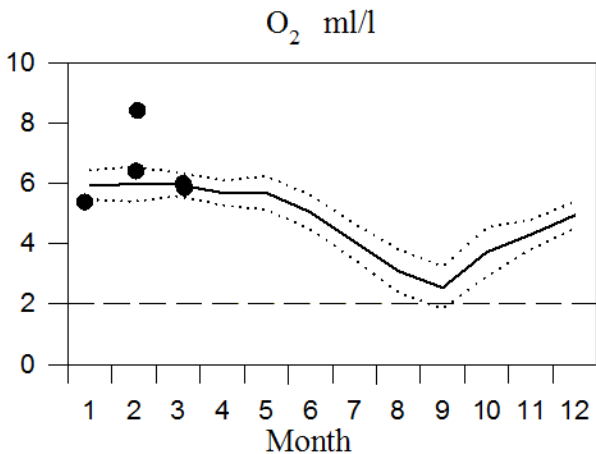
STATION ANHOLT E SURFACE WATER

Annual Cycles

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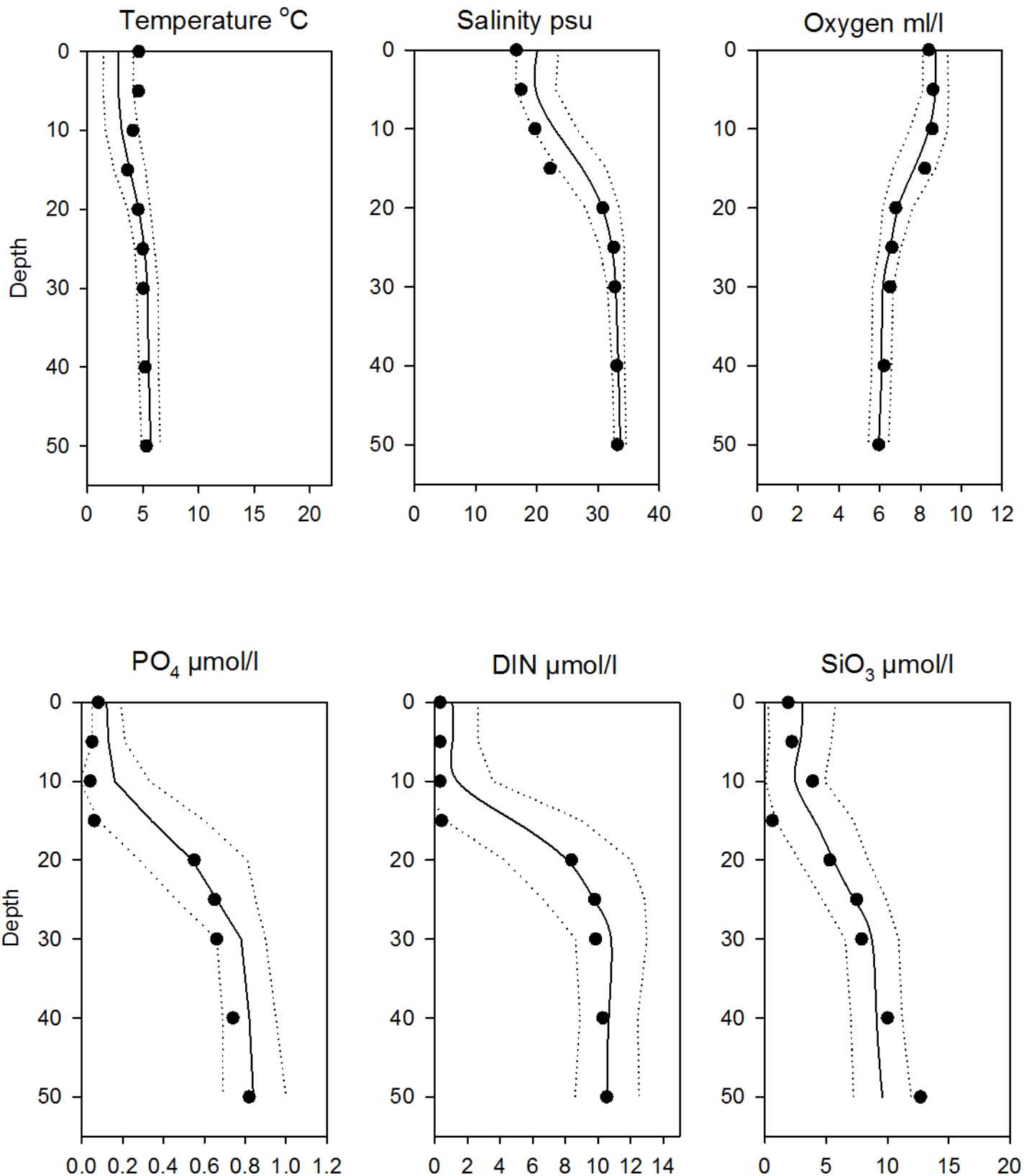


OXYGEN IN BOTTOM WATER (depth > 50m)



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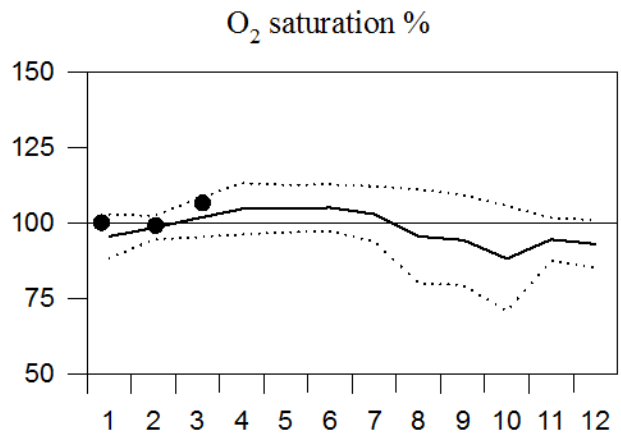
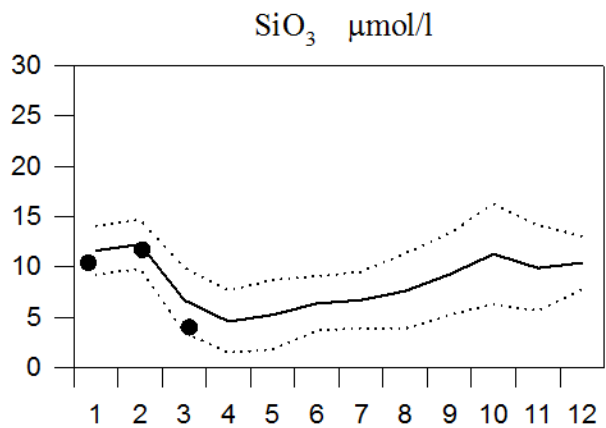
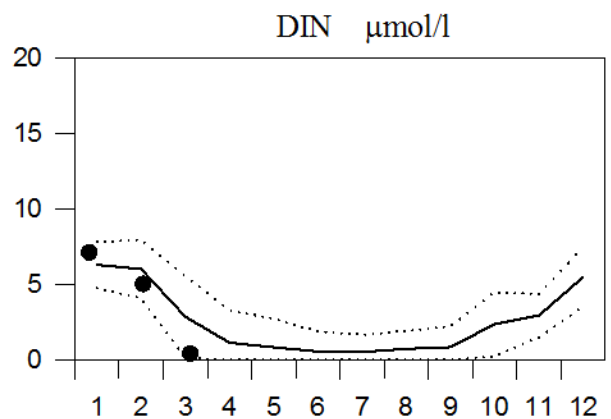
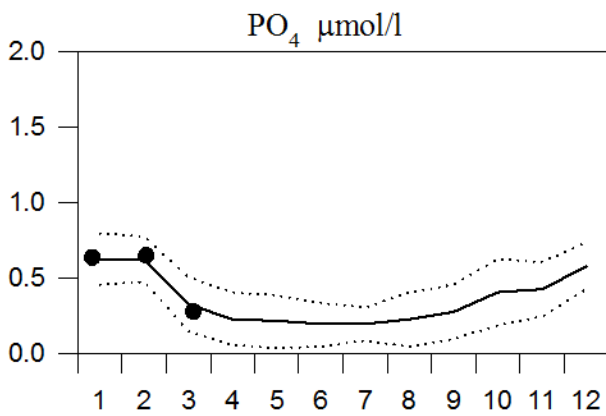
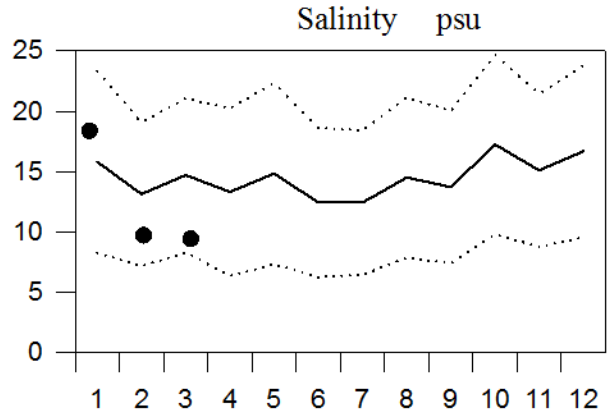
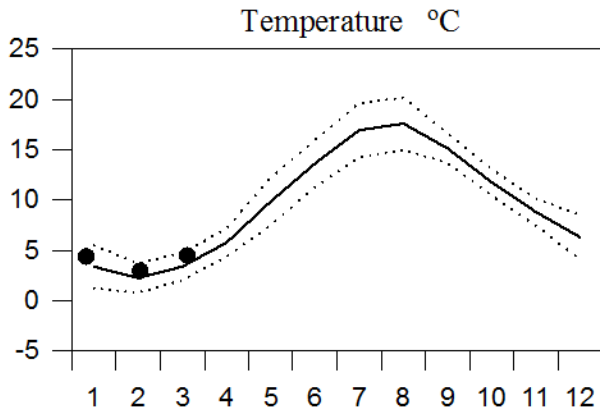
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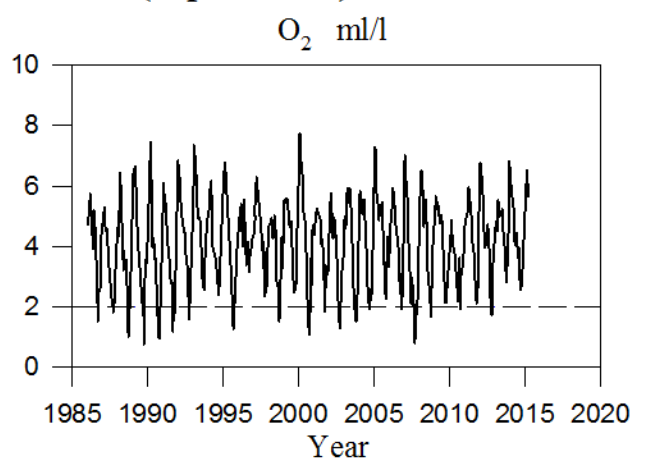
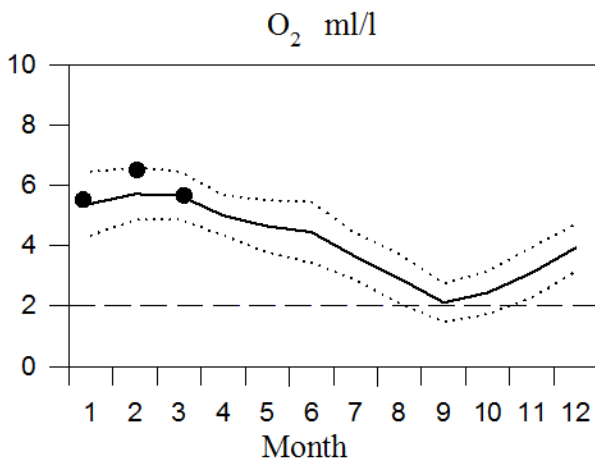
STATION W LANDSKRONA SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2015

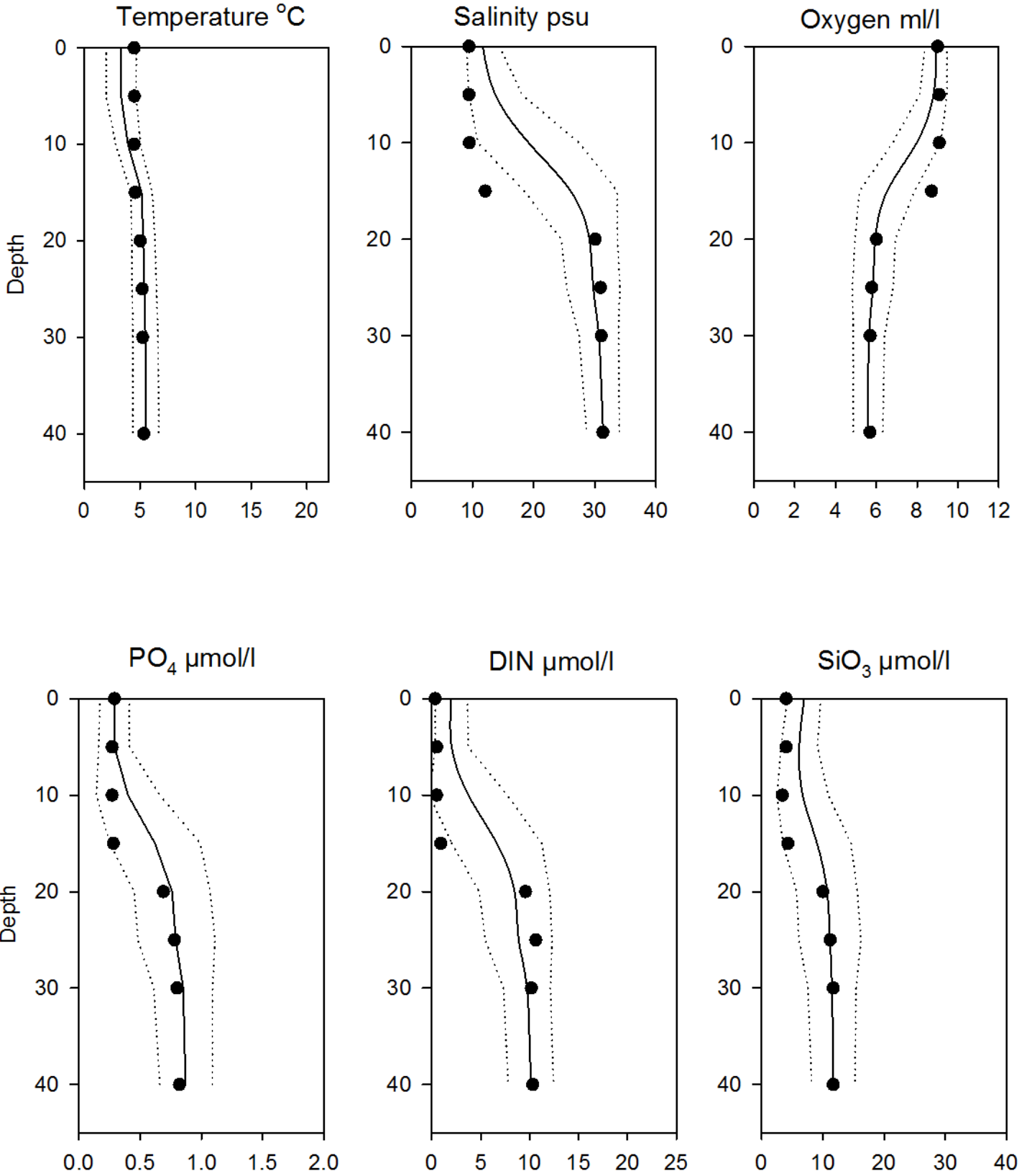


OXYGEN IN BOTTOM WATER (depth >40m)



Vertical profiles W Landskrona March

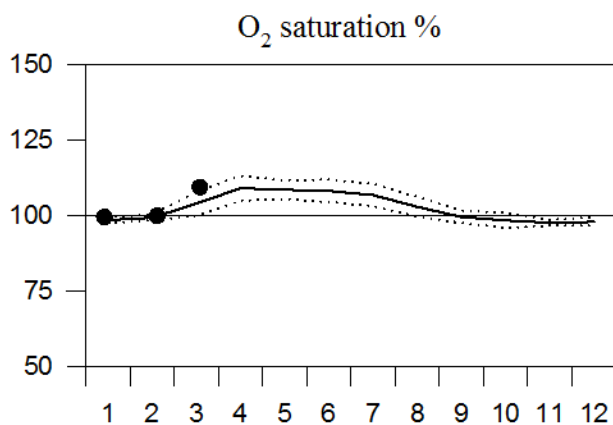
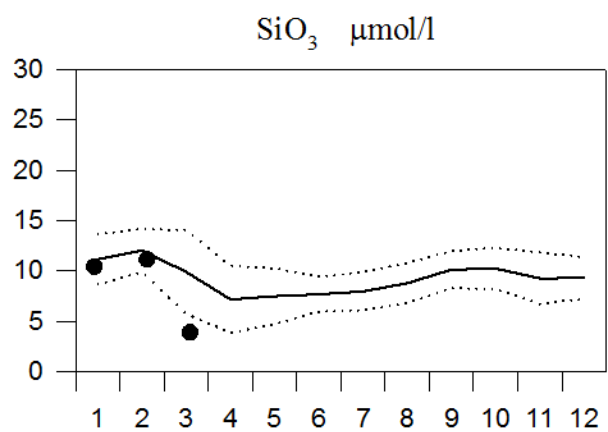
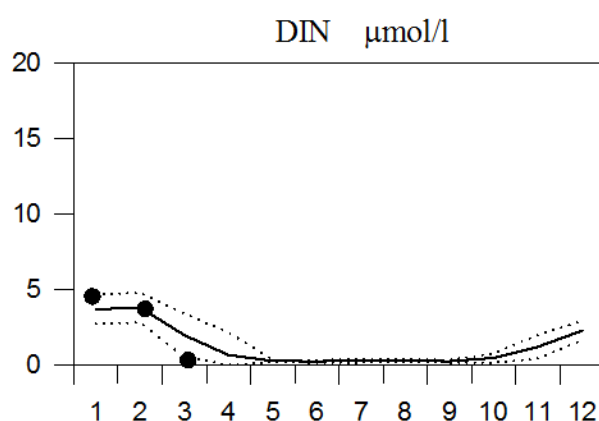
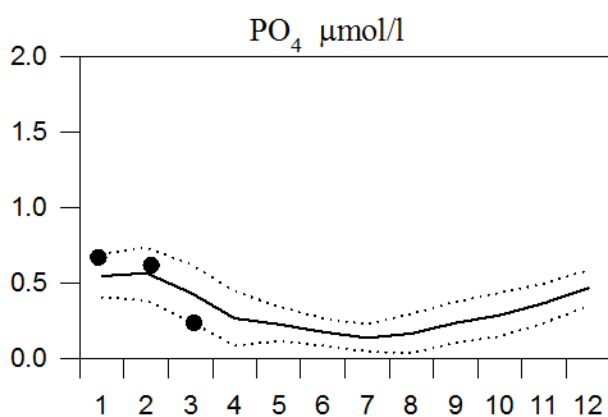
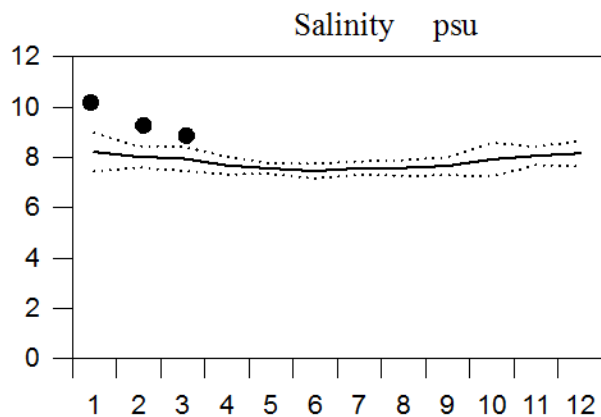
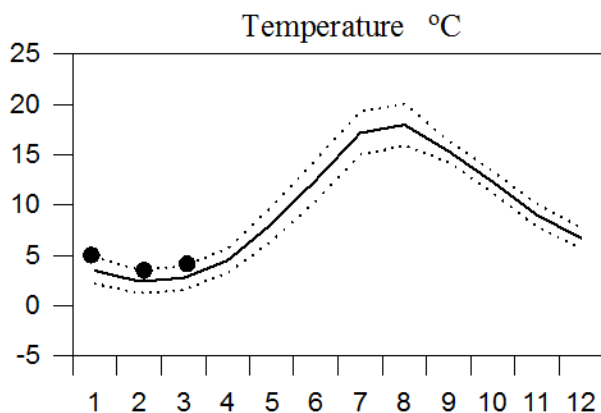
— Mean 1996-2010 St.Dev. ● 2015



