

Report from the SMHI monitoring cruise with R/V Aranda



© Ilkka Lastumäki
http://itameri.kuvat.fi

Survey period: 2014-09-01 - 2014-09-08
Survey area: Skagerrak, Kattegat 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 and the Baltic Proper. Data presented in this report have been subject to preliminary quality control procedures only.

The water temperature in the surface layer was above normal in Skagerrak and the Baltic Proper. The thermocline in Skagerrak was found at 75-100 meters which is significantly deeper than normal. Nutrients in the surface layer showed normal concentrations except for silicate that in the Western and Eastern Gotland Basin was elevated.

The western parts of the Arkona Basin were oxygenated while the eastern parts suffered from acute hypoxia from depth exceeding 35 meters. Oxygen conditions in the Eastern Gotland Basin had deteriorated in the central parts where anoxia was found from 125 meters and acute hypoxia from 80 meters depth. Though, in the southern parts of the Eastern Gotland Basin oxygenated bottom water was registered which indicate that a pulse of new bottom water had reached the basin. In the Western Gotland Basin anoxic condition was found from 75 meters and anoxia from 55-65 meters. Also at Släggö on the west coast of Sweden, acute hypoxia was found in the bottom water.

The next cruise will begin on the 20th of October and will cover Skagerrak, Kattegat and the Baltic Proper.

PRELIMINARY RESULTS

The cruise was performed onboard the Finnish research vessel Aranda and began in Helsinki on 1st September and ended in Hango on the 8th. Winds during the expedition were weak to moderate, mainly from northeast or south. Air temperature varied between 15-18°C.

To investigate the oxygen situation in the south eastern Baltic Proper two extra stations were taken in this area. Water samples were also collected to evaluate a new biomolecule method for phytoplankton analysis. The samples will be analysed using both microscope and by sequencing rDNA. The sampling, which is a collaboration between SMHI and KTH Science for Life Laboratory started during the summer 2014 and is planned to continue for about a year. During the cruise scientists from Umeå and Stockholm University also collected water samples for analysis of methyl-mercury and total mercury. The aim was to investigate the water concentrations and the bioaccumulation of mercury in the Baltic Sea.

The Skagerrak

The thermocline was found at 70-100 meters depth and the temperature in the upper layer was 15-17°C, which is both deeper and warmer than normal. The halocline was unevenly developed in the area and was found at 5-20 meters depth. The salinity in the whole water column was normal for the season.

In the surface layer all nutrients showed low concentrations which is typical for the season.

Phosphate varied from 0.04-0.12 µmol/l, silicate from 0.1-1.6 µmol/l and the concentration of inorganic nitrogen (sum of nitrite + nitrate) was below the detection limit (<0.10 µmol/l).

The lowest oxygen concentration, 2.0 ml/l, which also is the limit for acute hypoxia, was found in the bottom water at the station Släggö, in the outer parts of the Gullmars fjord.

The Kattegat and the Sound

The sea surface temperature was around 17°C in the whole area, which is normal for the season.

The thermocline was found at 30-40 meters depth in the central parts and about 10-15 meters depth in the Sound and along the Swedish coast. Salinity in the surface water was normal or slightly lower than normal and varied between 15.8-22.1 psu in Kattegat and about 8.5 psu in the Sound and the halocline was found at 10-20 meters depth.

Surface concentrations of nutrients was normal for the season except for silicate at Anholt E which was much higher than normal, 5.7 µmol/l. In the remaining areas silicate concentrations varied between 0.3-1.3 µmol/l and in the Sound 9.3 µmol/l. The phosphate concentration varied between 0.05-0.13 µmol/l. The sum of nitrite+nitrate was below the detection limit (<0.10 µmol/l).

Bottom water oxygen concentrations were normal and varied between 2.6-3.9 ml/l, lowest in the Sound.

The Baltic Proper

The water temperatures were above normal in the whole area, varying from 15.6 to 17.5°C and the thermocline was found at 20-30 meters depth. The salinity in the surface layer was normal for the season and varied between 6.4 and 8.5 psu. The halocline was found at depths between 60 and 70 meters in the western and eastern Gotland Basins, while it was located shallower, between 35 and 50 meters in the southern parts. All nutrients in the surface layer showed normal values, except for silicate which was elevated in the western and eastern Gotland Basin, 9.3-11.9 µmol/l. In the remaining areas the silicate concentration varied between 7.2-9.0 µmol/l. Concentrations of phosphate was in the interval 0.06-0.18 µmol/l and inorganic nitrogen (nitrite + nitrate) was below detection limit in the whole investigated area.



The oxygen concentration in the western Arkona Basin was high, 4.25 ml/l, due to an inflow through the Sound of about 25 km³ that occurred during mid-August. Though, in the eastern parts, oxygen concentration at the bottom was below the limit for acute hypoxia from 35 meters to the bottom. In the Bornholm Basin and Hanö Bight acute hypoxia was found at depths exceeding 60-65 meters.

At the Gotland deep (BY15), where a first pulse of oxygenated water was observed in Juli-August, hydrogen sulphide was again found from 125 meters depth and acute hypoxia was found from 80 meters depth. In the southeast parts of the Baltic Proper acute hypoxia was found from 65-70 meters depth but no hydrogen sulphide was found in the bottom water at BY10. At an extra sampling station further south, oxygen concentration of 3.0 ml/l was found close to the bottom and up to 100 meters. Hence, a second pulse of oxygenated bottom water has reached this basin.

The pulses of oxygenated deep water that has been observed in the southeastern Baltic Proper and in the eastern Gotland Basin during the summer can originate from two inflows that were observed through the Sound in February and March on each ~30km³.

In the western Gotland Basin the oxygen situation was severe as acute hypoxia was found from depths exceeding 55-65 meters and hydrogen sulphide from 75 meters depths.

PARTICIPANTS

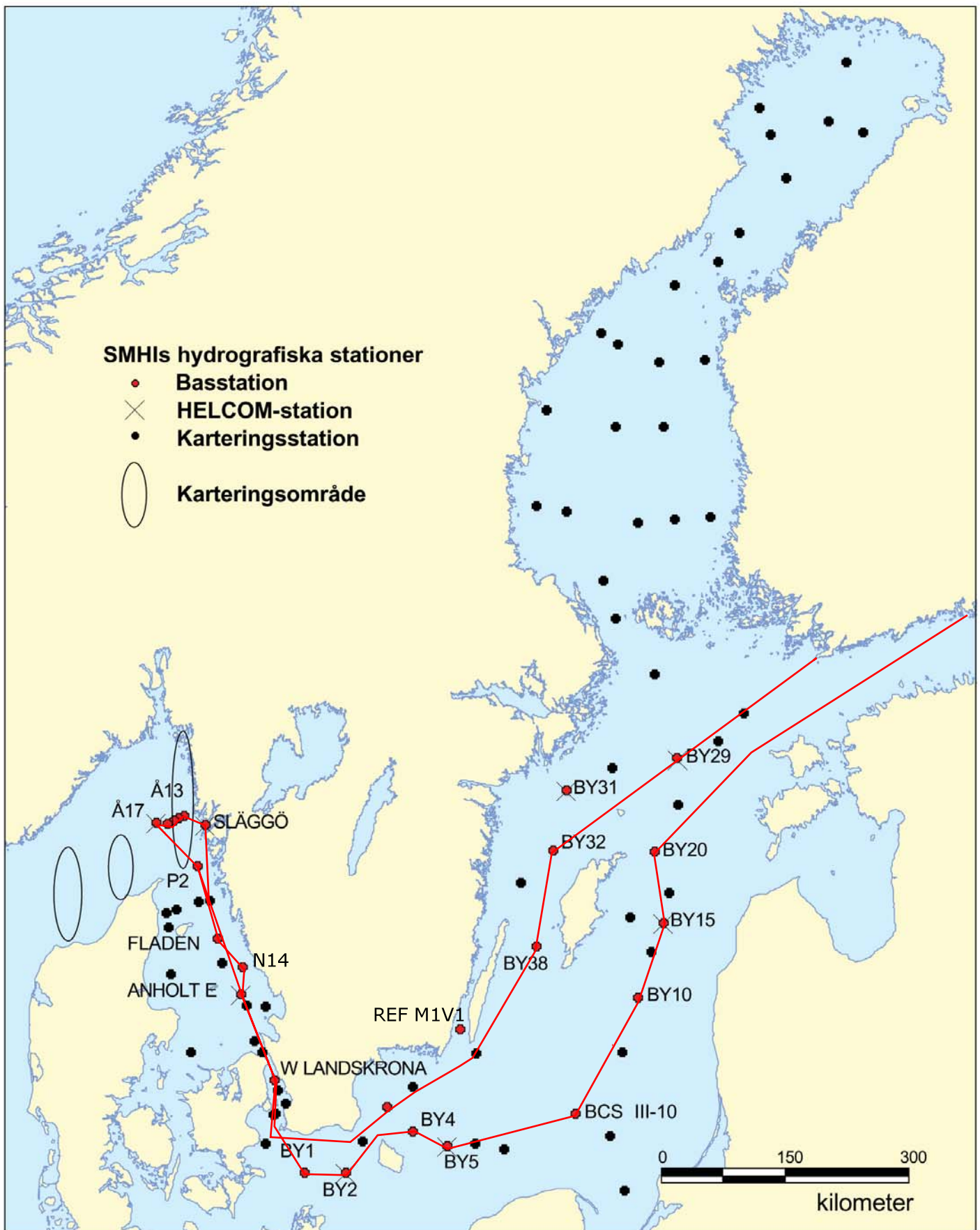
Name		Institute
Martin Hansson	Cruise leader	SMHI
Sari Sipilä (Helsinki – Lysekil)		SMHI
Karin Wesslander		SMHI
Sara Johansson		SMHI
Daniel Bergman-Sjöstrand		SMHI
Arne Svensson (Lysekil – Hanko)		SMHI
Erik Björn (Helsinki -Lysekil)		Umeå University
Anna Sorensen		Stockholm University