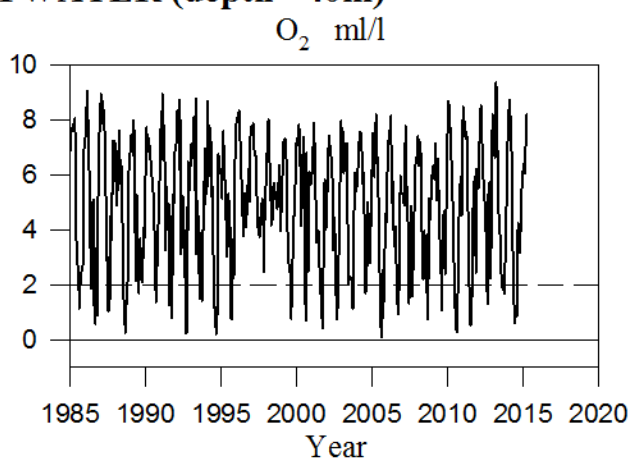
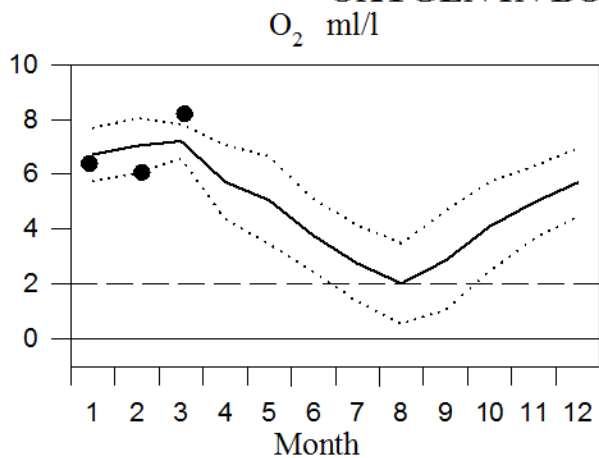
STATION BY1 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2015

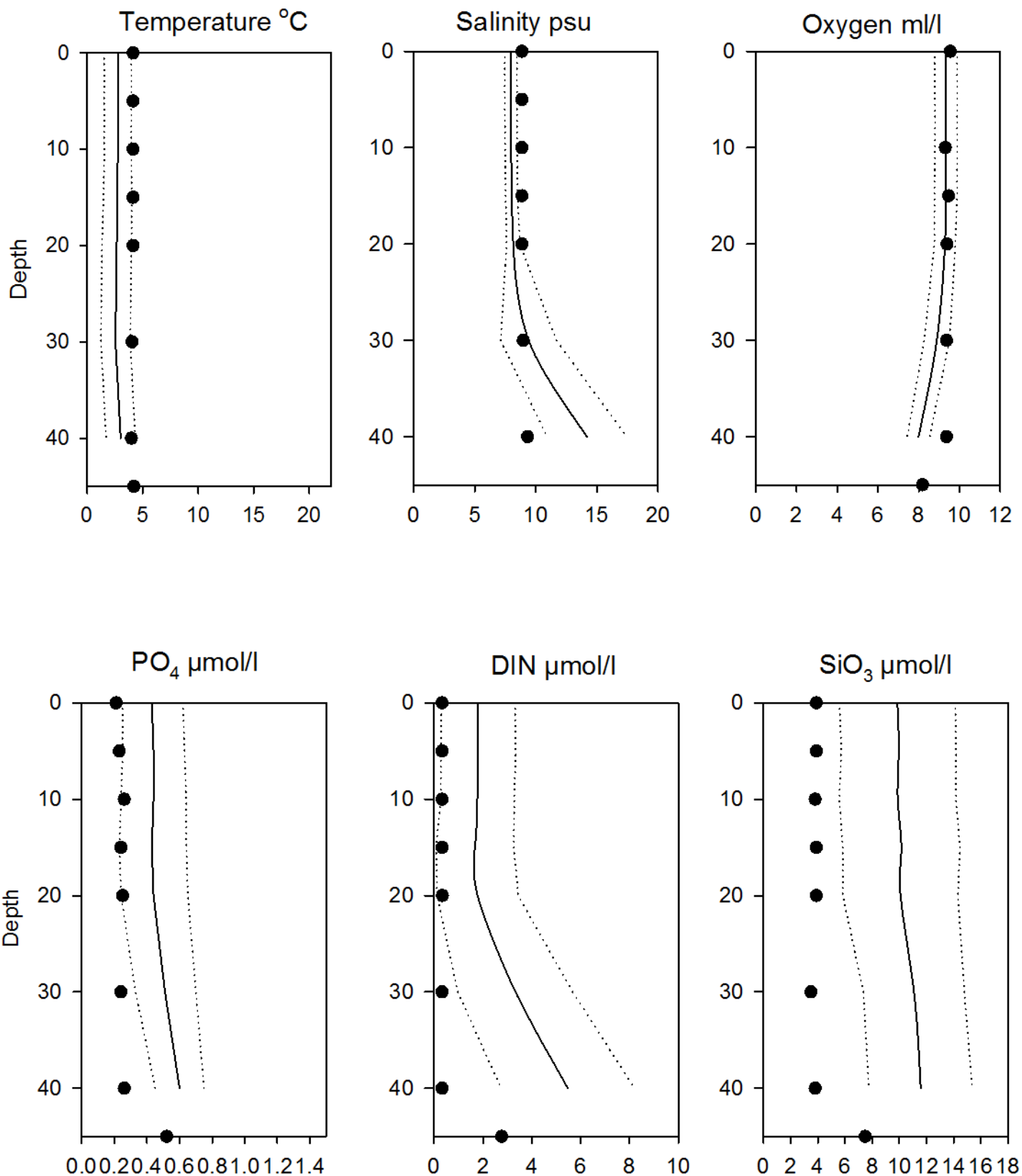


OXYGEN IN BOTTOM WATER (depth >40m)



Vertical profiles BY1 March

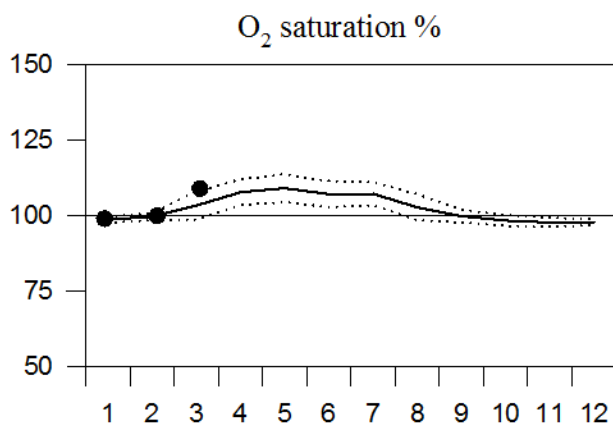
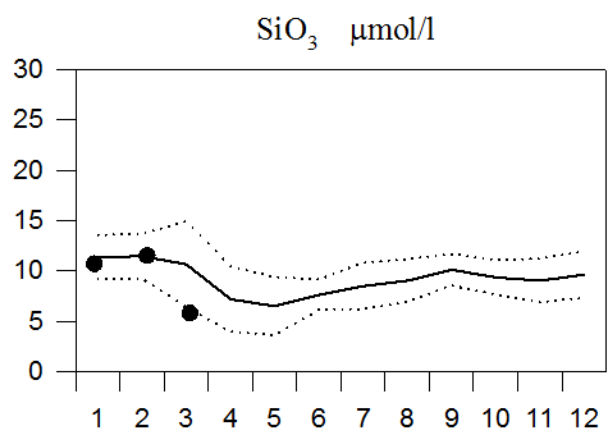
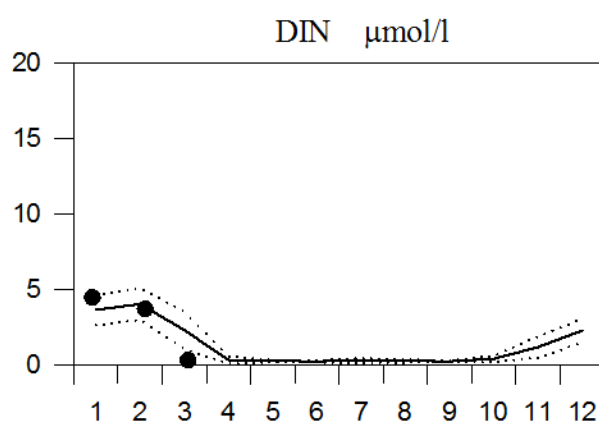
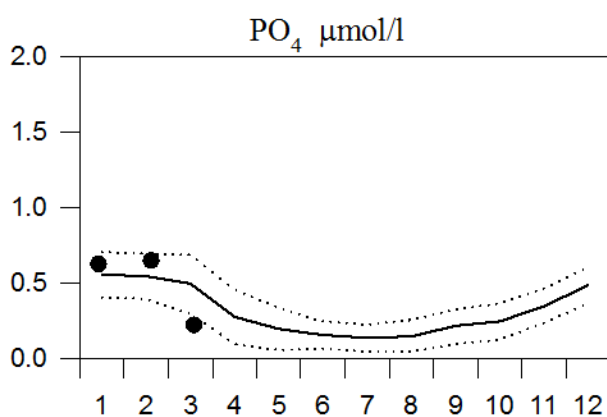
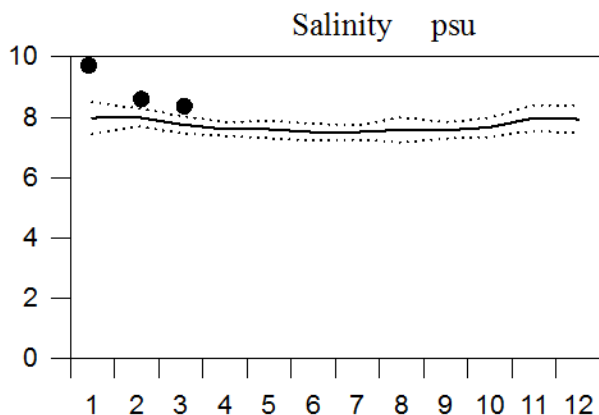
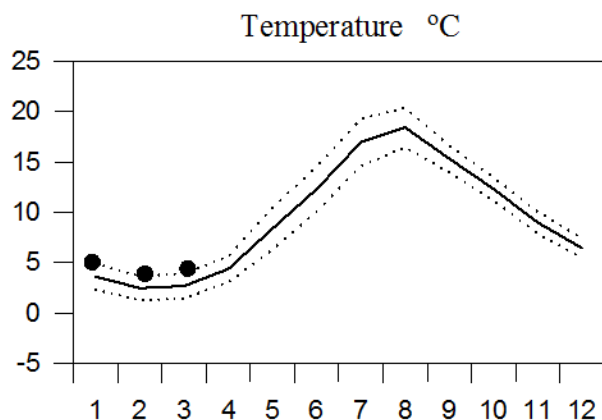
— Mean 1996-2010 St.Dev. ● 2015



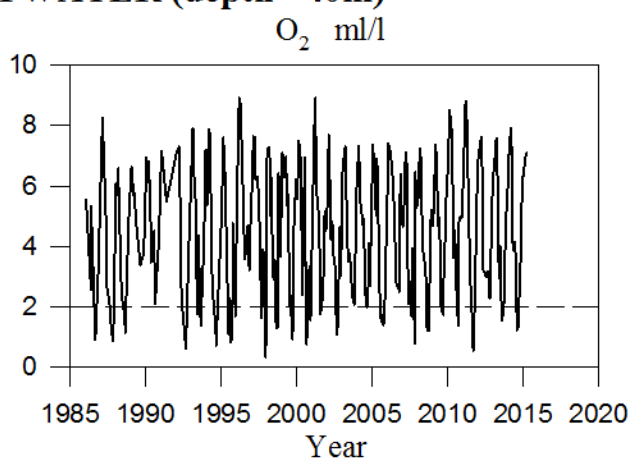
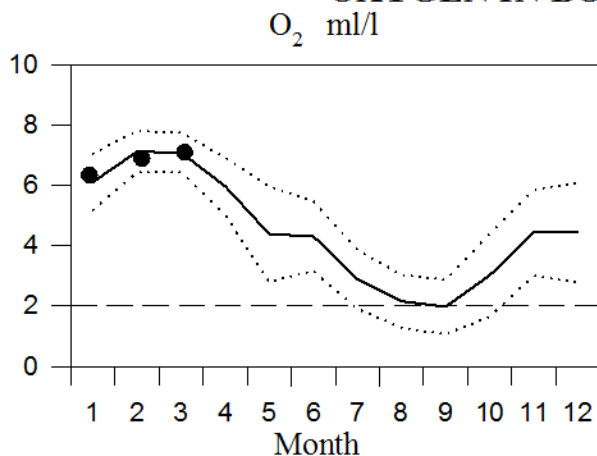
STATION BY2 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2015

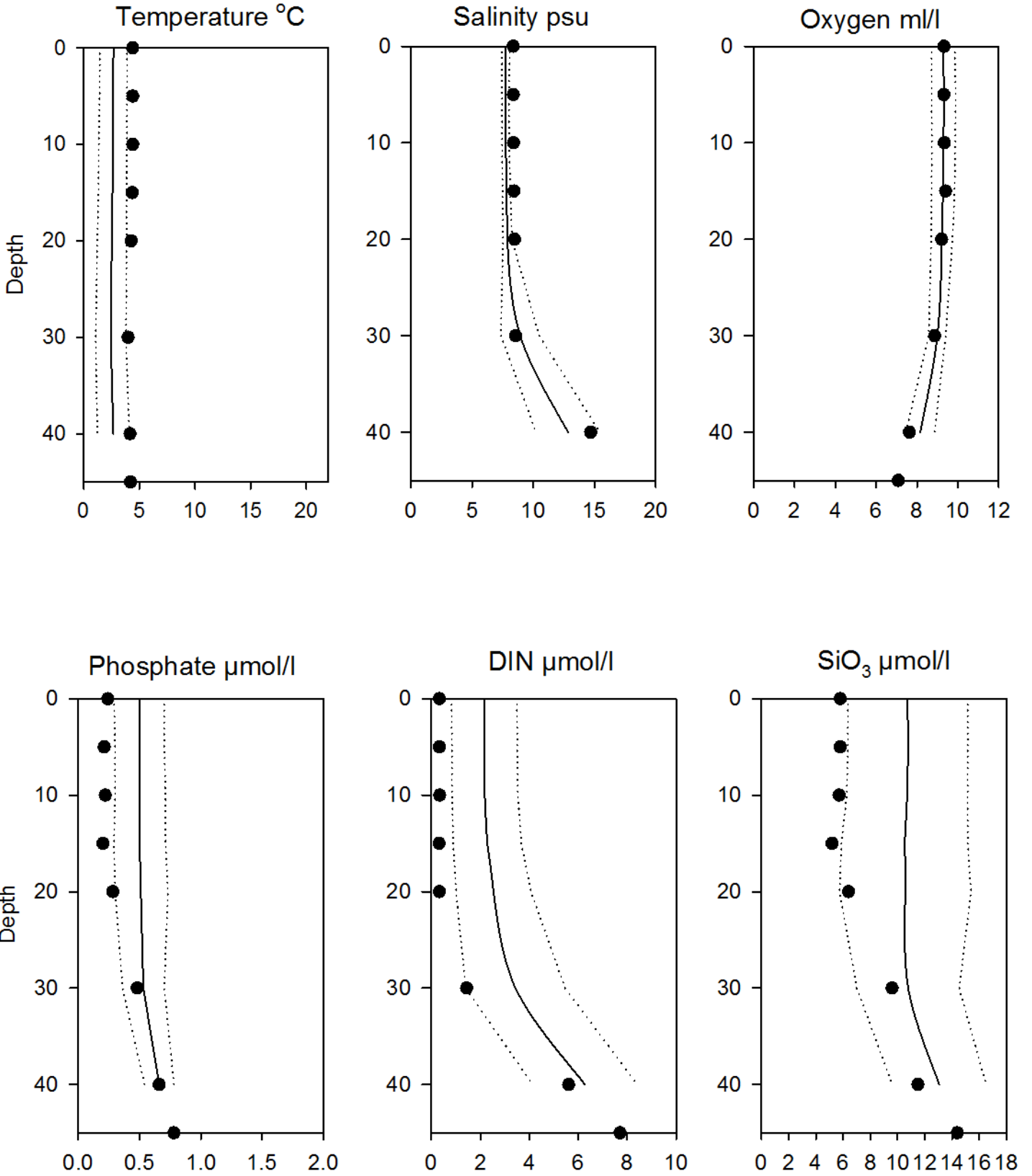


OXYGEN IN BOTTOM WATER (depth >40m)



Vertical profiles BY2 March

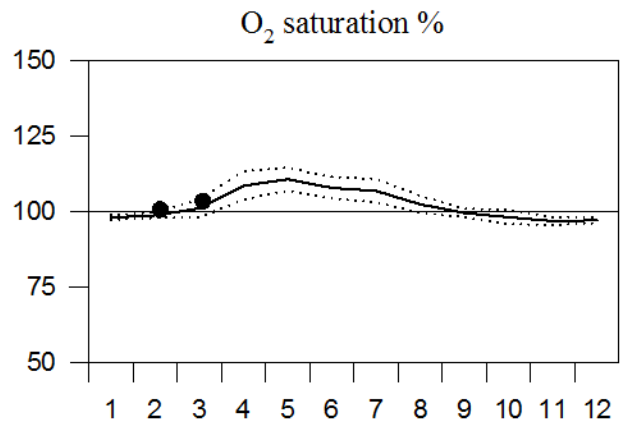
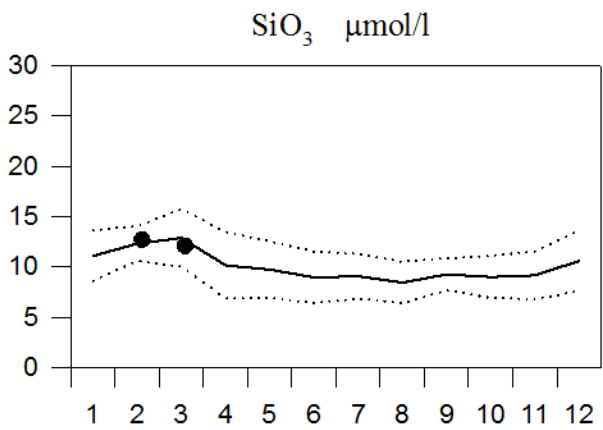
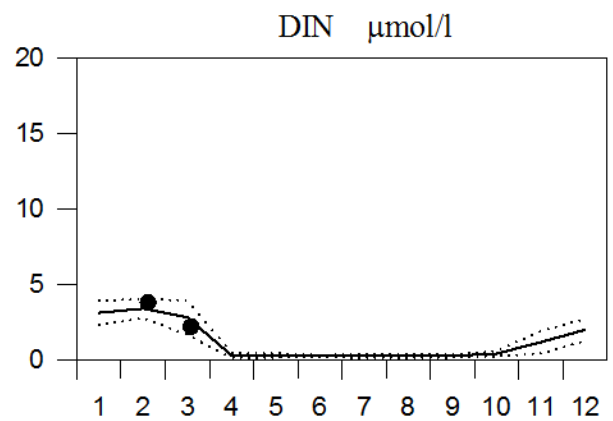
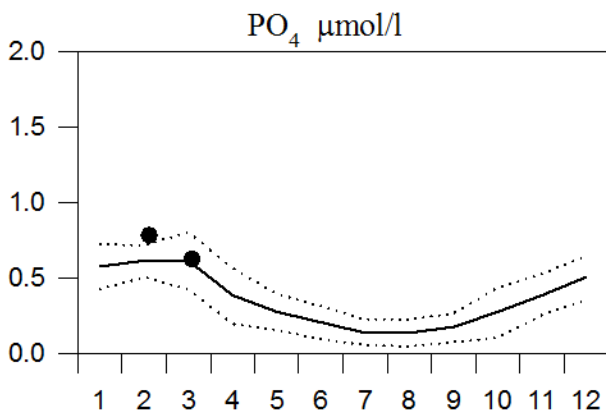
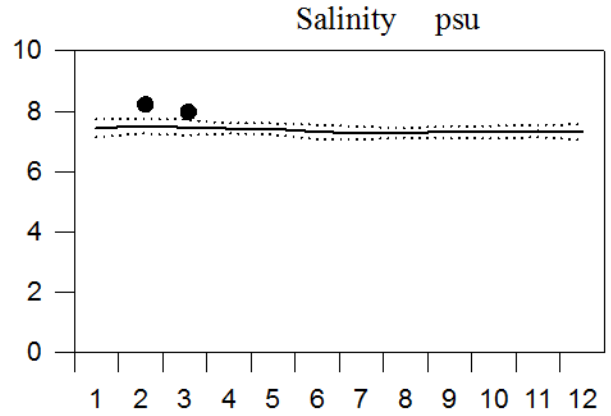
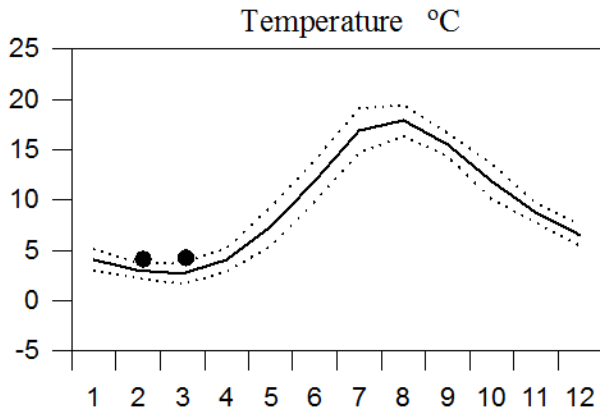
— Mean 1996-2010 St.Dev. ● 2015



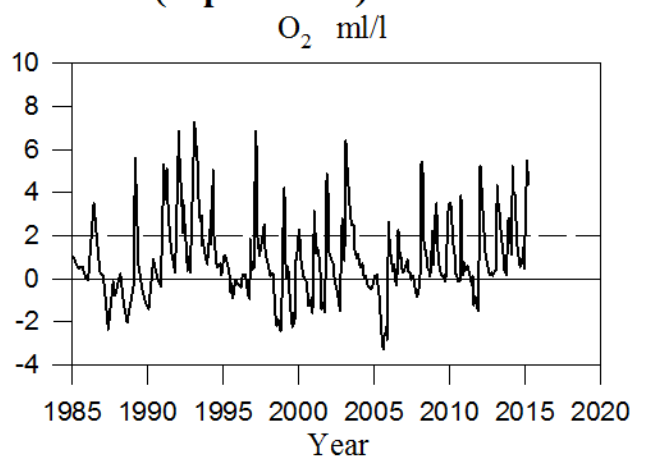
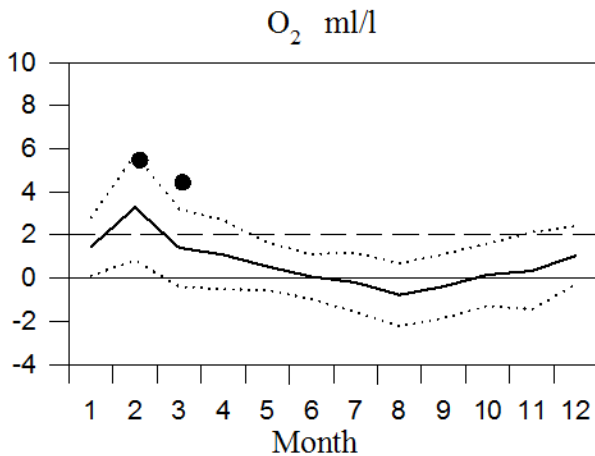
STATION BY4 SURFACE WATER

Annual Cycles

— Mean 1996-2010 ····· St.Dev. ● 2015

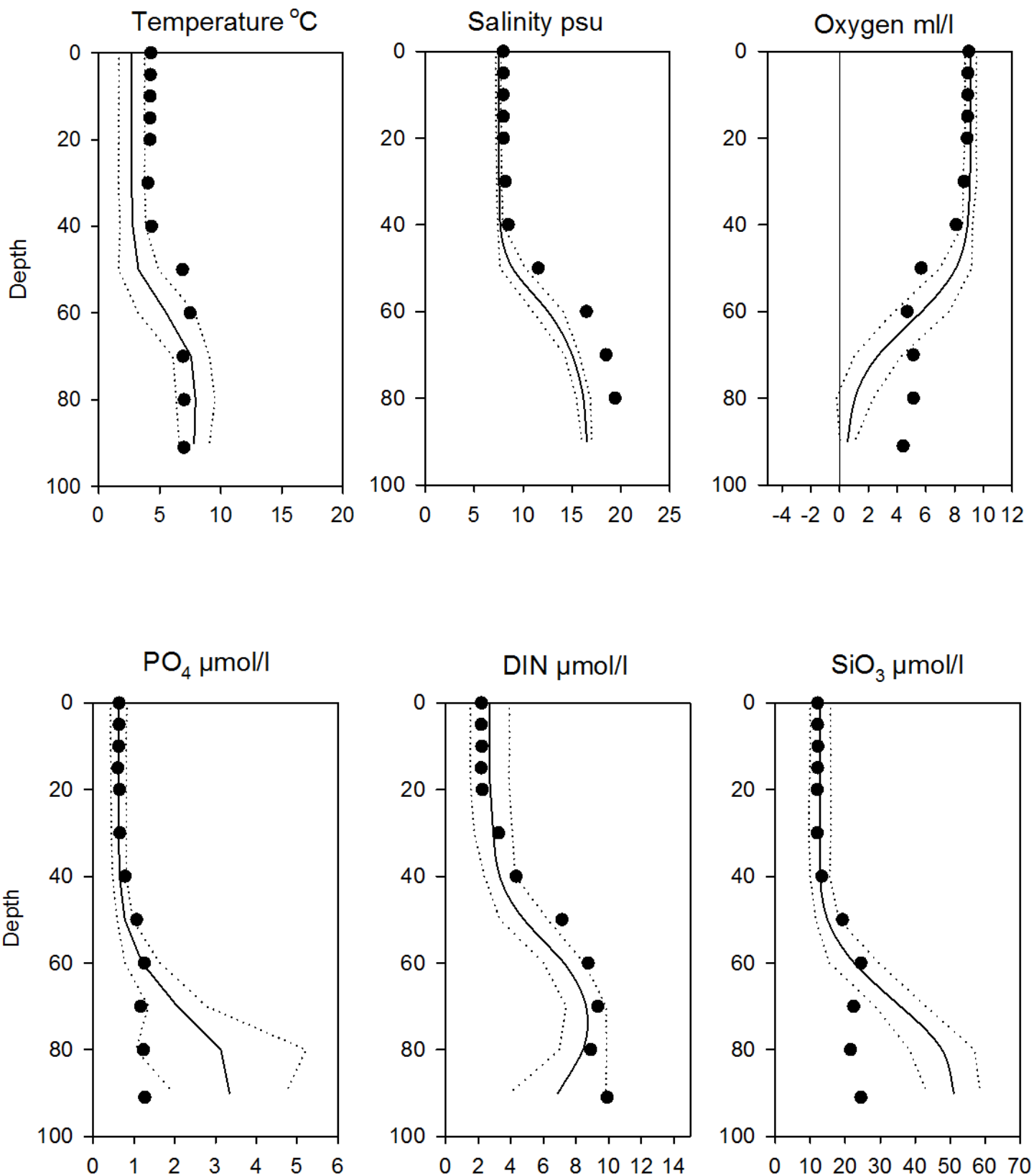


OXYGEN IN BOTTOM WATER (depth >80m)



Vertical profiles BY4 March

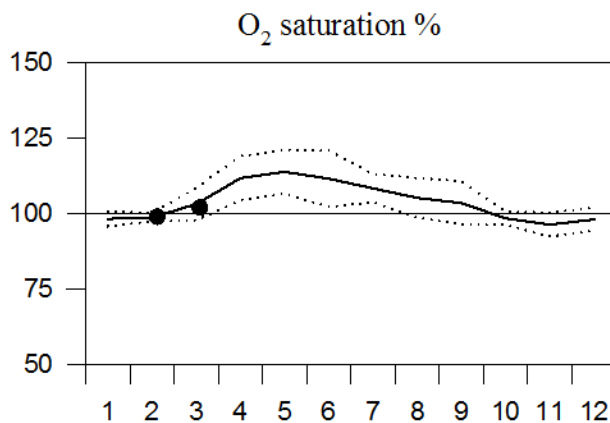
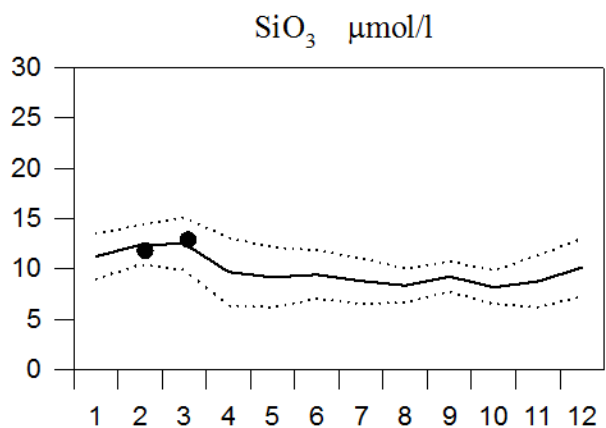
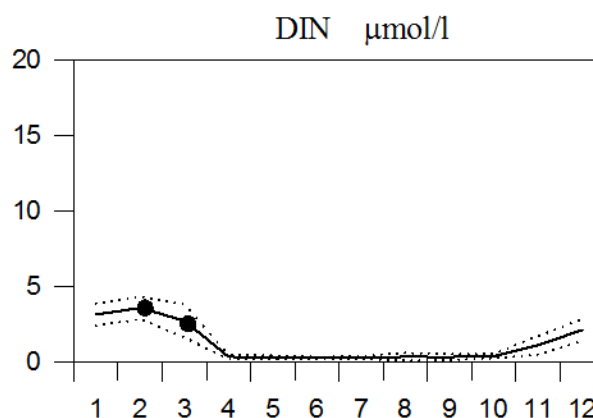
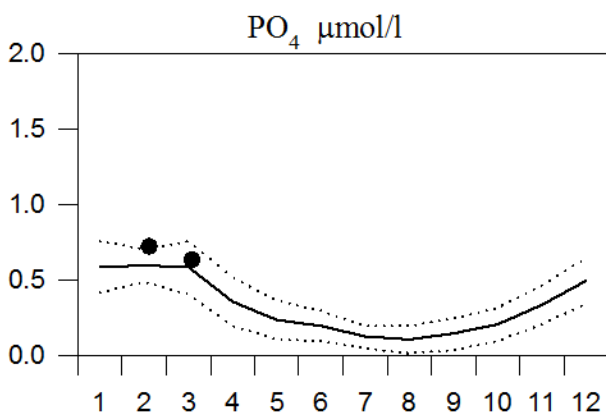
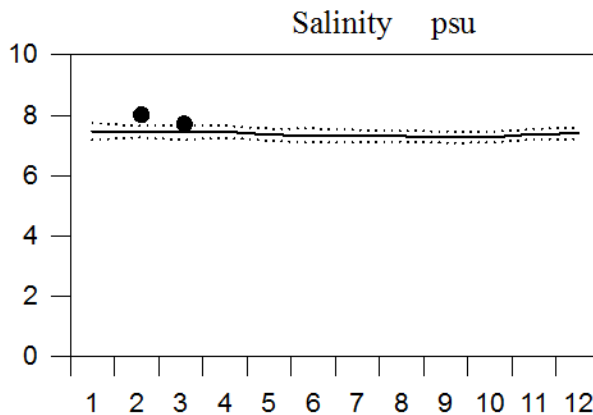
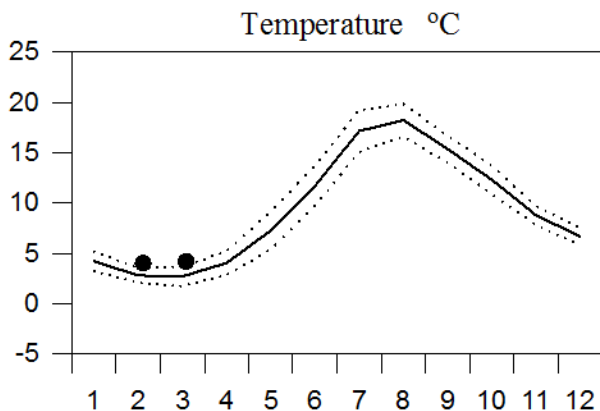
— Mean 1996-2010 St.Dev. ● 2015



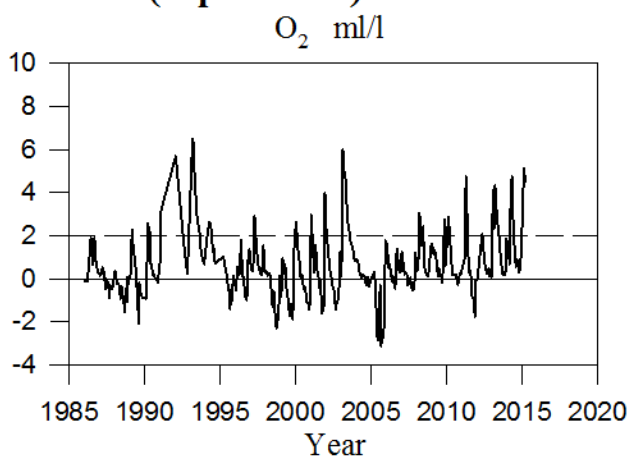
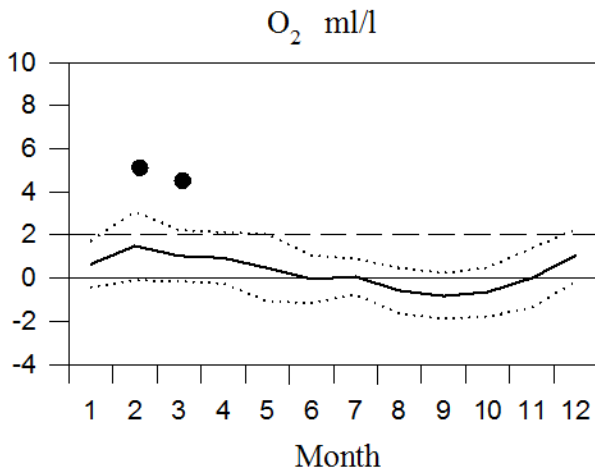
STATION BY5 SURFACE WATER

Annual Cycles

— Mean 1996-2010 ····· St.Dev. ● 2015

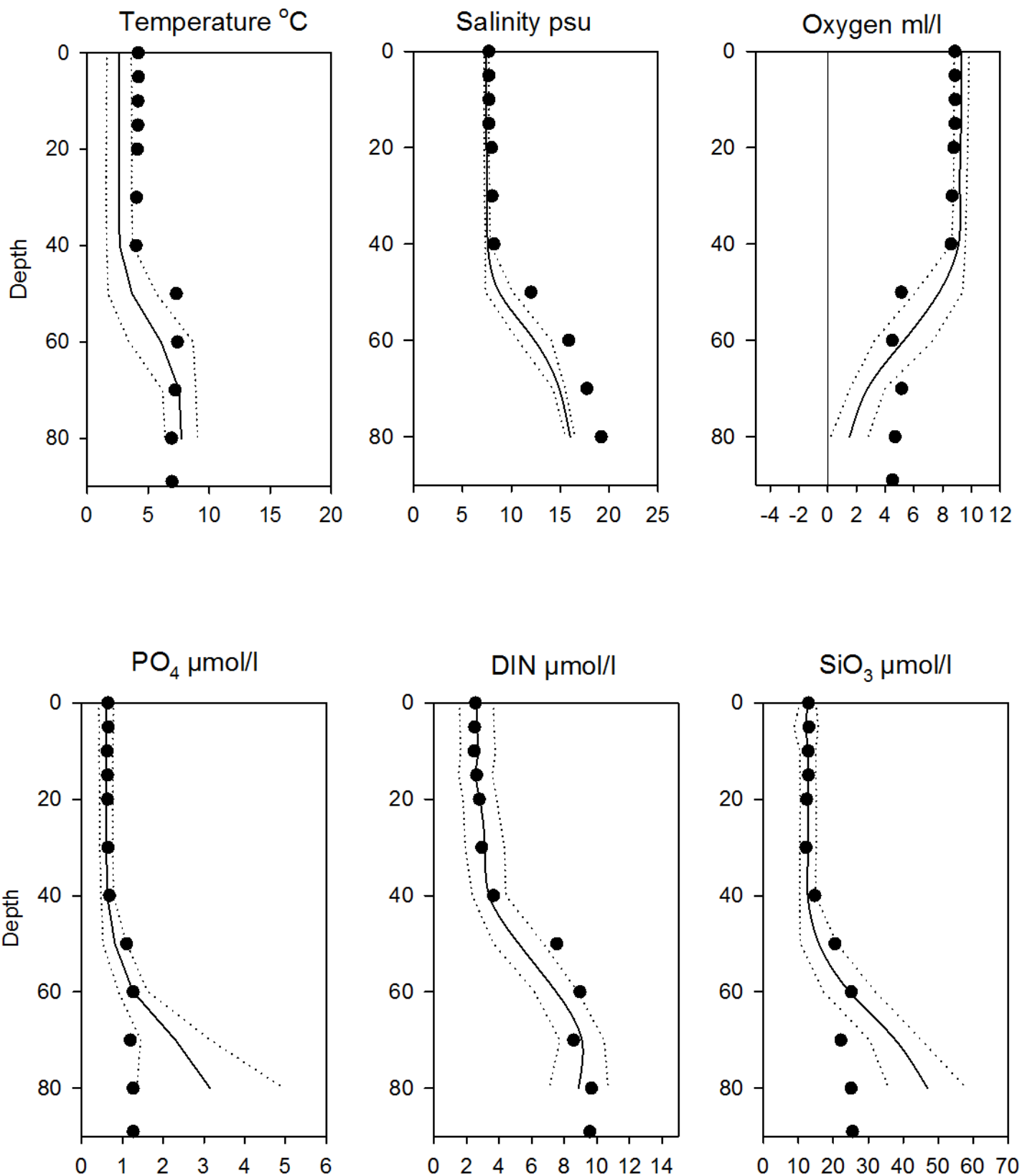


OXYGEN IN BOTTOM WATER (depth >80m)