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: 20140901-20140907
Series:



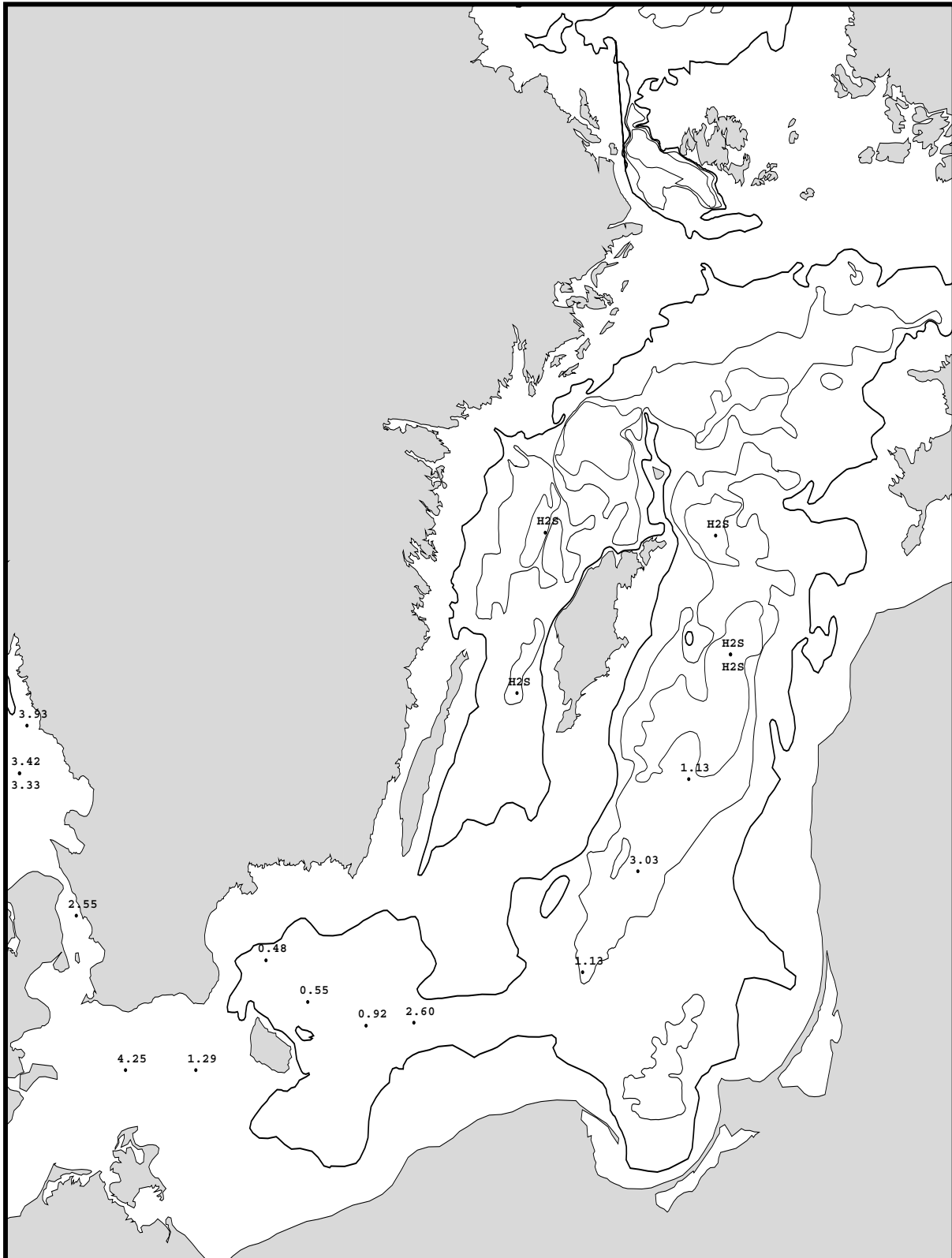
Bottom water oxygen concentration (ml/l)

Country: Finland
Ship : Aranda
Date : 20140902-20140907
Series : 0552-0577



Bottom water oxygen concentration (ml/l)

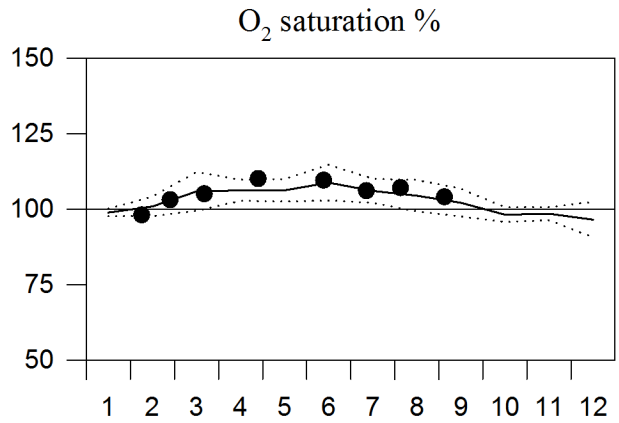
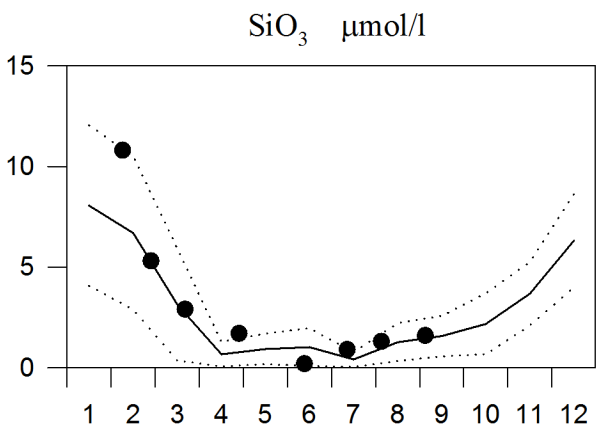
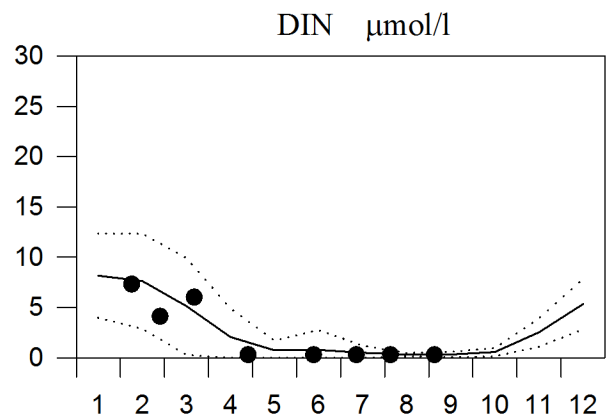
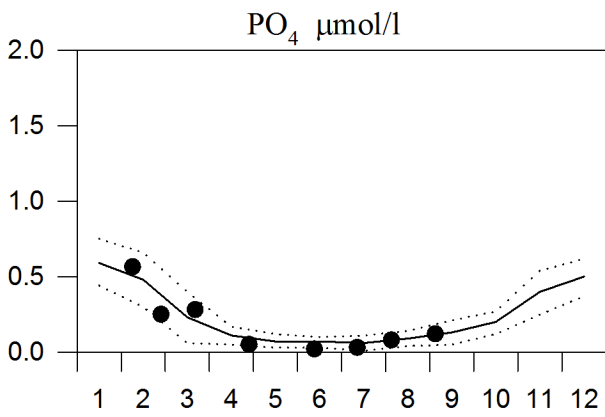
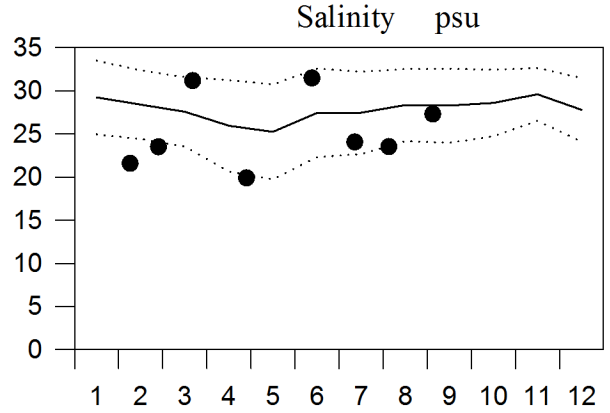
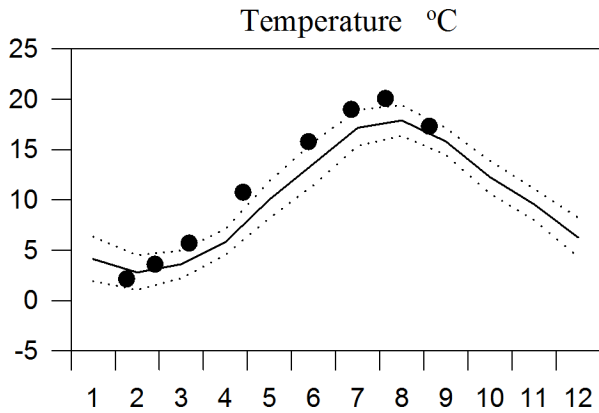
Country: Finland
Ship : Aranda
Date : 20140902-20140907
Series : 0552-0577



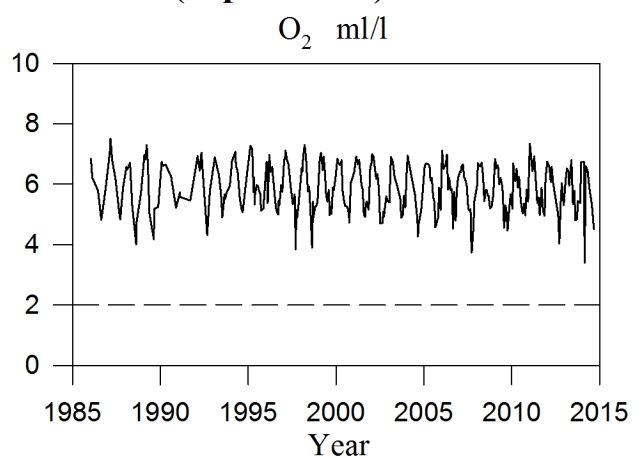
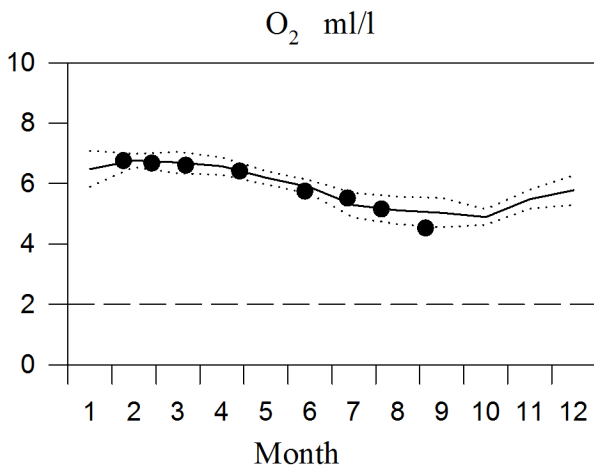
STATION P2 SURFACE WATER

Annual Cycles

— Mean 1996-2010 ····· St.Dev. ● 2014

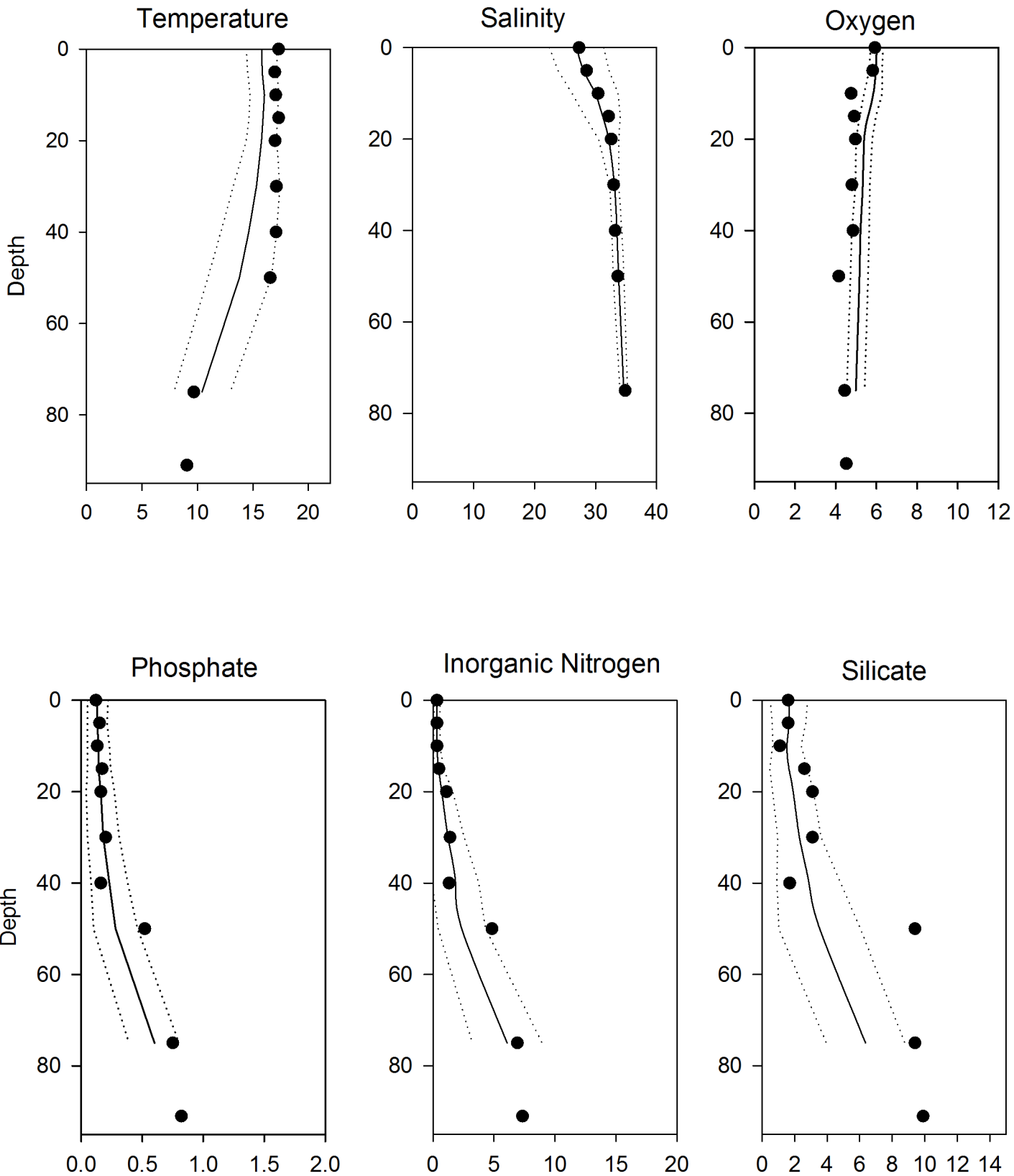


OXYGEN IN BOTTOM WATER (depth >75m)