Vertical profiles BY5 March

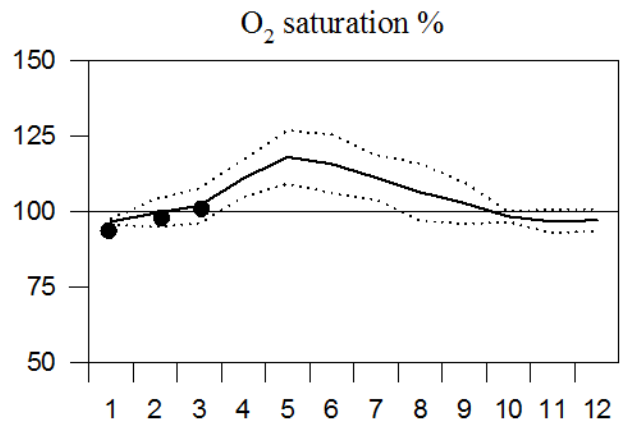
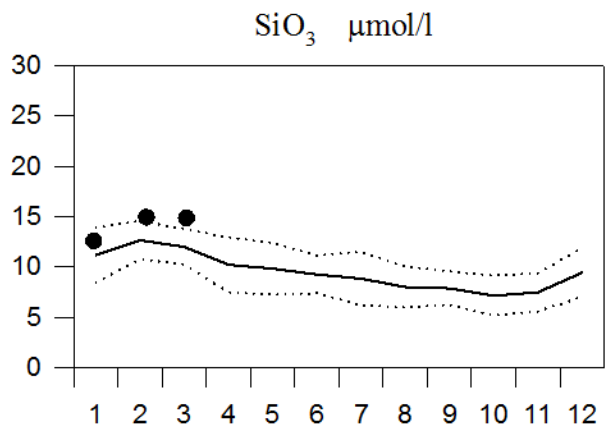
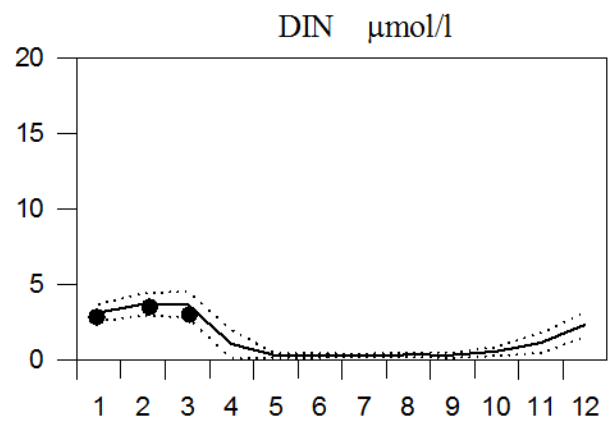
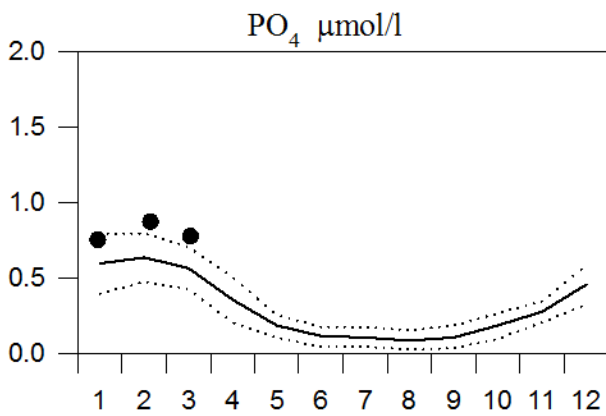
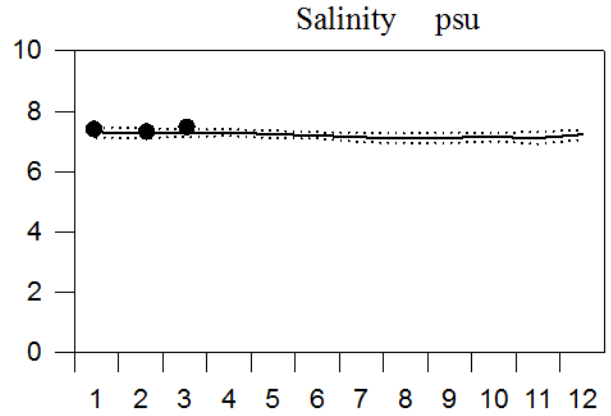
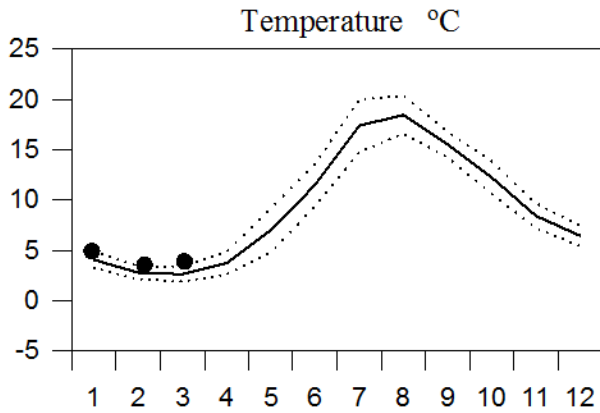
— Mean 1996-2010 St.Dev. ● 2015



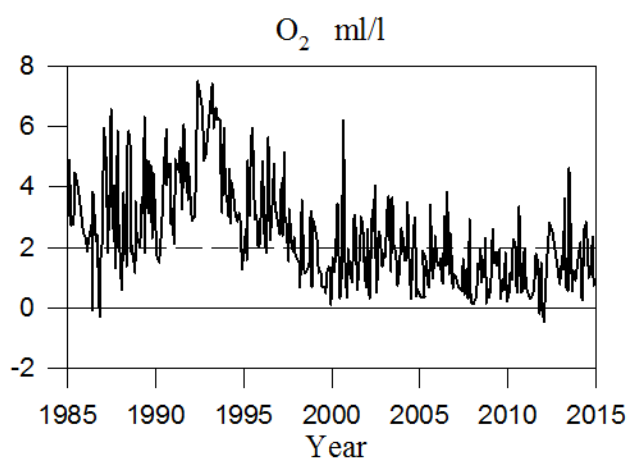
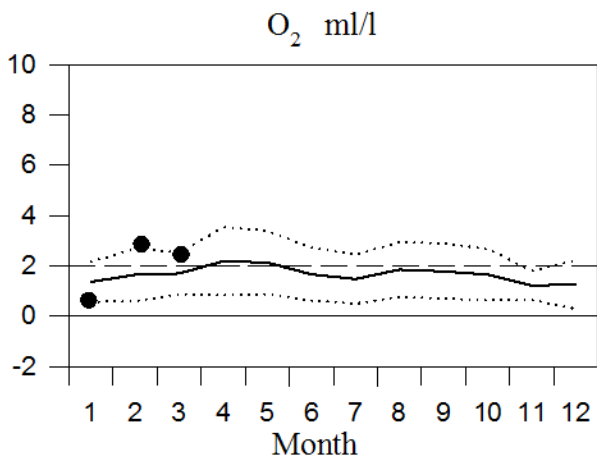
STATION BCS III-10 SURFACE WATER

Annual Cycles

— Mean 1996-2010 ····· St.Dev. ● 2015

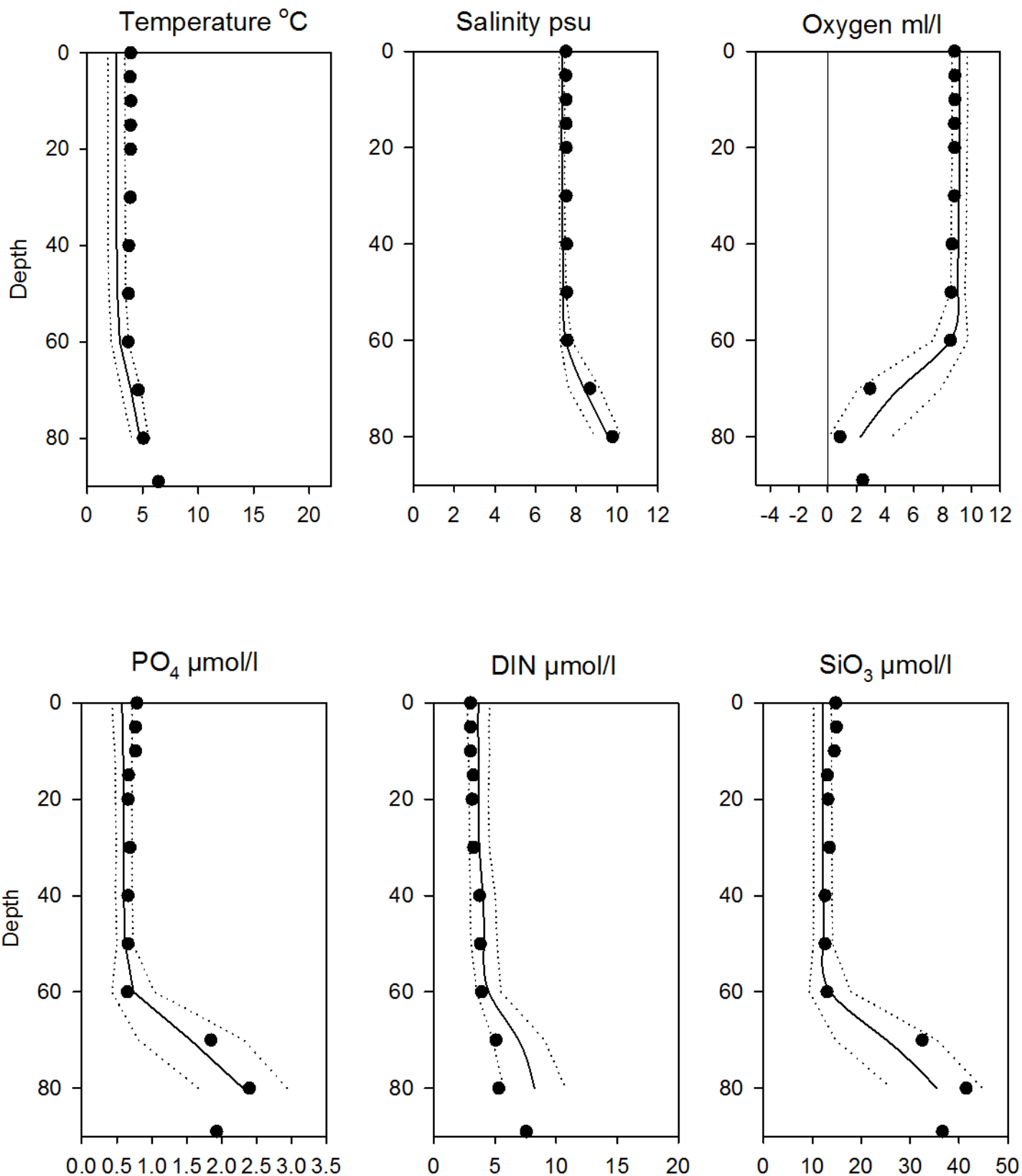


OXYGEN IN BOTTOM WATER (depth > 80m)



Vertical profiles BCS III-10 March

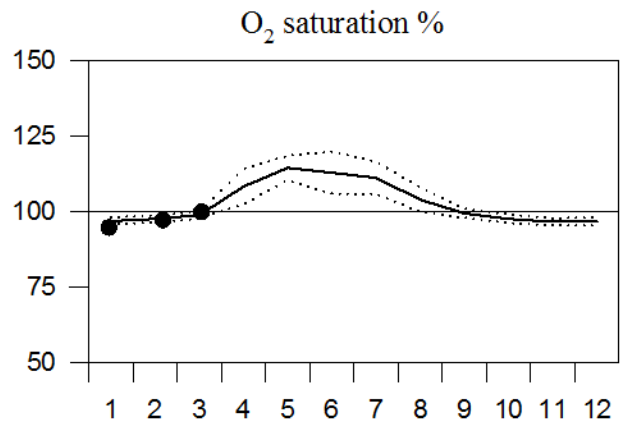
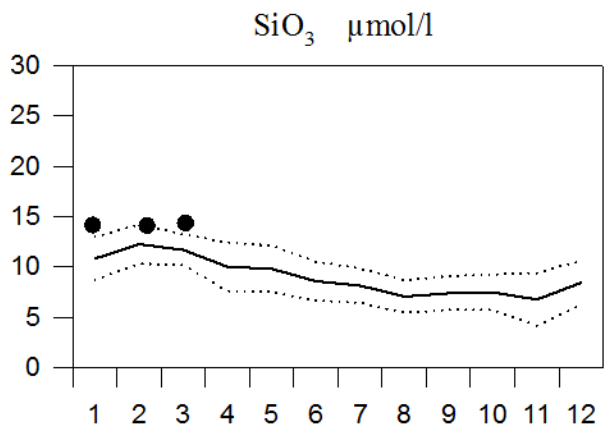
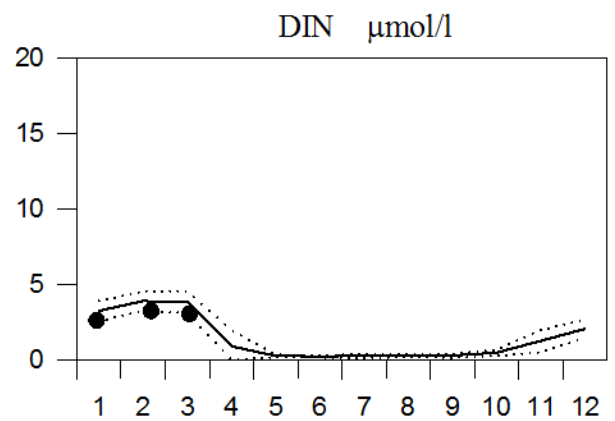
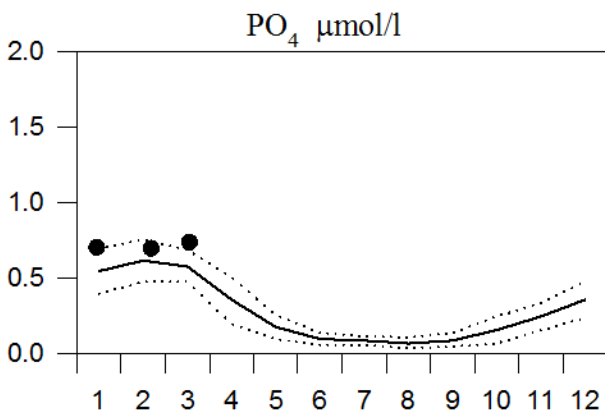
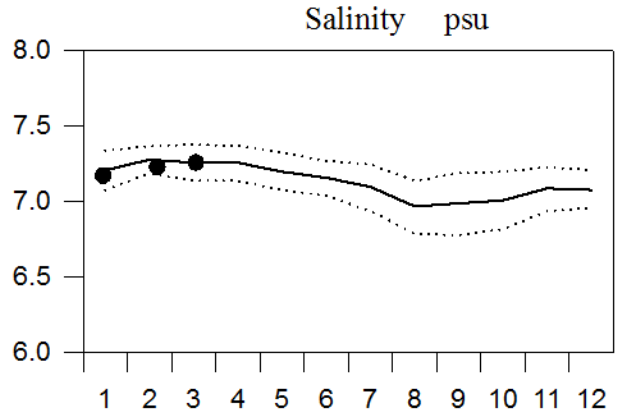
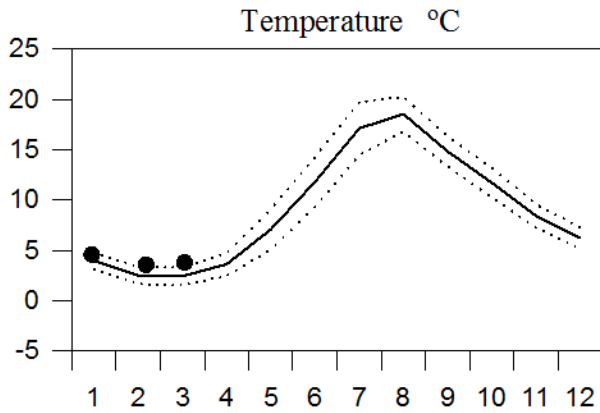
— Mean 1996-2010 St.Dev. ● 2015



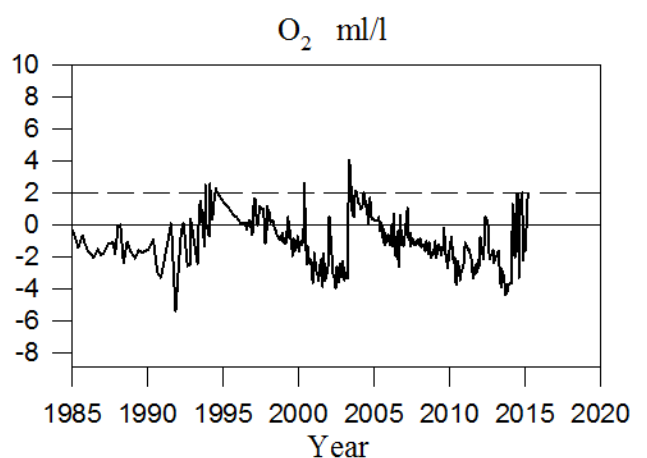
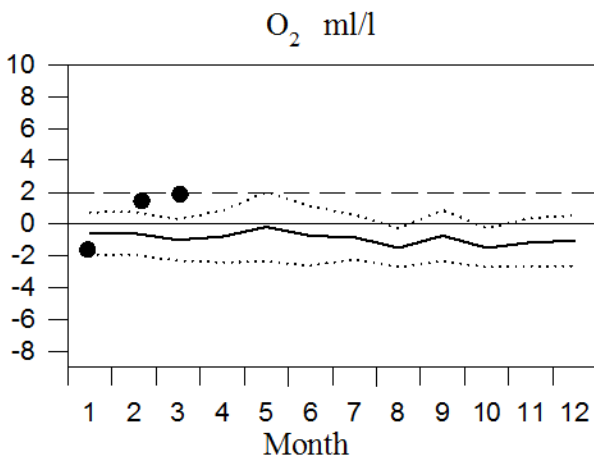
STATION BY10 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2015

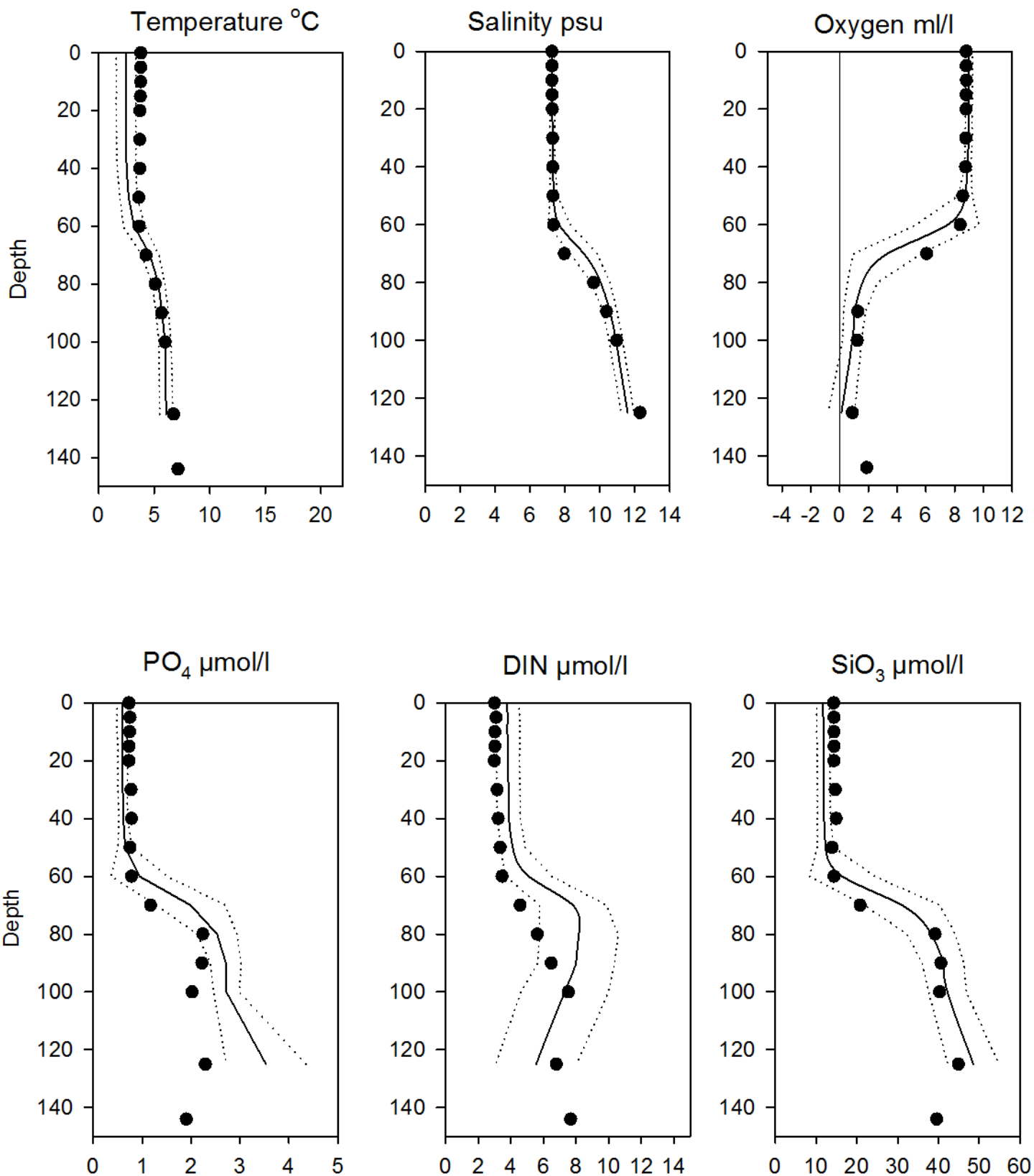


OXYGEN IN BOTTOM WATER (depth >125m)



Vertical profiles BY10 March

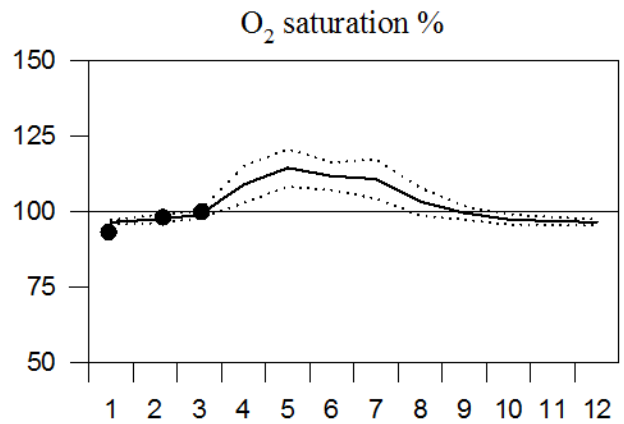
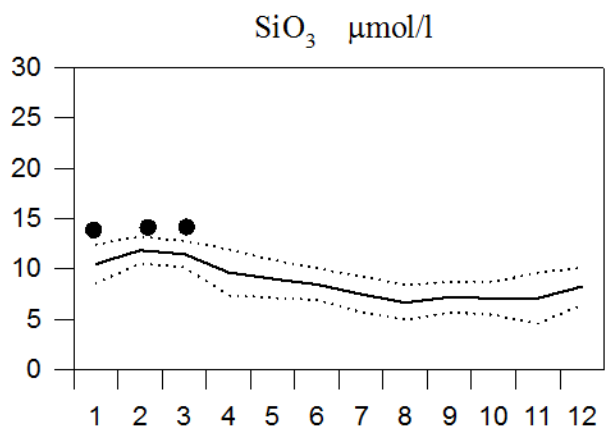
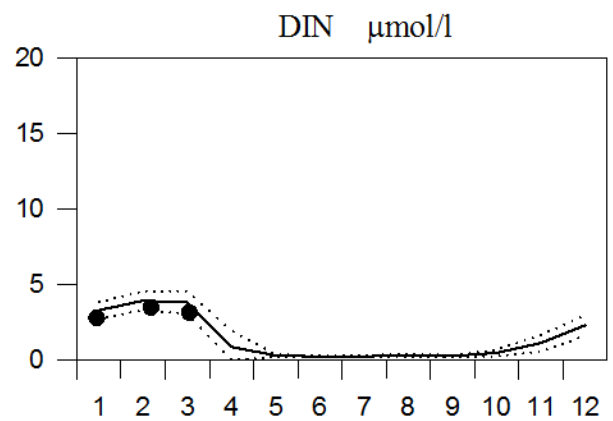
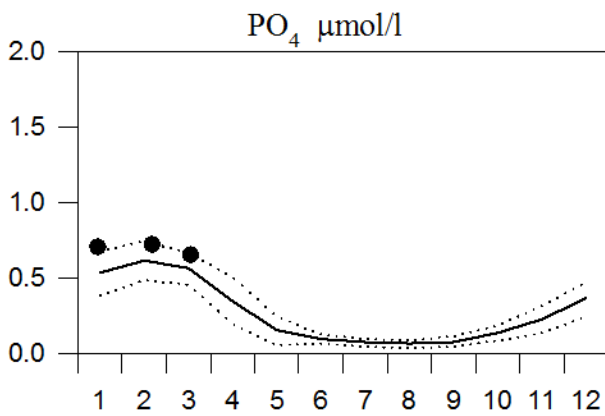
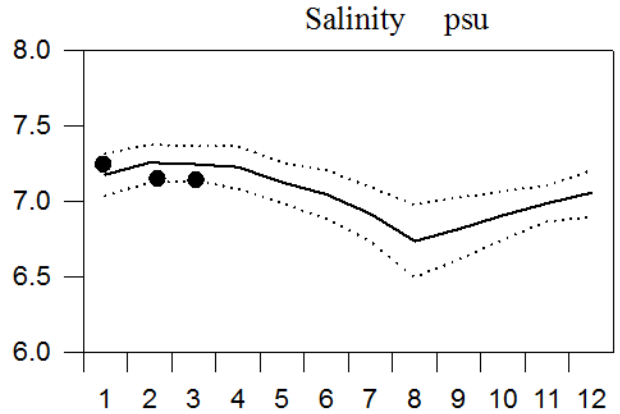
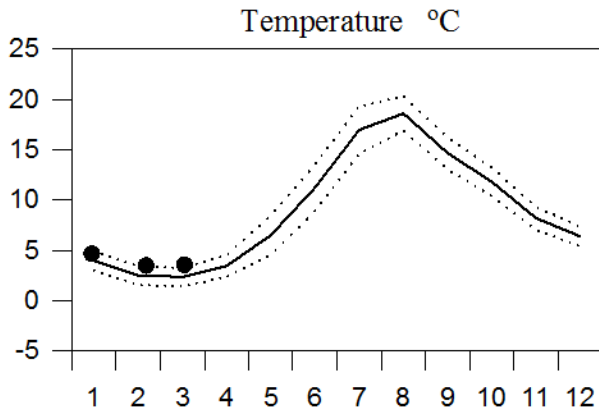
— Mean 1996-2010 St.Dev. ● 2015



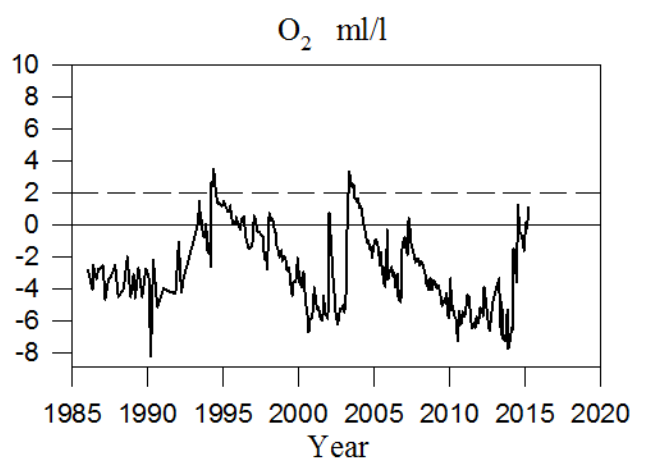
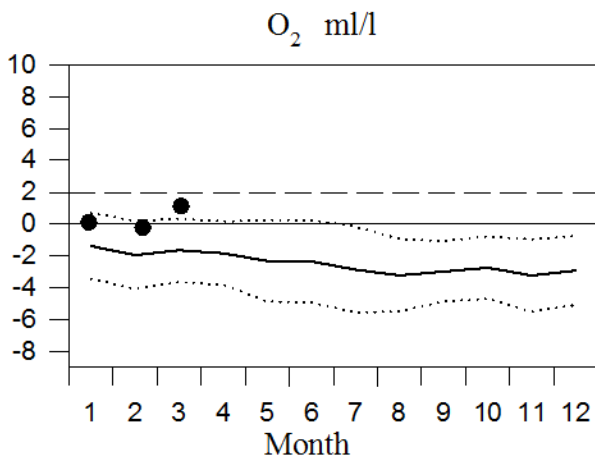
STATION BY15 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2015

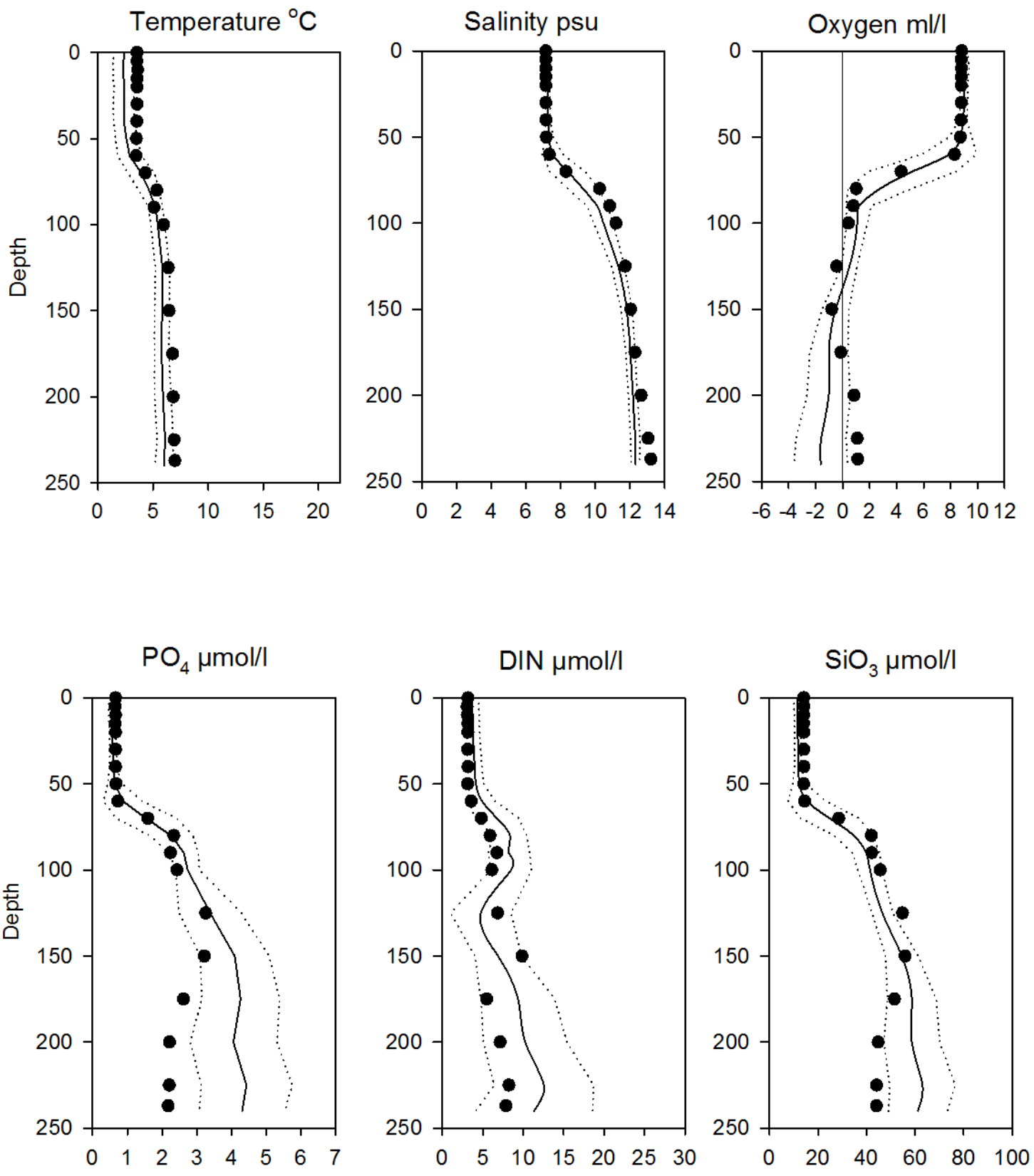


OXYGEN IN BOTTOM WATER (depth >225m)



Vertical profiles BY15 March

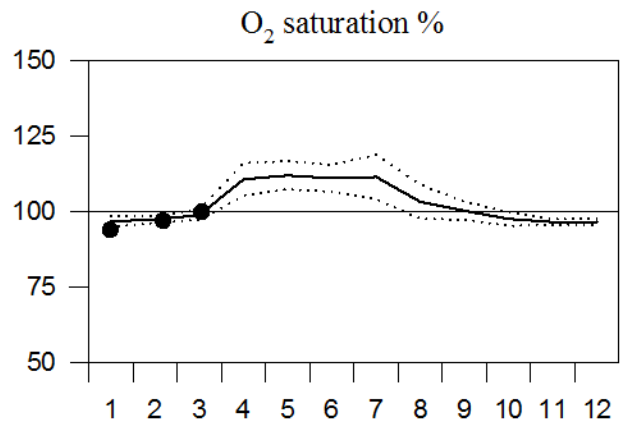
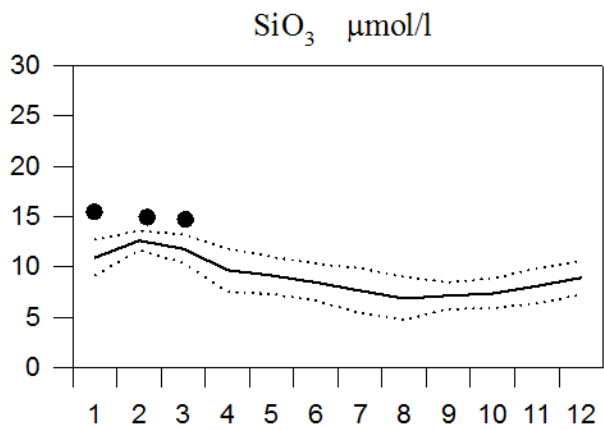
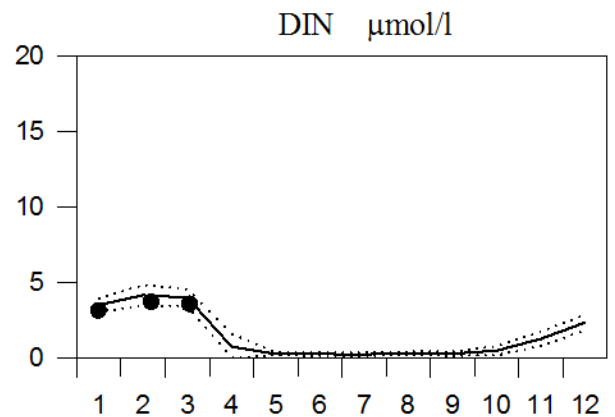
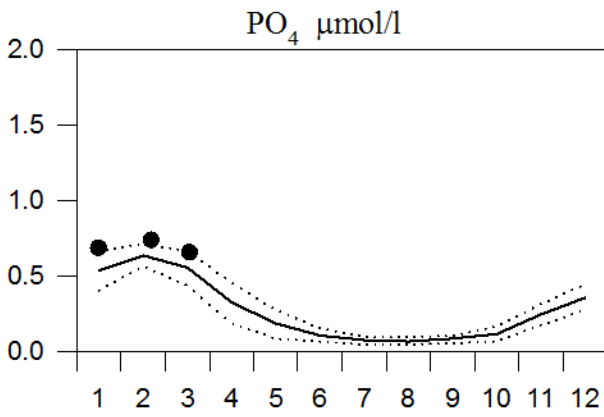
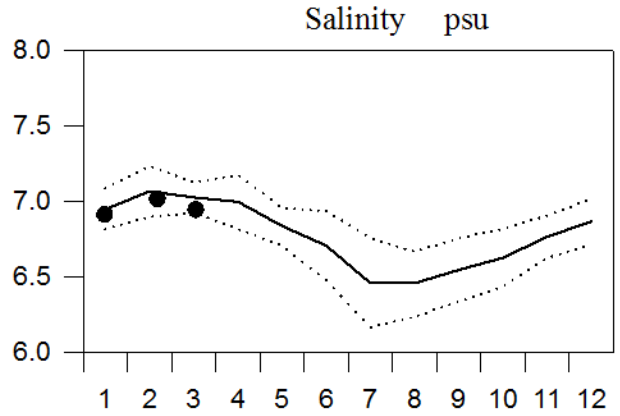
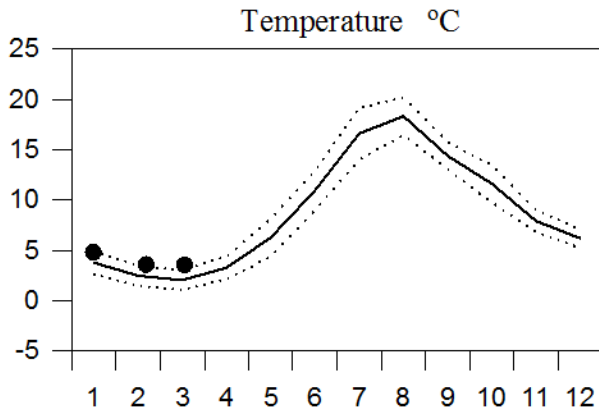
— Mean 1996-2010 St.Dev. ● 2015