Vertical profiles P2 September

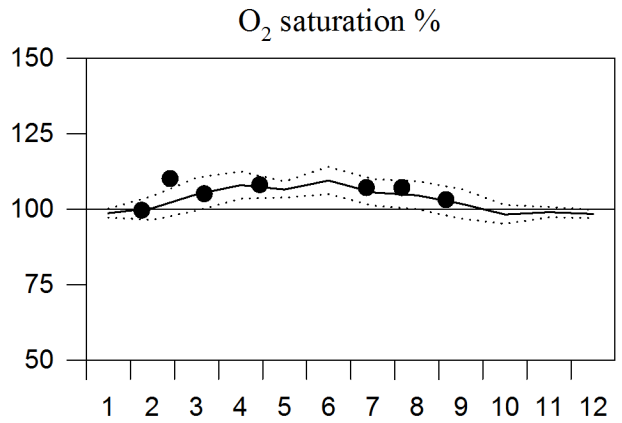
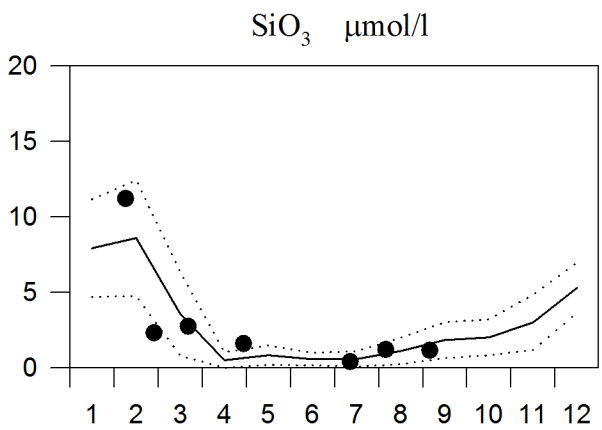
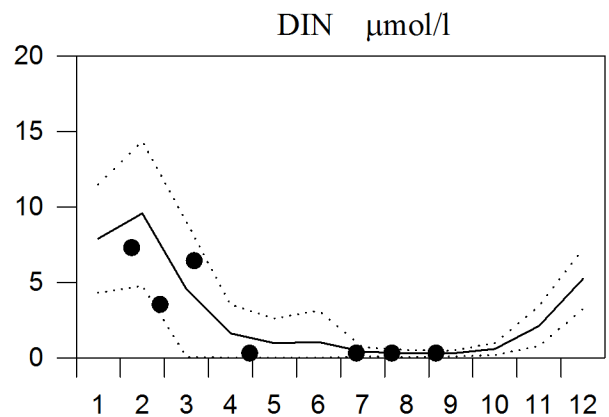
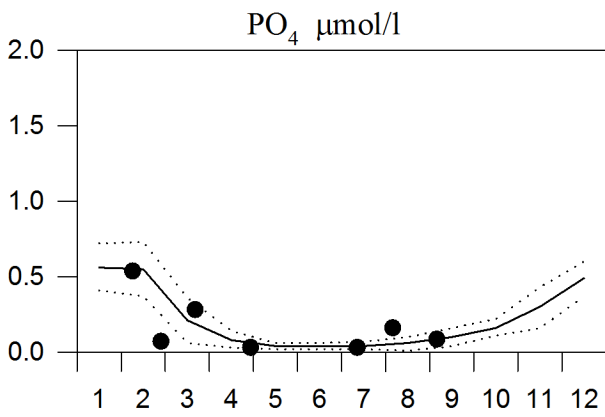
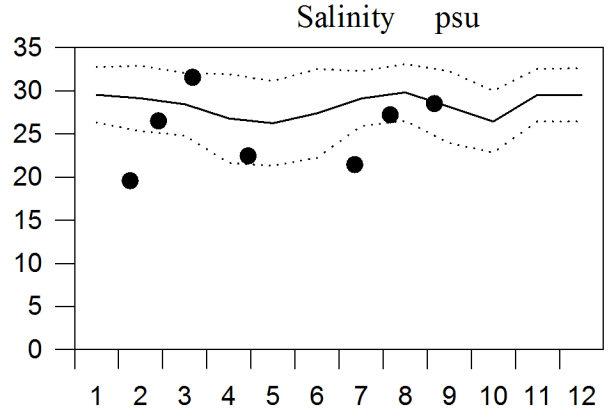
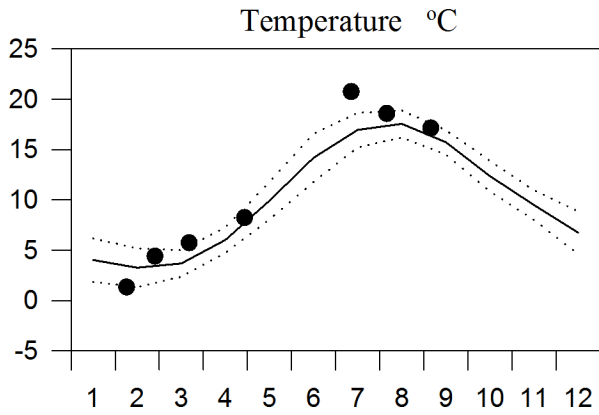
— Mean 1996-2010 St.Dev. ● 2014



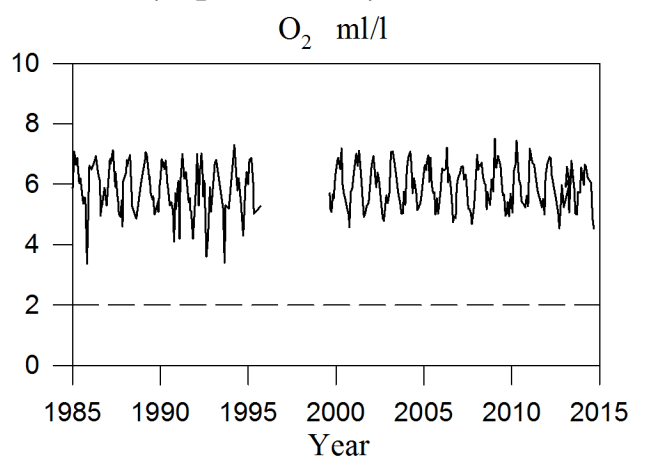
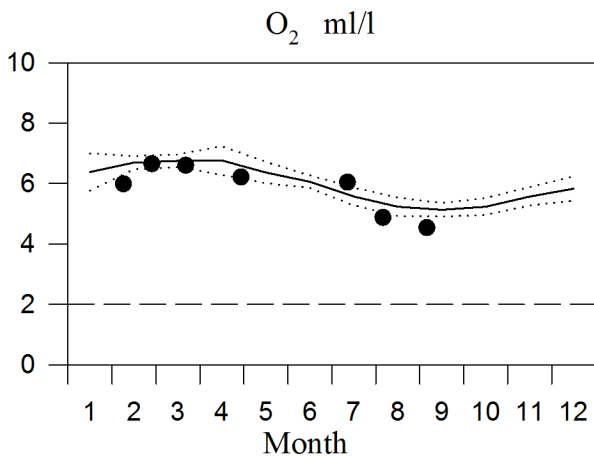
STATION Å13 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2014



OXYGEN IN BOTTOM WATER (depth >=75m)



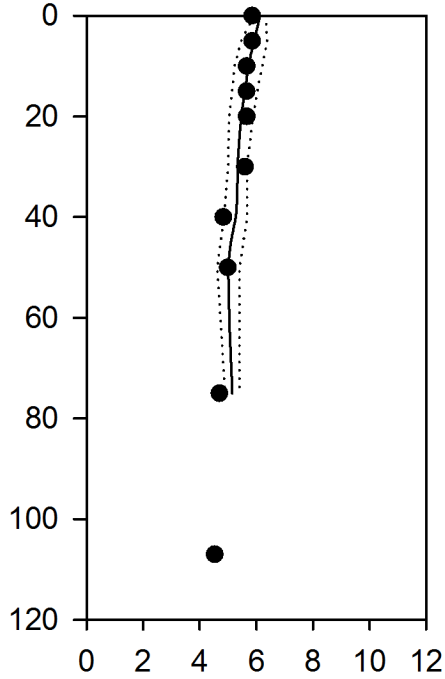
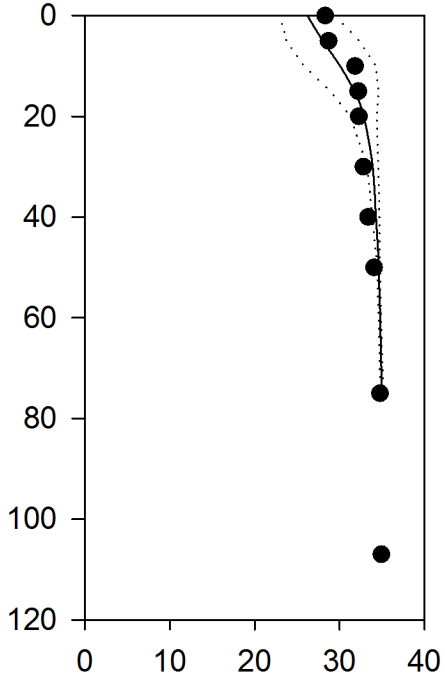
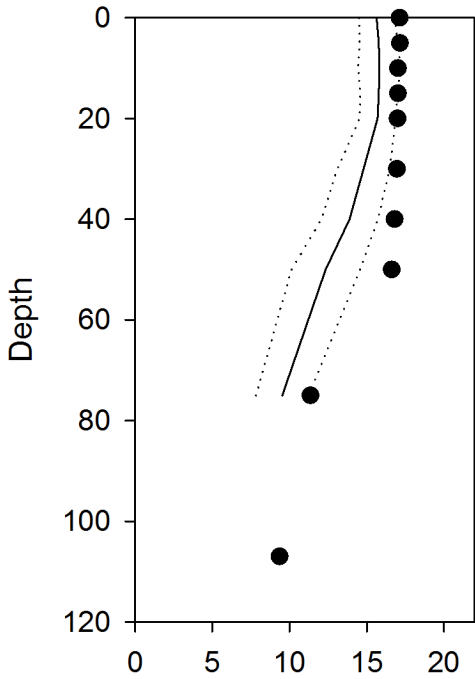
Vertical profiles Å13 September