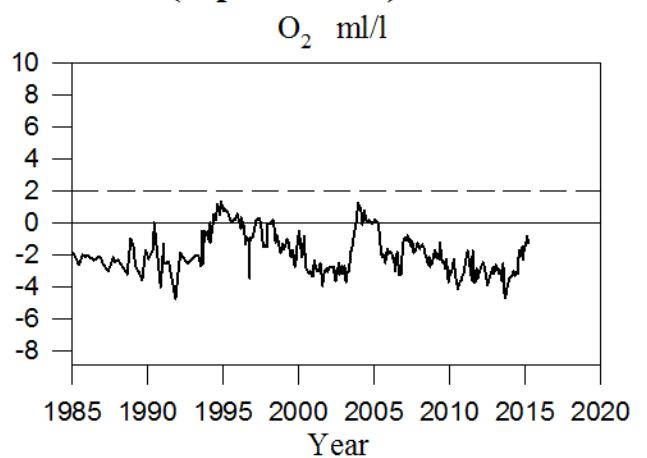
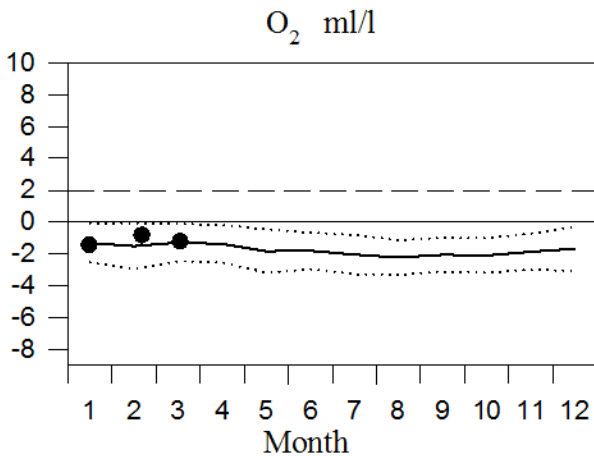
STATION BY20 SURFACE WATER

Annual Cycles

— Mean 1996-2010 ····· St.Dev. ● 2015

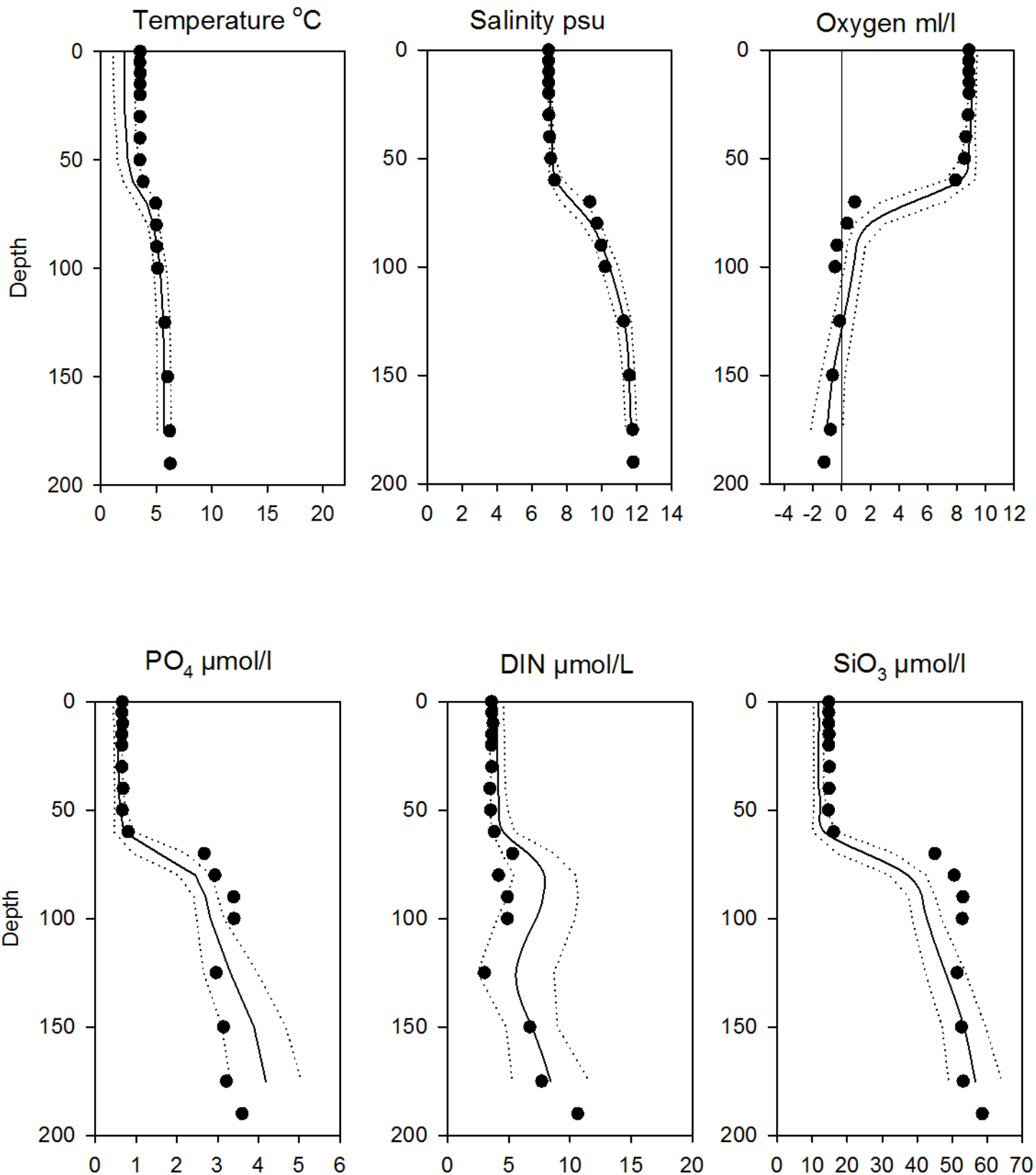


OXYGEN IN BOTTOM WATER (depth >175m)



Vertical profiles BY20 March

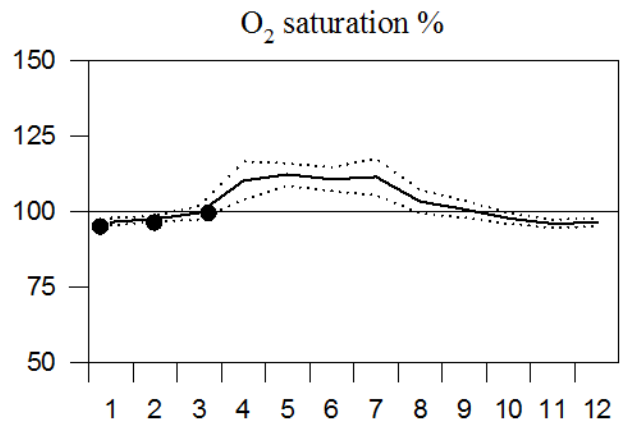
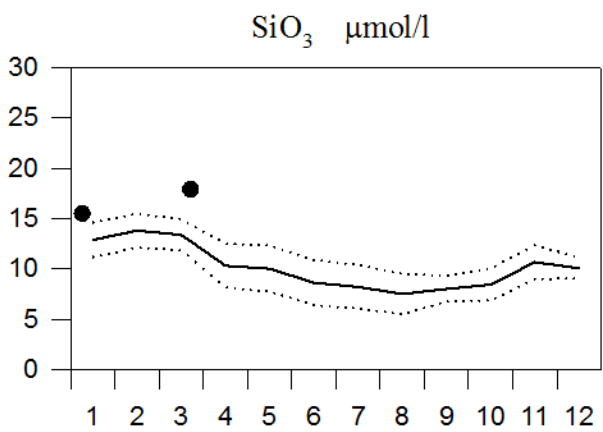
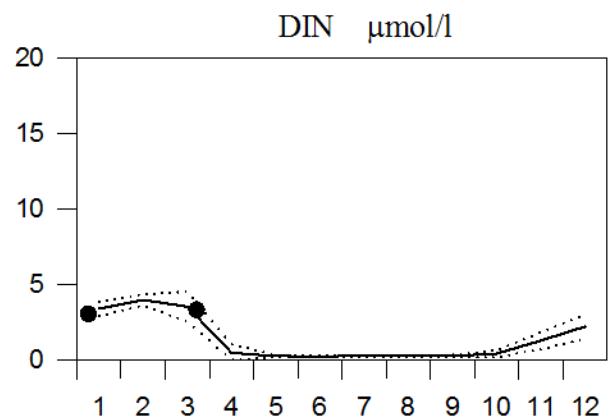
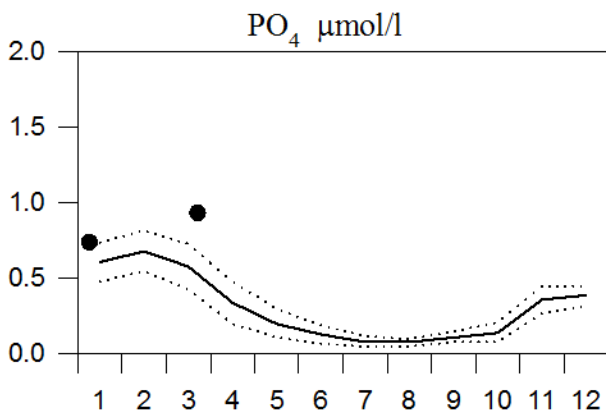
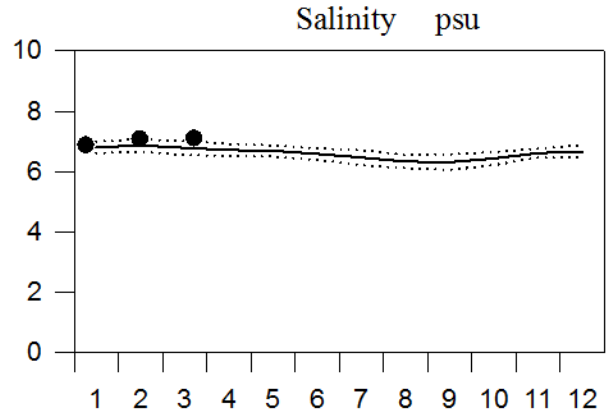
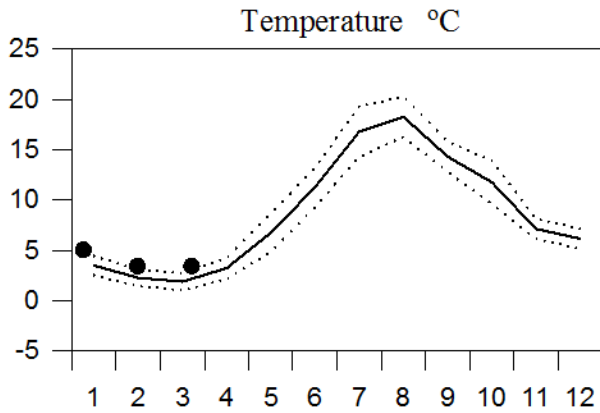
— Mean 1996-2010 St.Dev. ● 2015



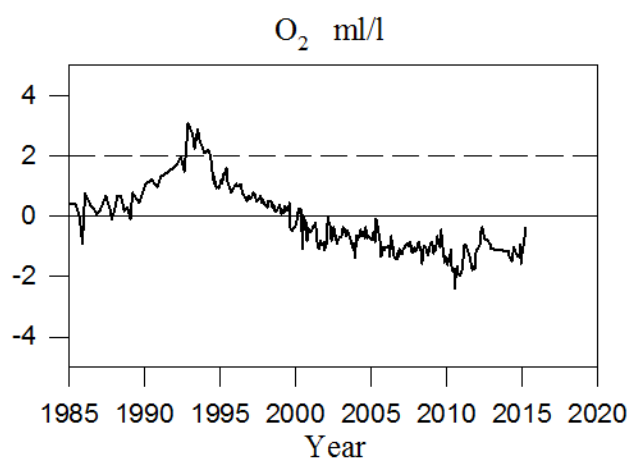
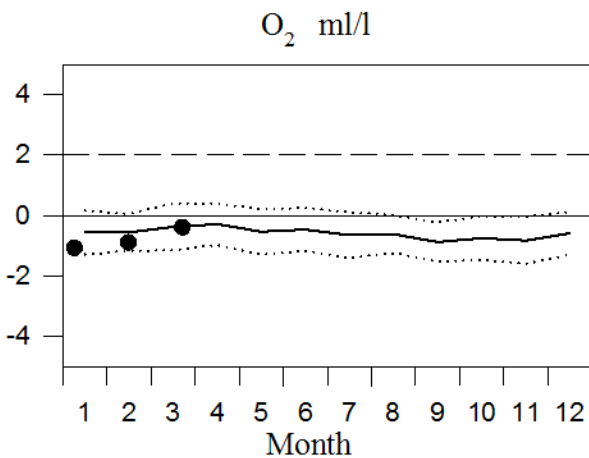
STATION BY32 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2015

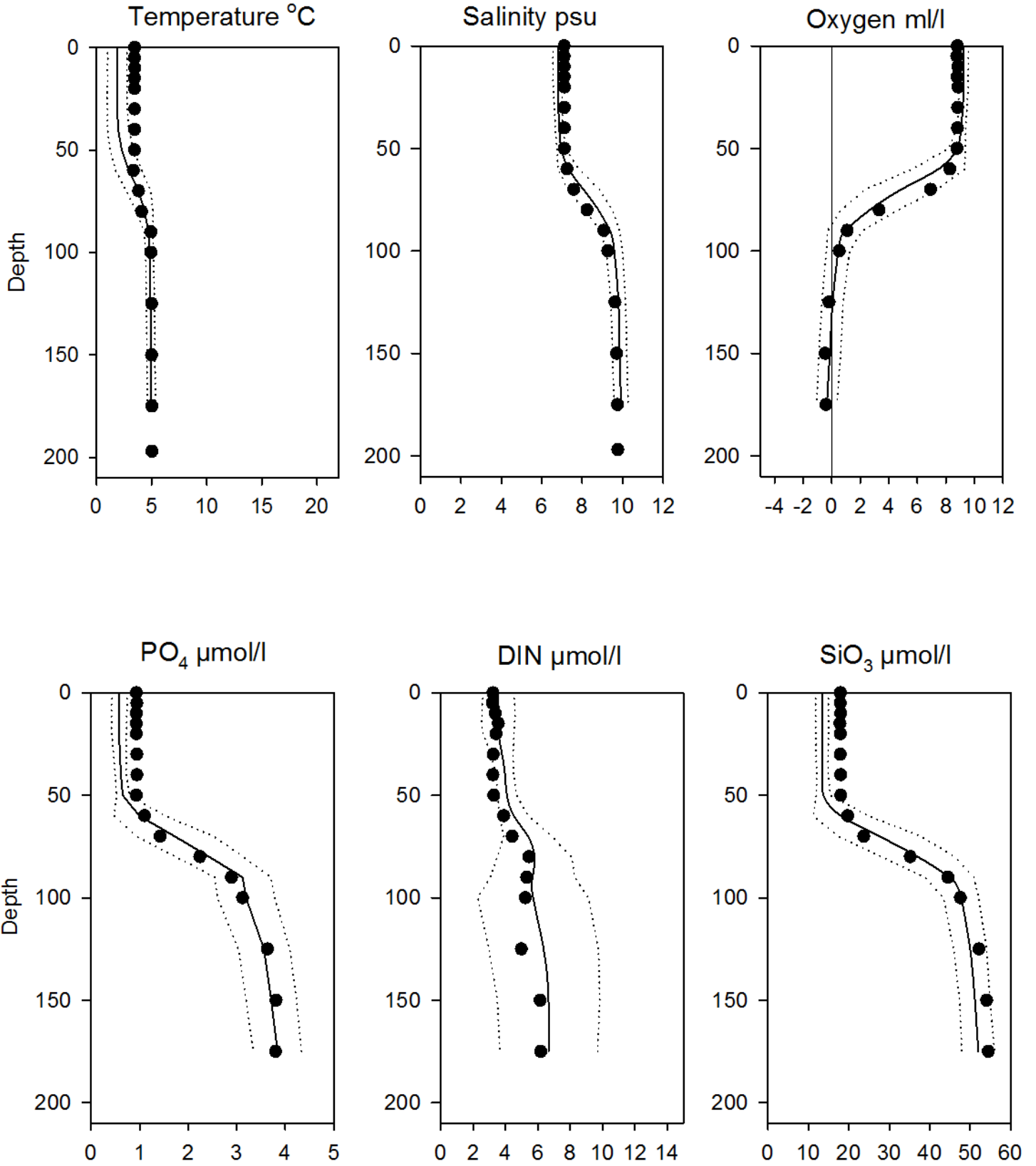


OXYGEN IN BOTTOM WATER (depth > 175m)