— Mean 1996-2010 St.Dev. ● 2014

Temperature

Salinity

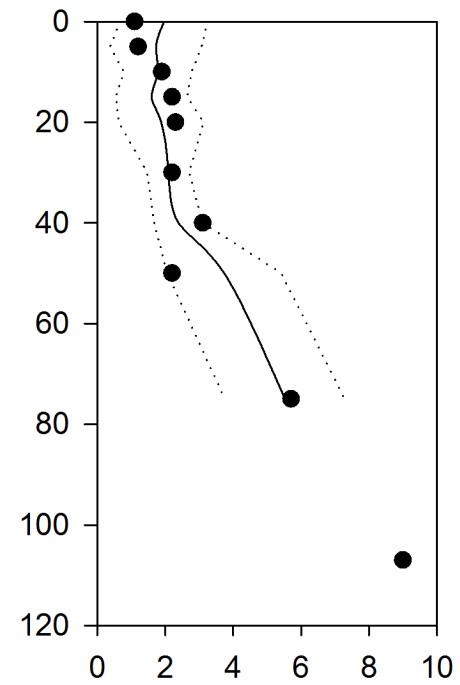
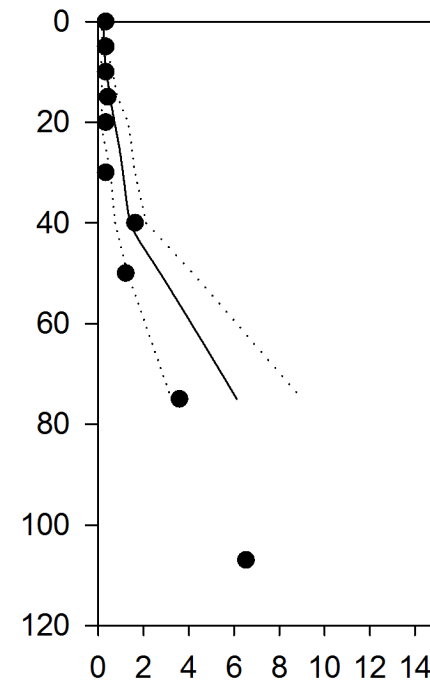
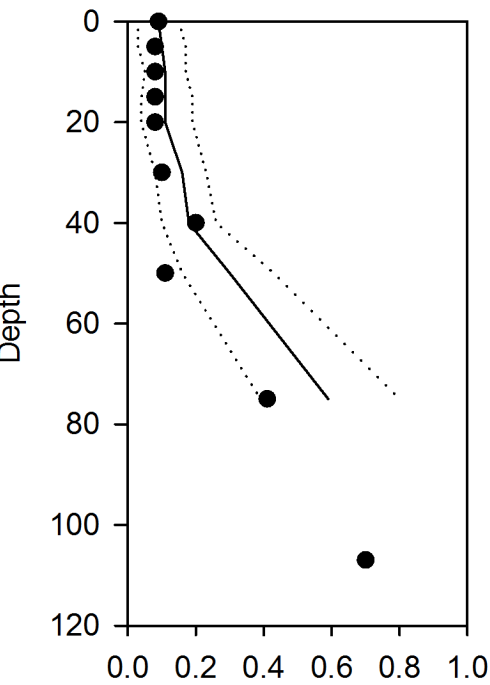
Oxygen



Phosphate

Inorganic Nitrogen

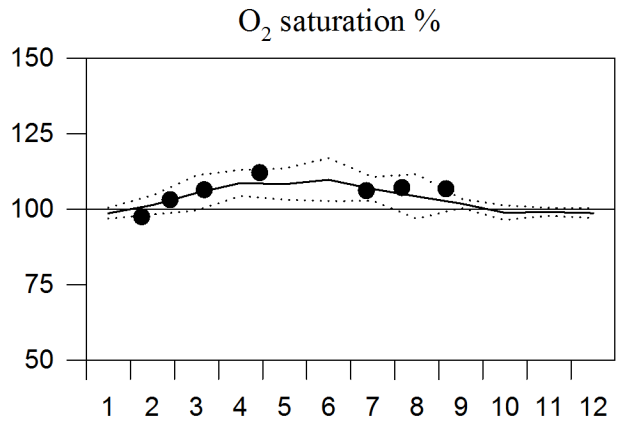
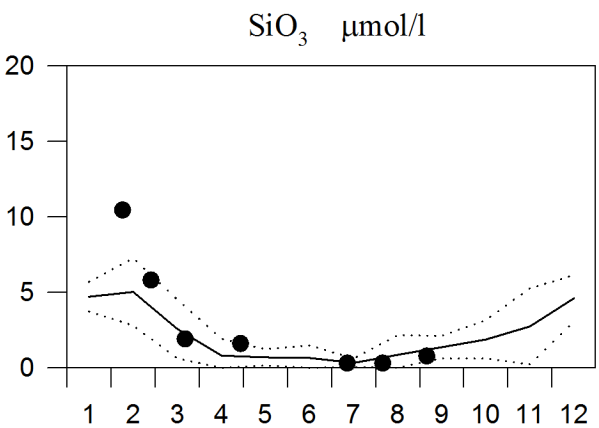
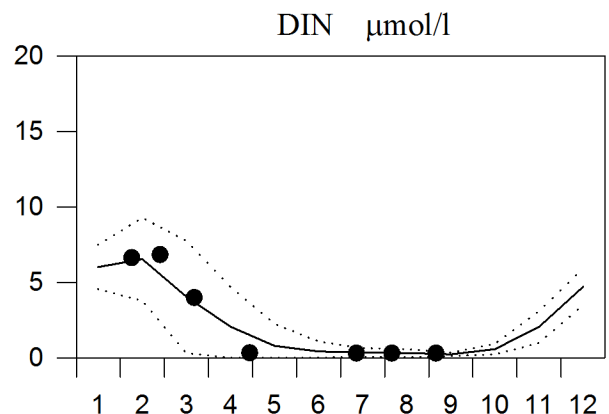
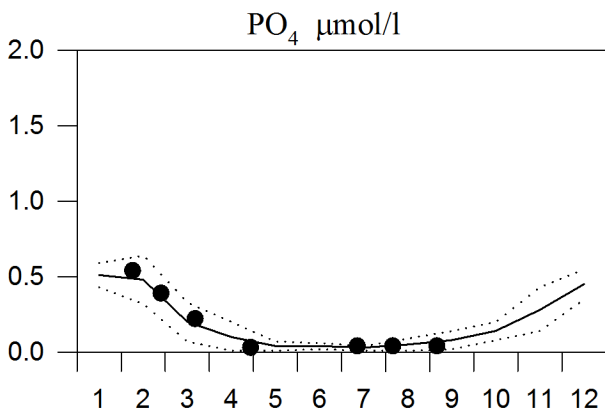
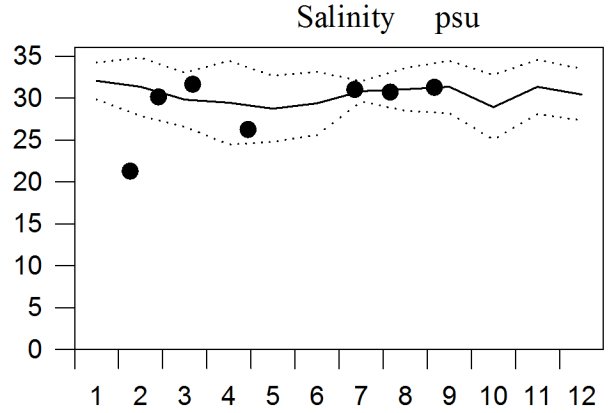
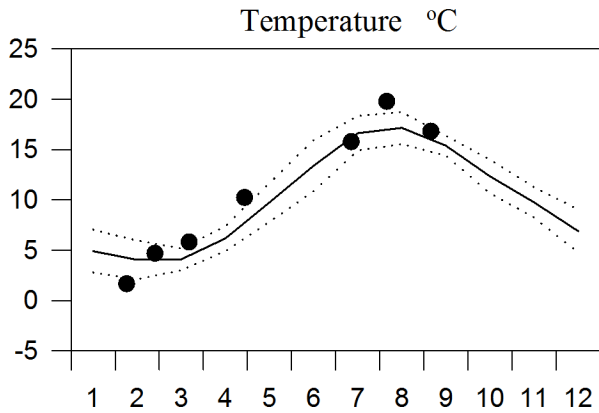
Silicate



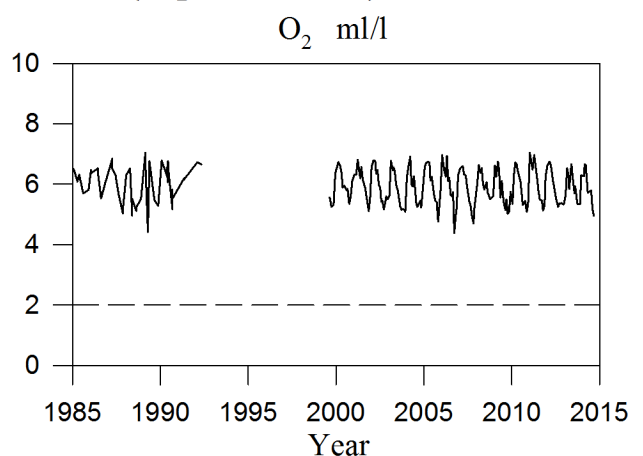
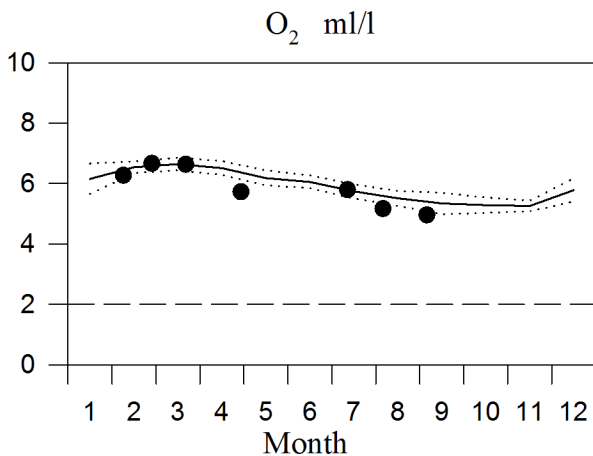
STATION Å15 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2014



OXYGEN IN BOTTOM WATER (depth >=125m)



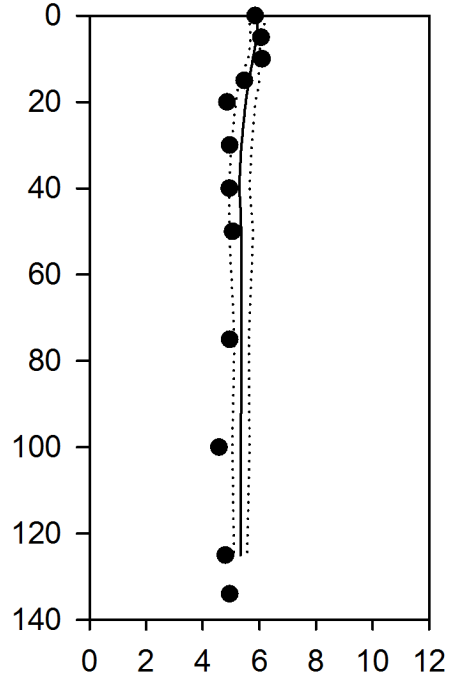
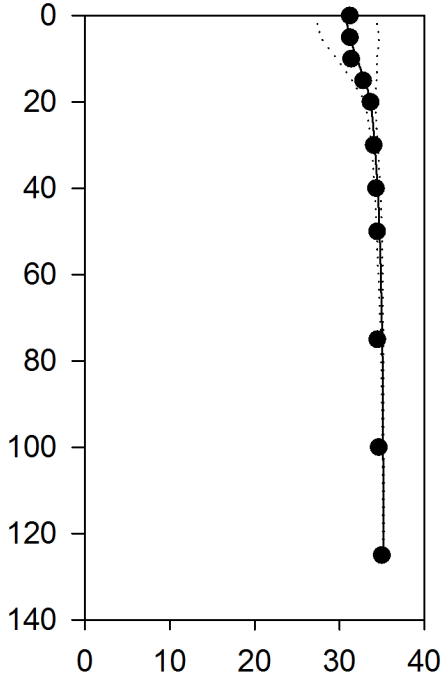
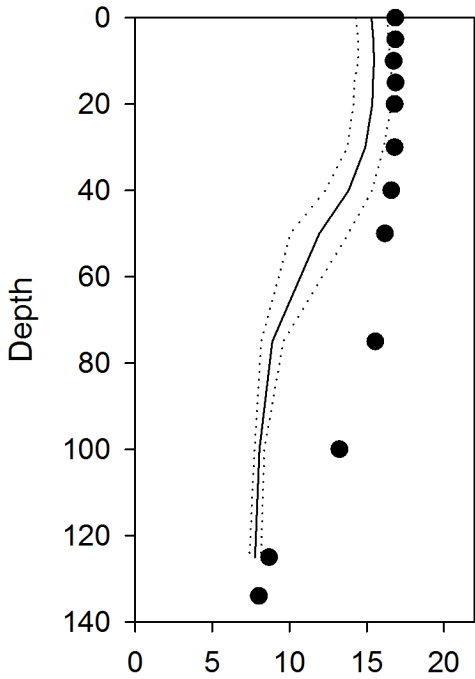
Vertical profiles Å15 September

— Mean 1996-2010 St.Dev. ● 2014

Temperature

Salinity

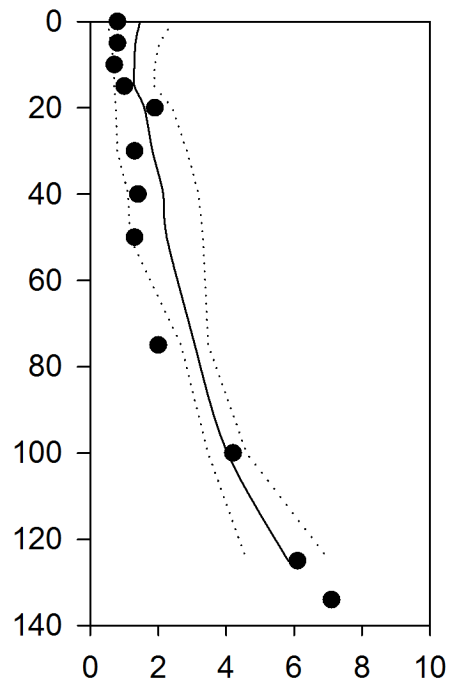
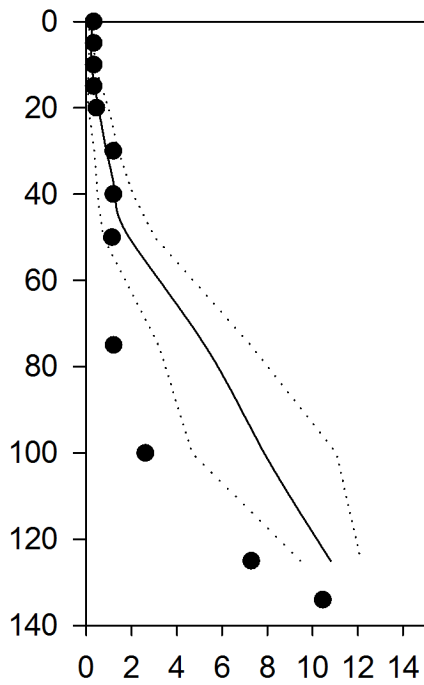
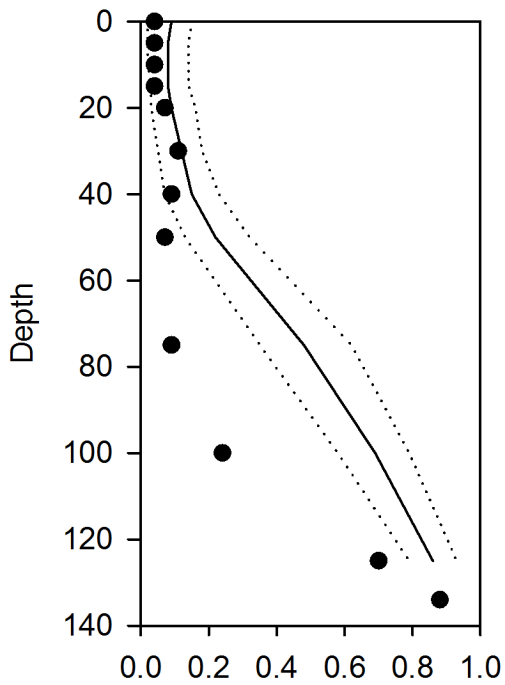
Oxygen