Vertical profiles BY32 March

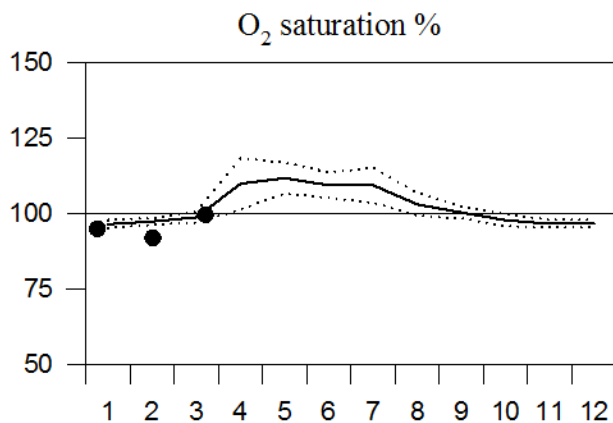
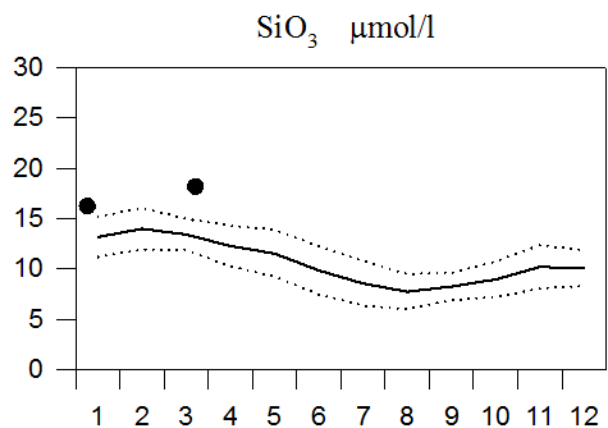
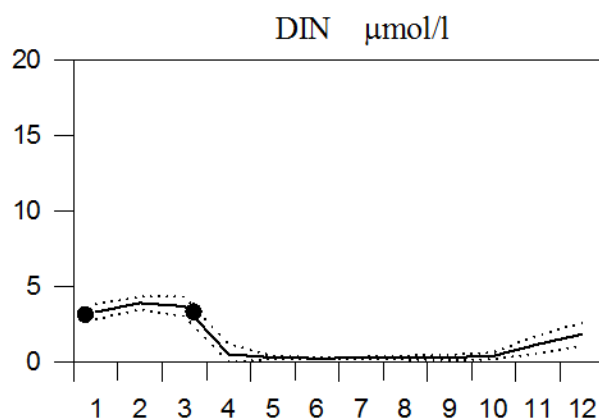
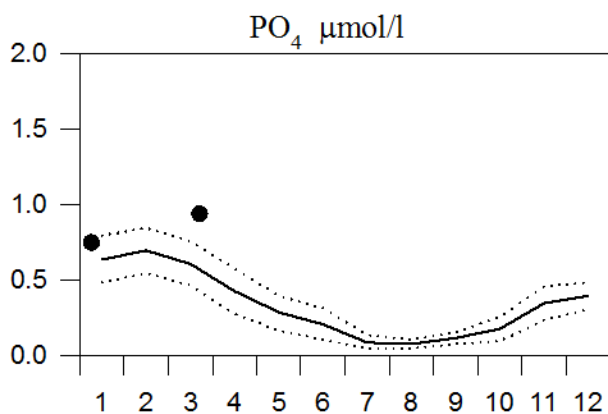
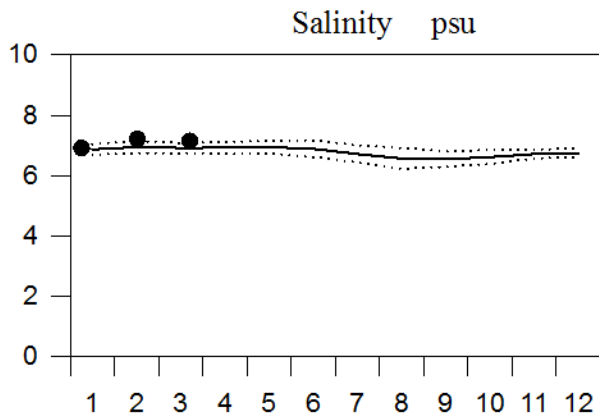
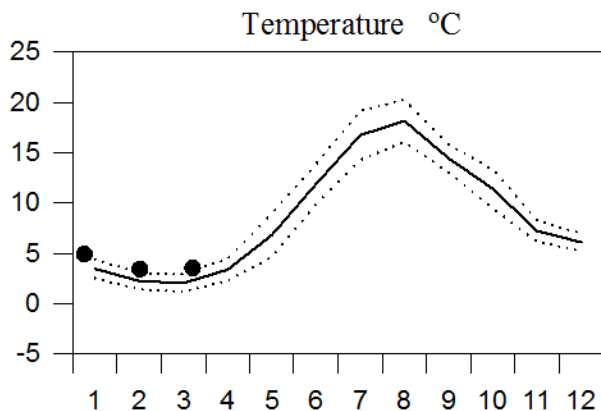
— Mean 1996-2010 St.Dev. ● 2015



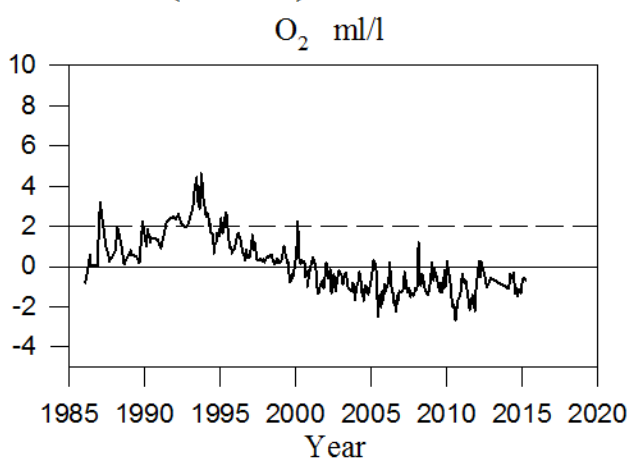
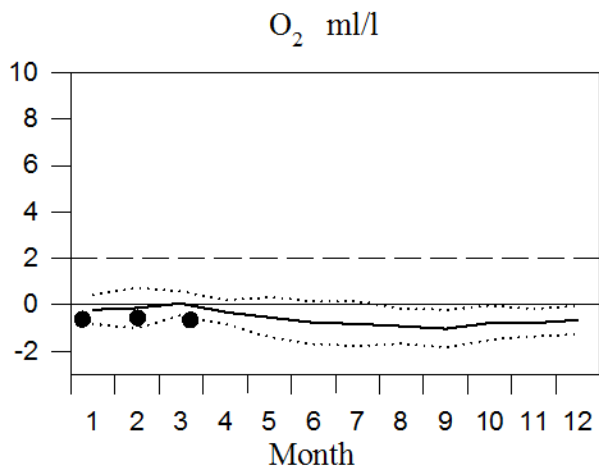
STATION BY38 SURFACE WATER

Annual Cycles

— Mean 1996-2010 ····· St.Dev. ● 2015

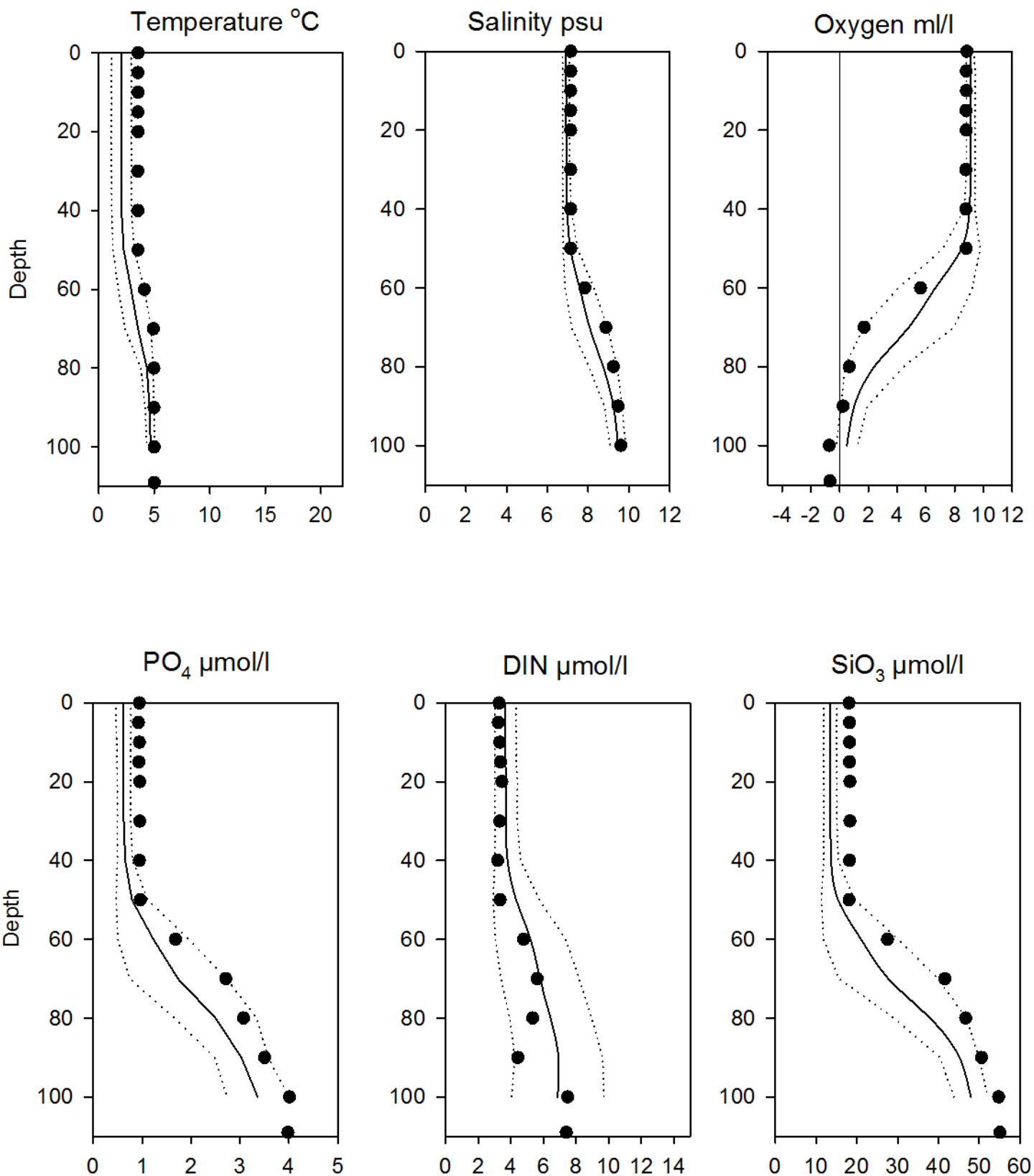


OXYGEN IN BOTTOM WATER (> 100m)



Vertical profiles BY38 March

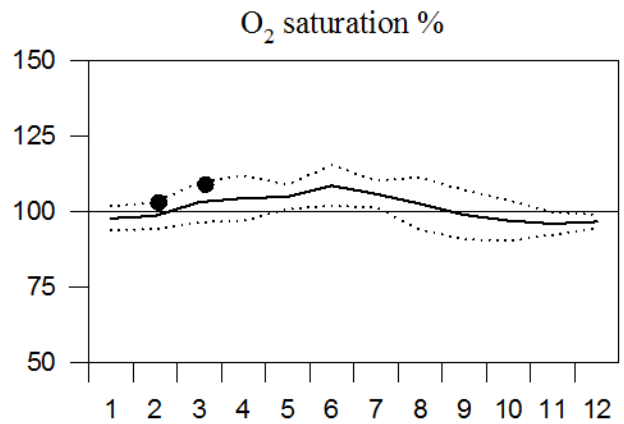
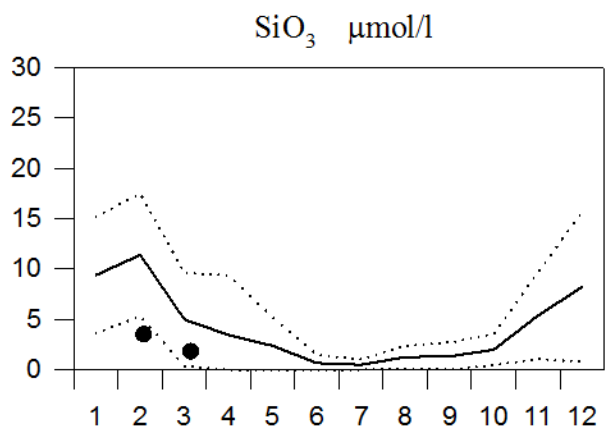
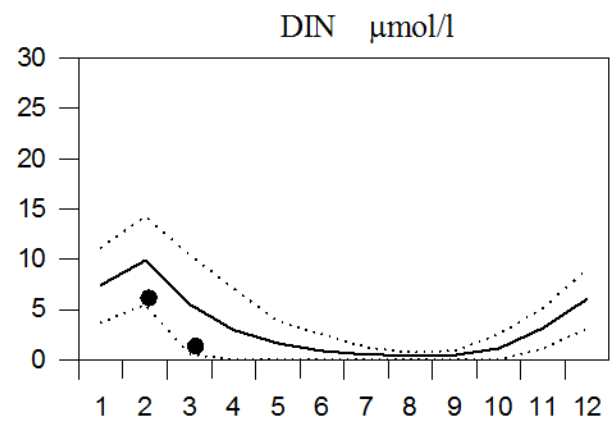
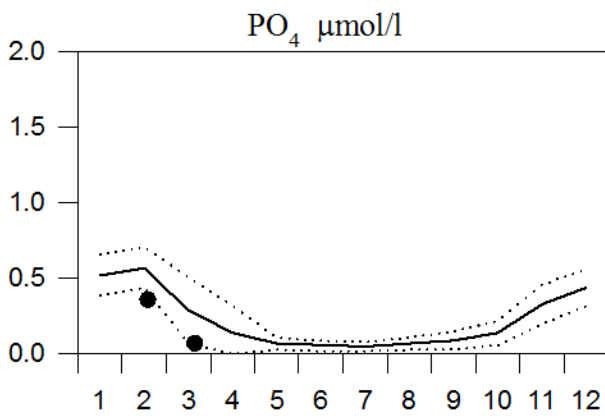
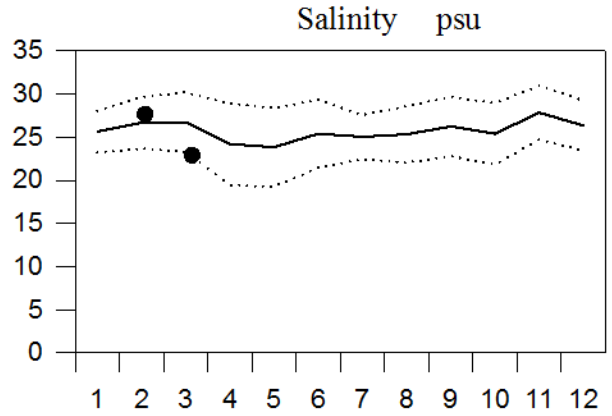
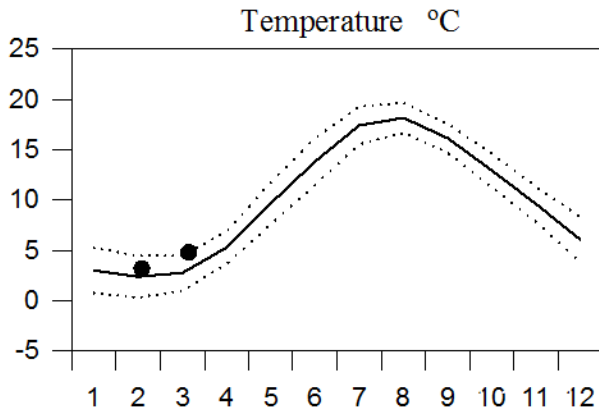
— Mean 1996-2010 St.Dev. ● 2015



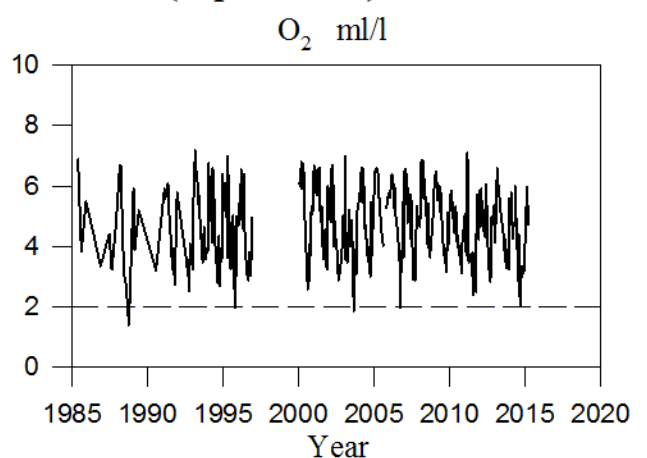
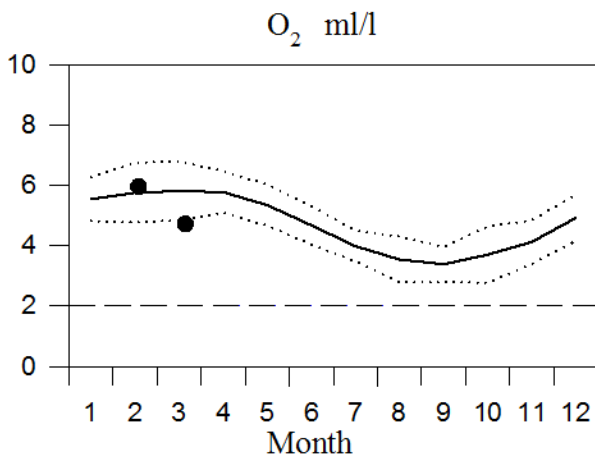
STATION SLÄGGÖ SURFACE WATER

Annual Cycles

— Mean 1996-2010 ····· St.Dev. ● 2015

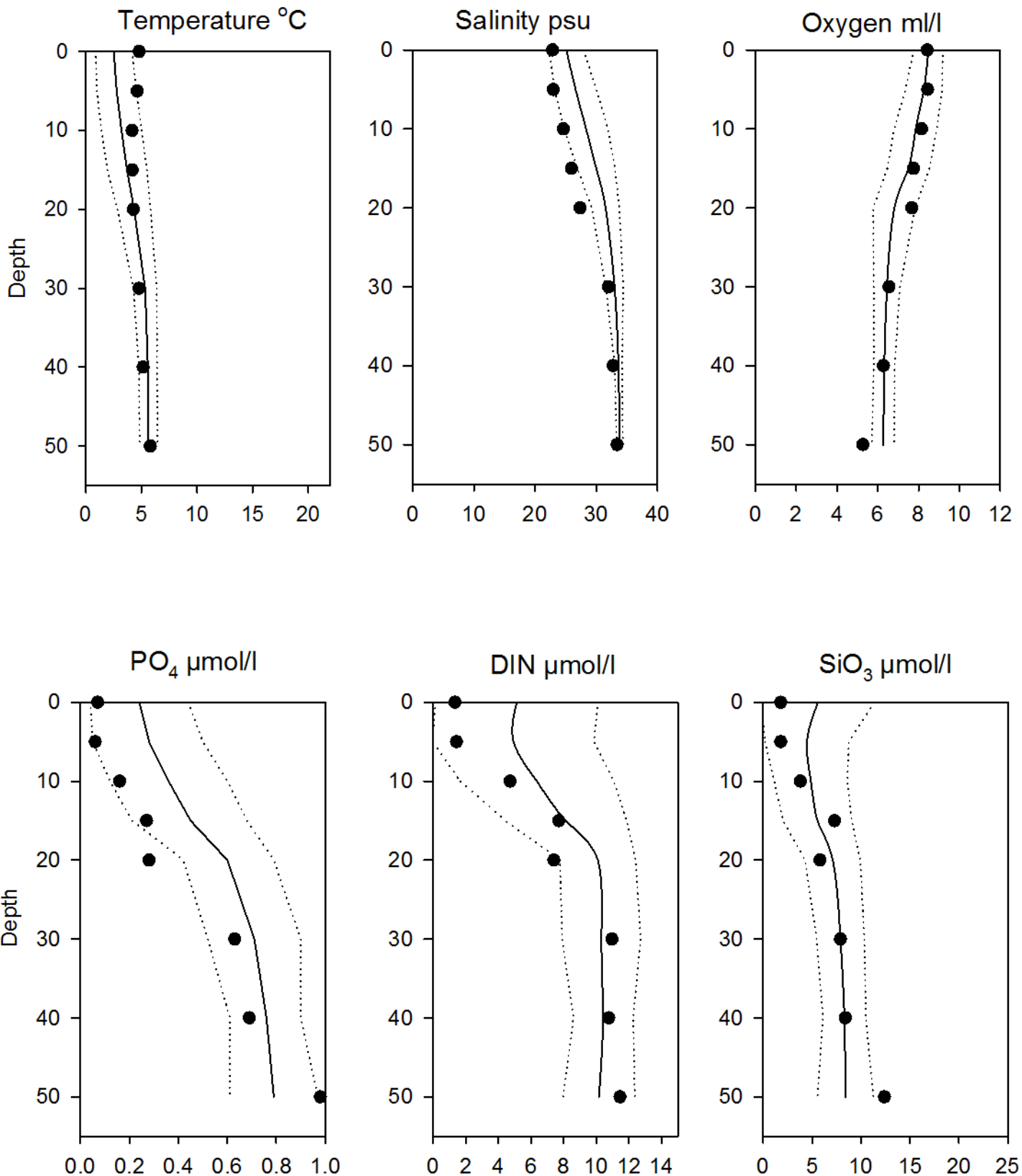


OXYGEN IN BOTTOM WATER (depth >50m)