Phosphate

Inorganic Nitrogen

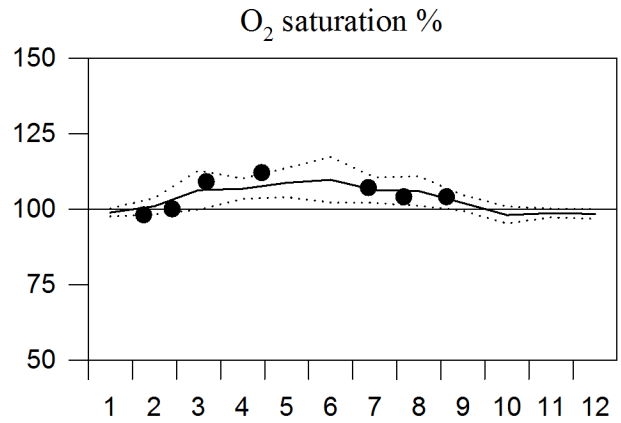
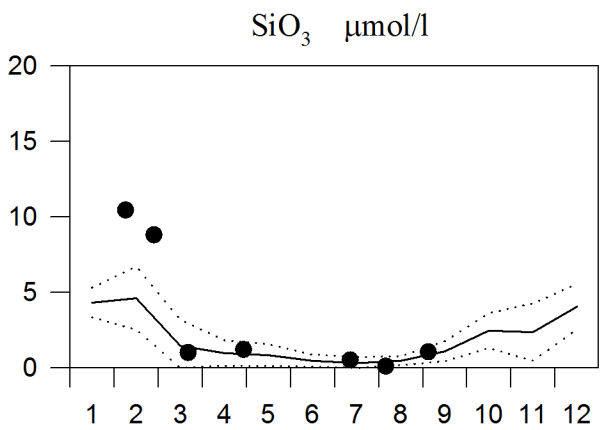
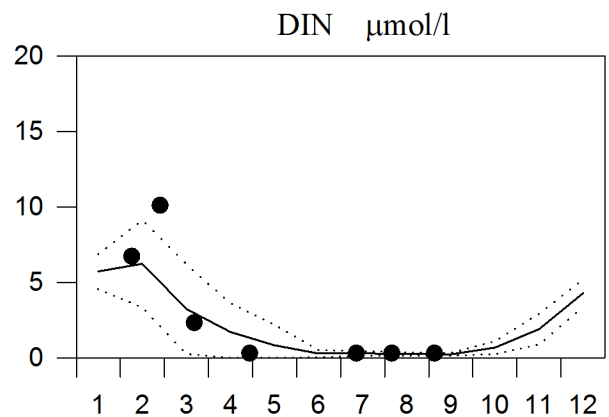
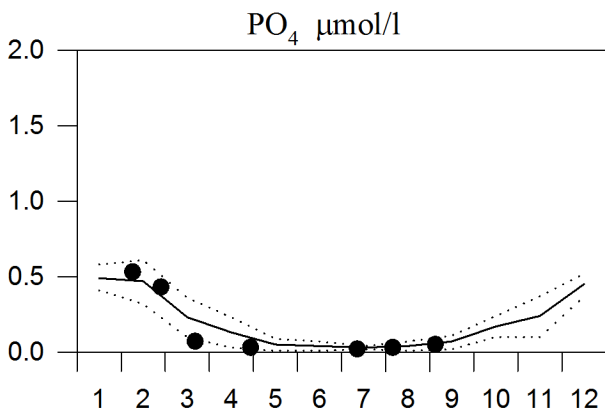
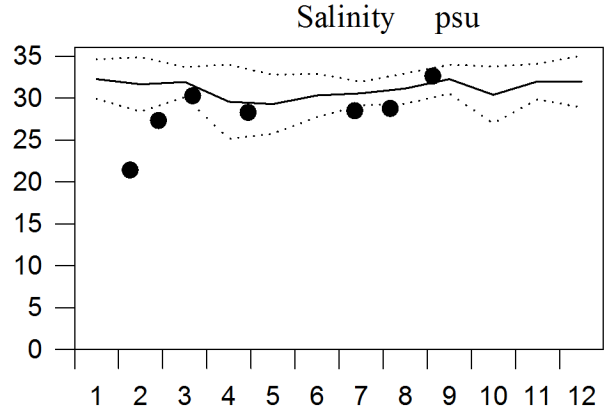
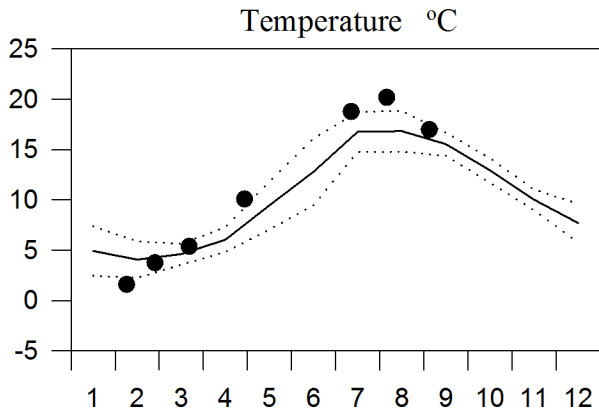
Silicate



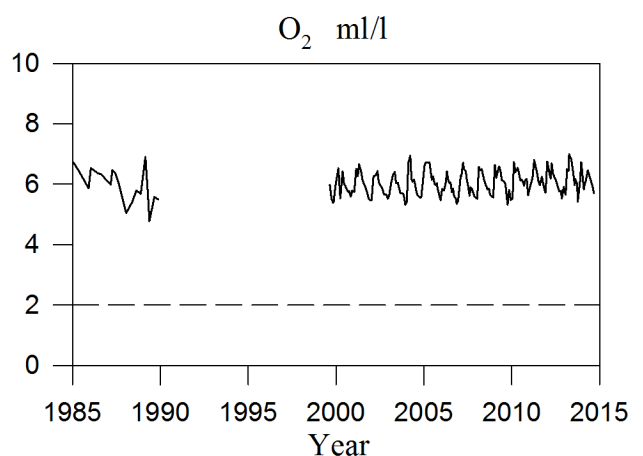
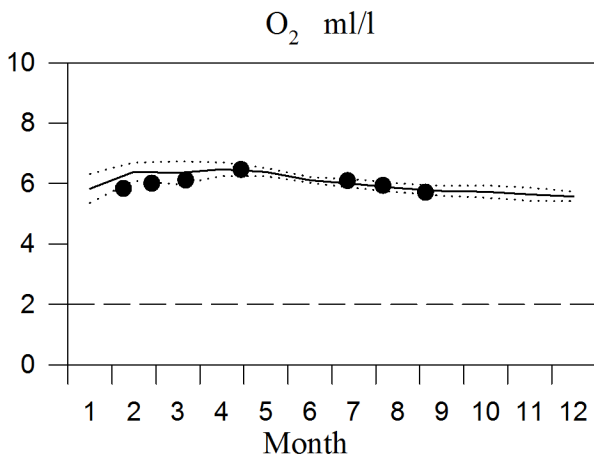
STATION Å17 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2014

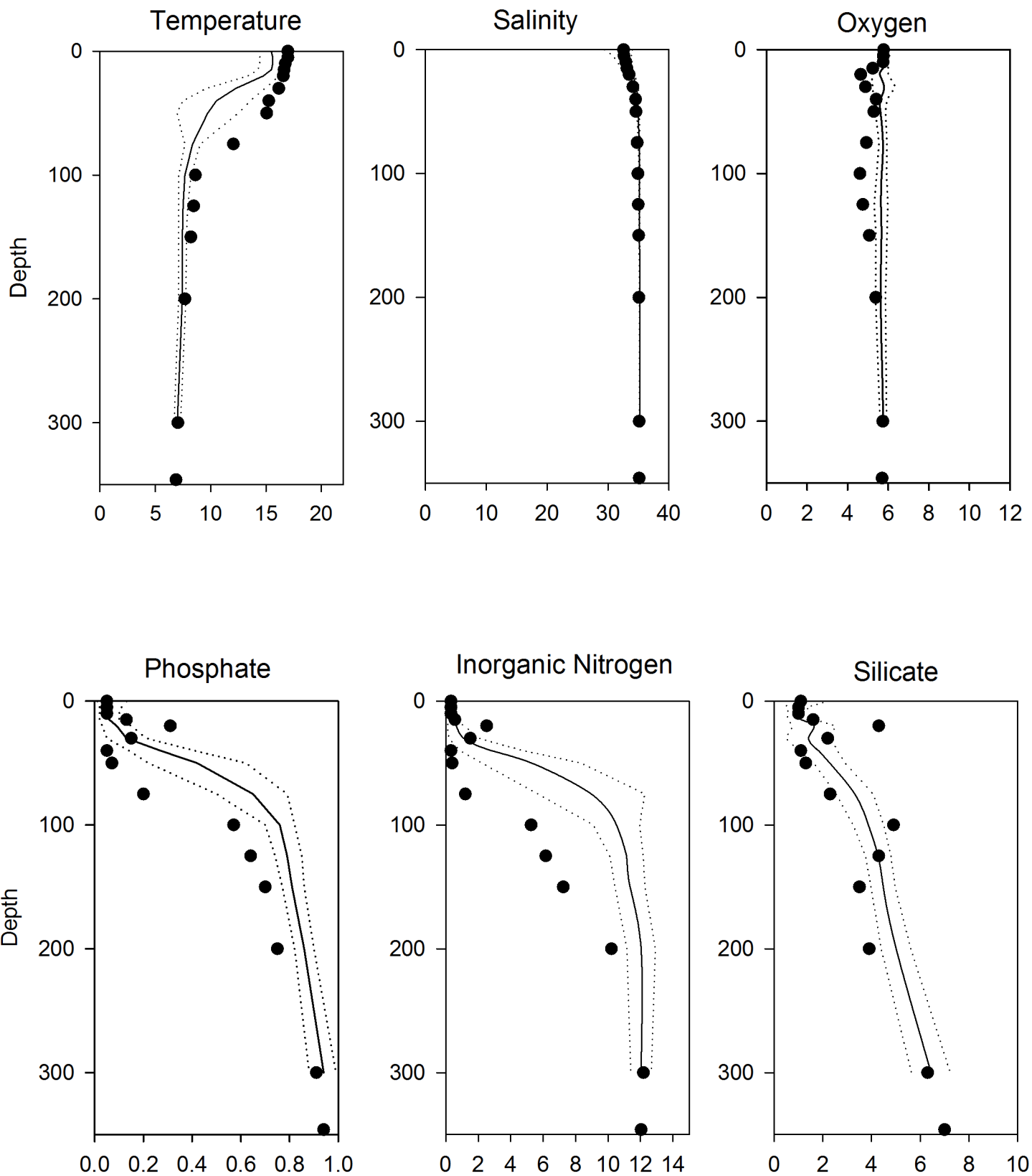


OXYGEN IN BOTTOM WATER (depth = 300m)