Vertical profiles Släggö March

— Mean 1996-2010 St.Dev. ● 2015



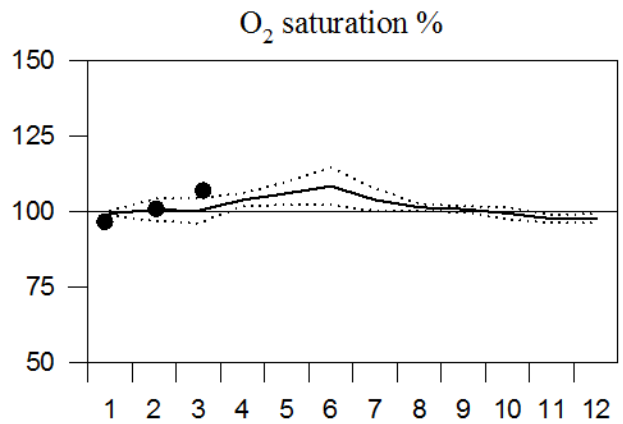
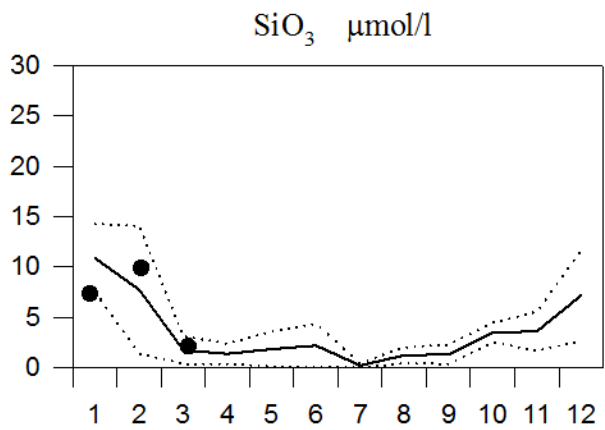
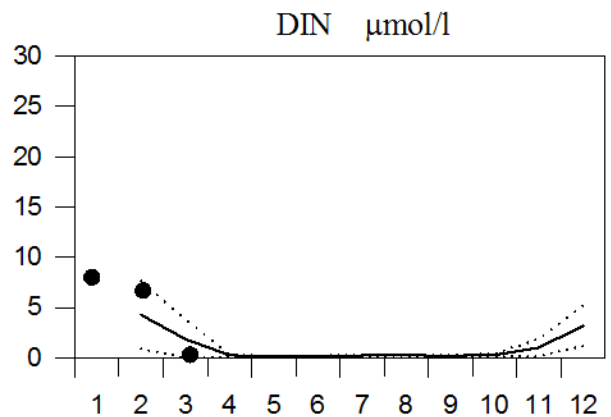
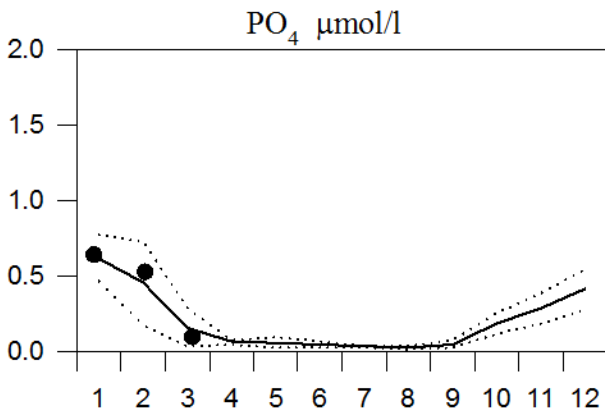
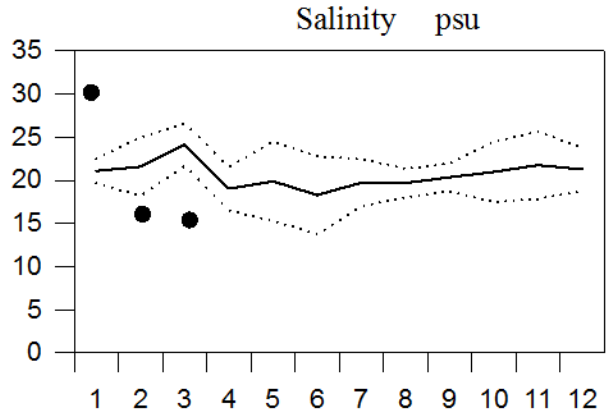
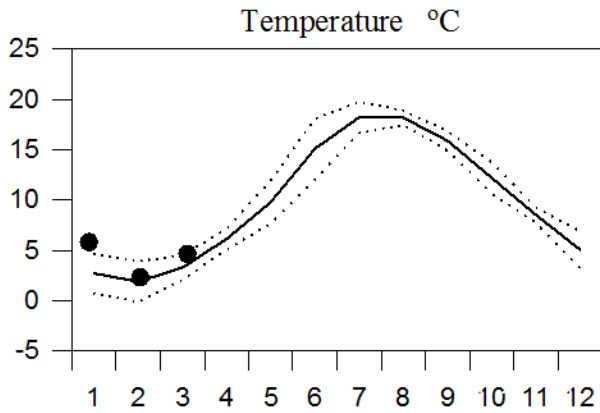
STATION N14 Falkenberg SURFACE WATER

Annual Cycles

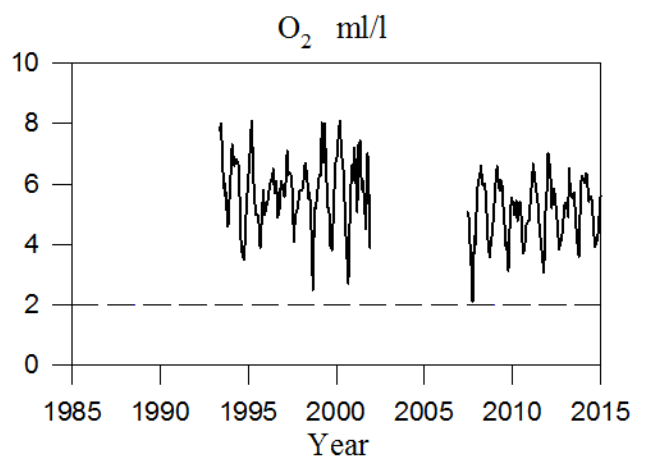
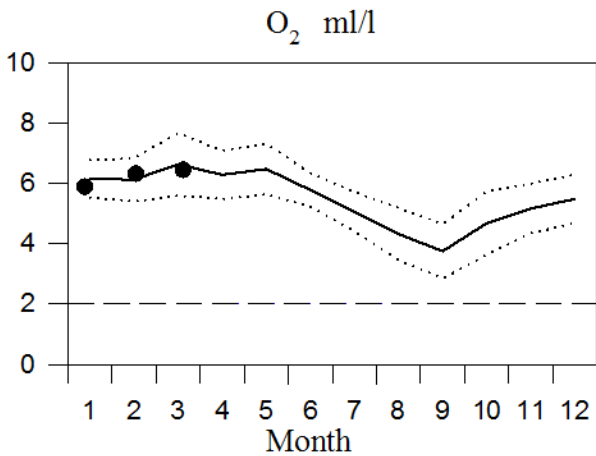
— Mean 2007-2010

..... St.Dev.

● 2015

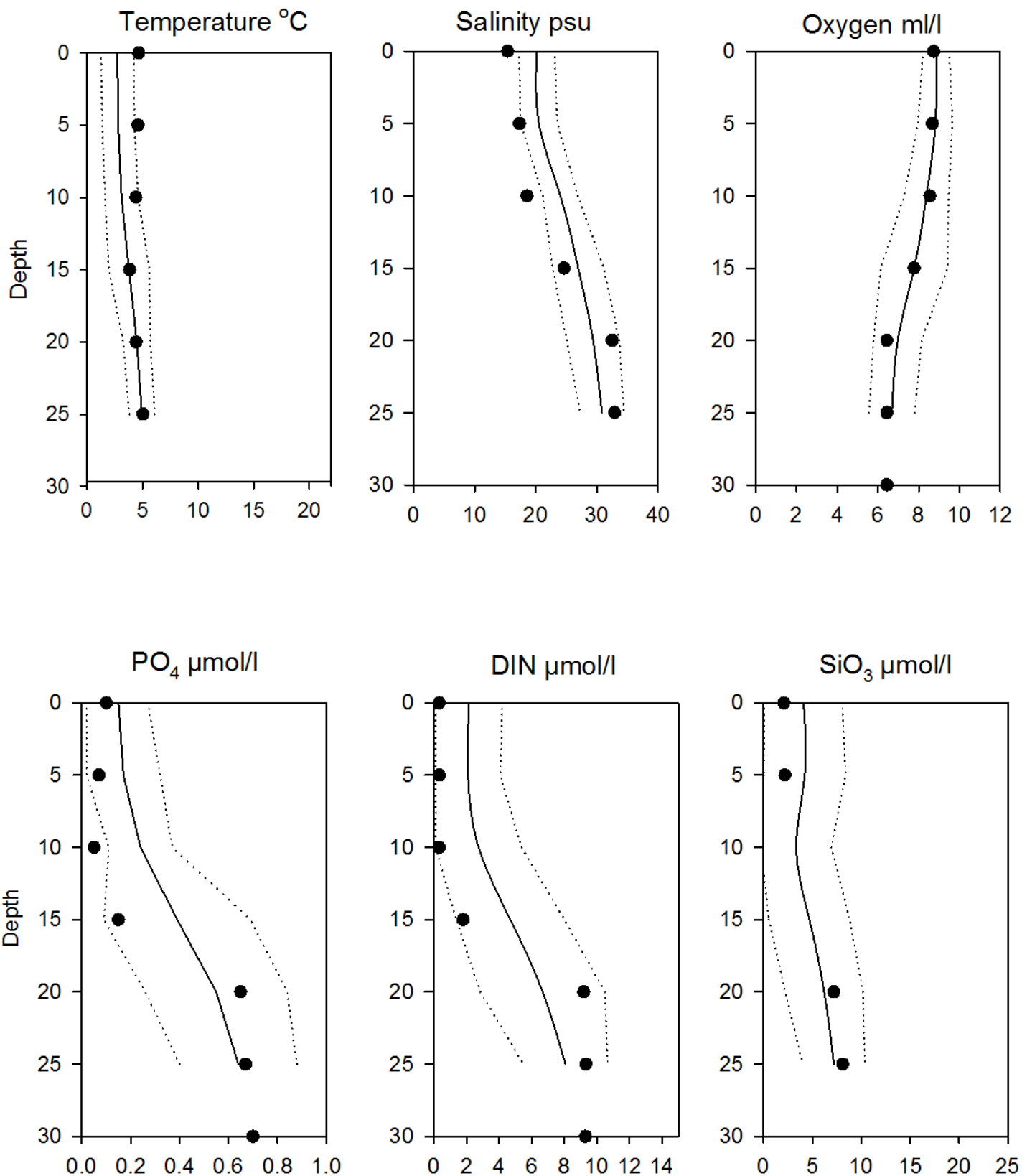


OXYGEN IN BOTTOM WATER (depth > 25m)



Vertical profiles N14 Falkenberg March

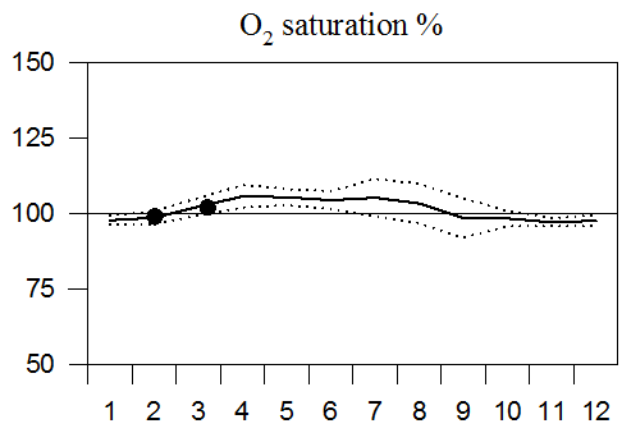
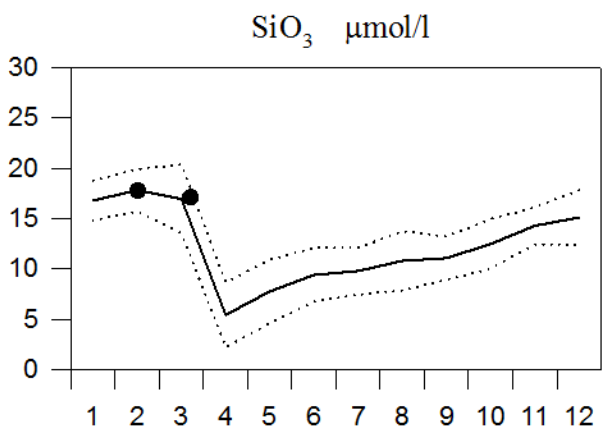
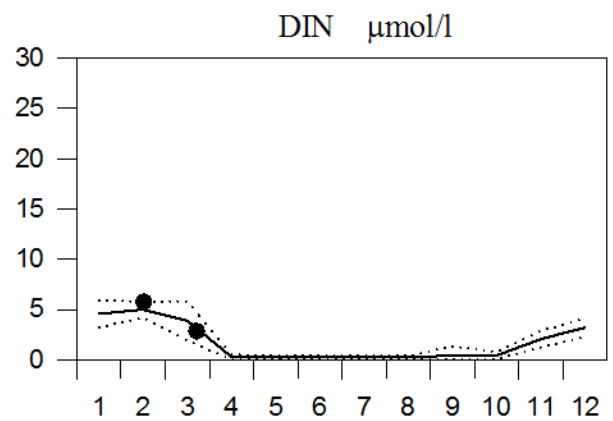
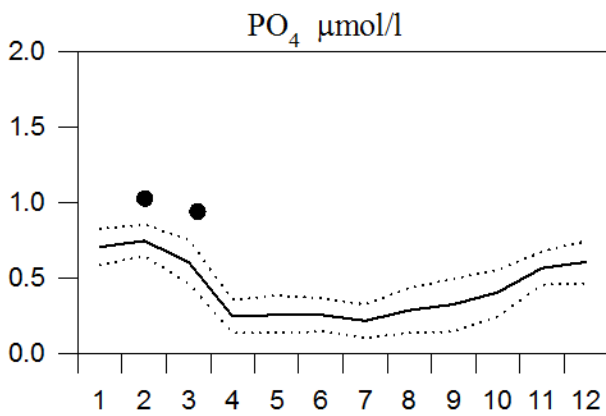
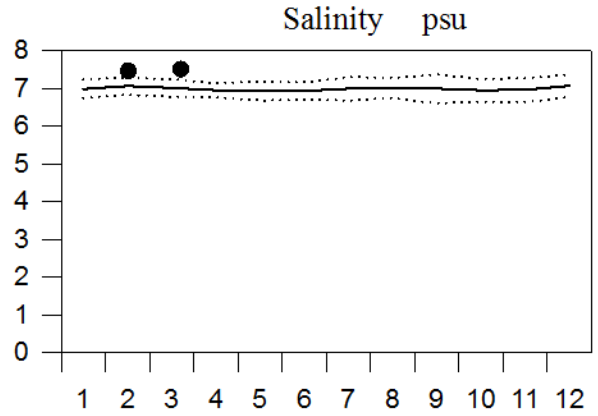
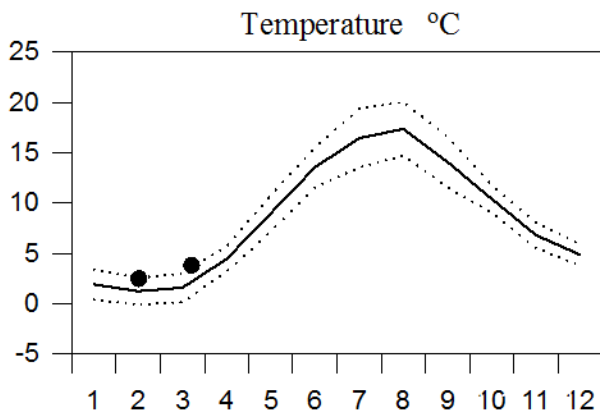
— Mean 1996-2010 St.Dev. ● 2015



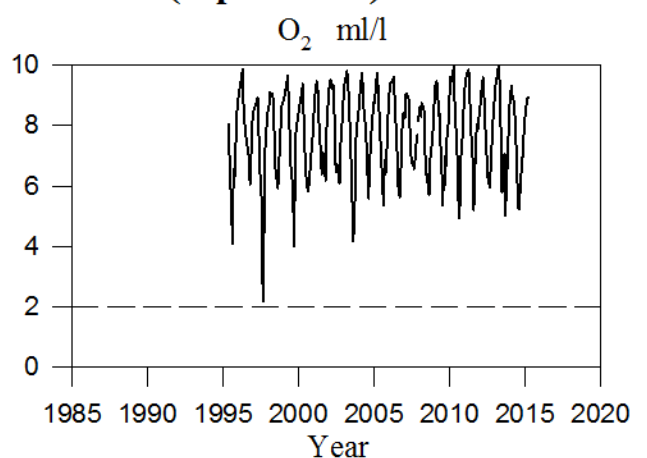
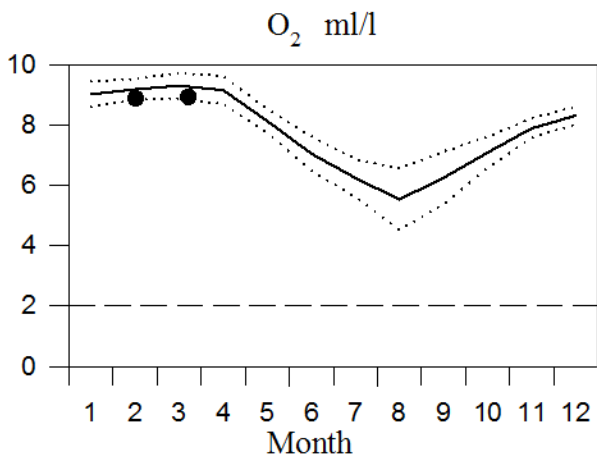
STATION REF M1V1 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2015



OXYGEN IN BOTTOM WATER (depth >15m)



Vertical profiles Ref M1V1 March

— Mean 1996-2010 St.Dev. ● 2015