Vertical profiles Å17 September

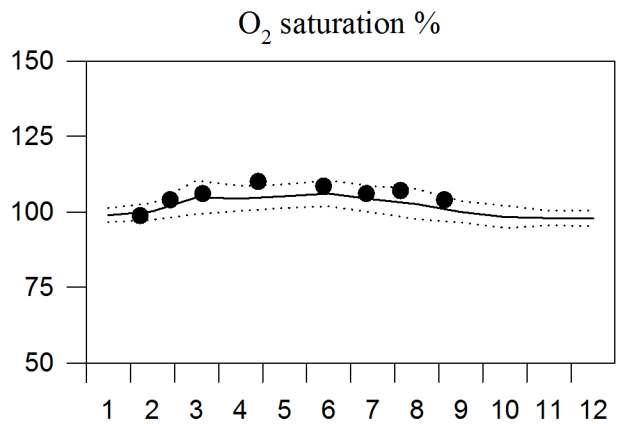
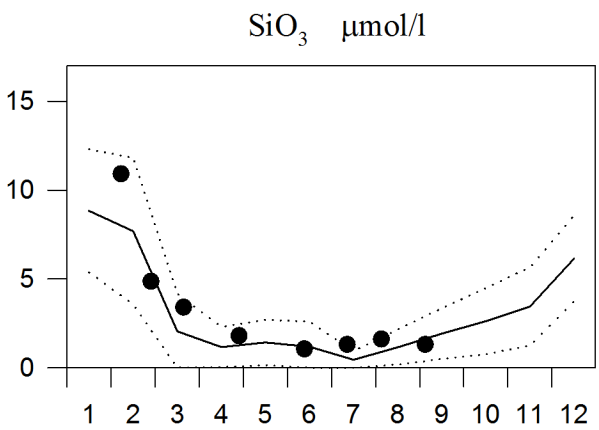
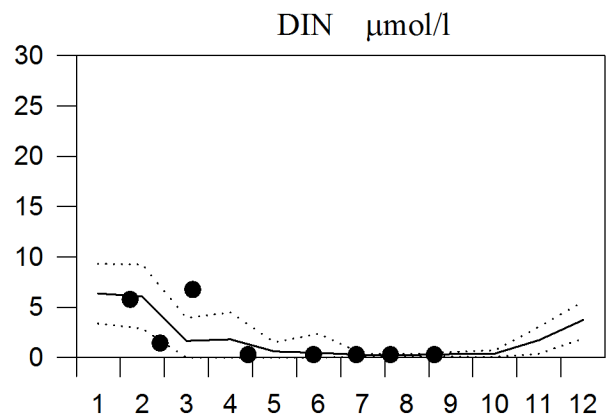
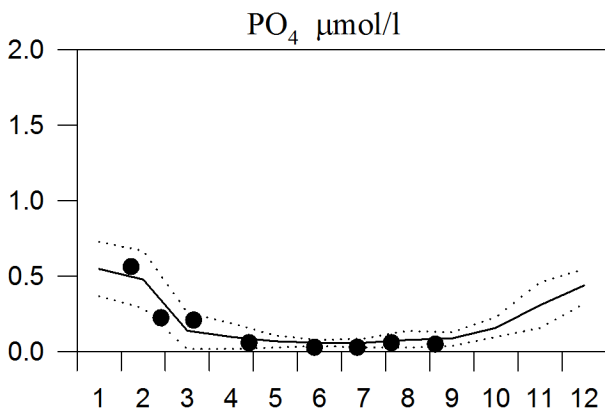
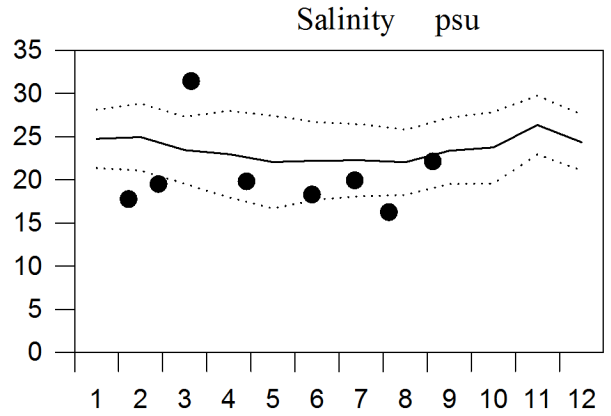
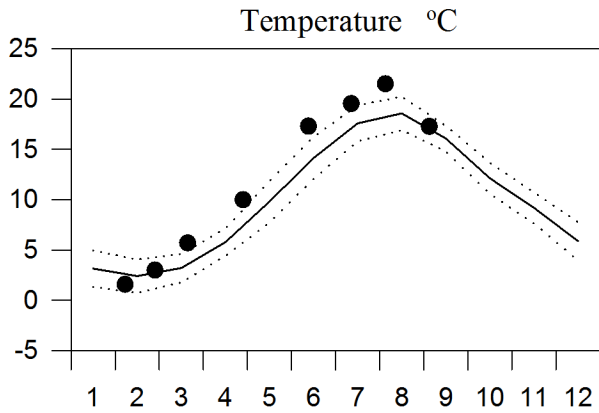
— Mean 1996-2010 St.Dev. ● 2014



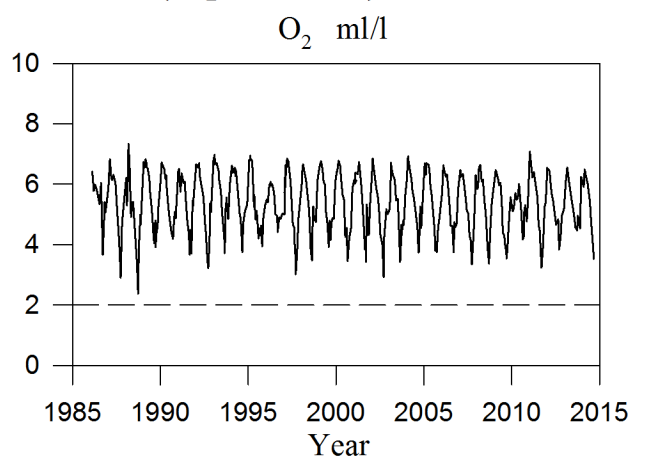
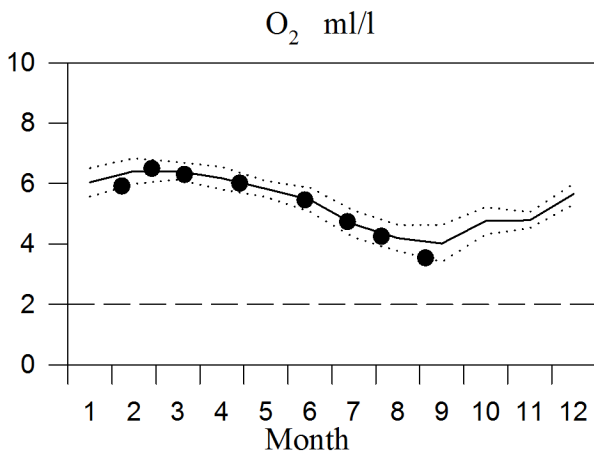
STATION FLADEN SURFACE WATER

Annual Cycles

— Mean 1996-2010 ····· St.Dev. ● 2014



OXYGEN IN BOTTOM WATER (depth > 70m)



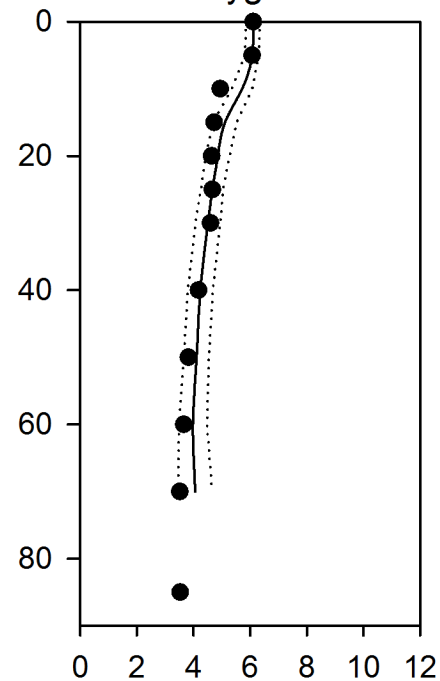
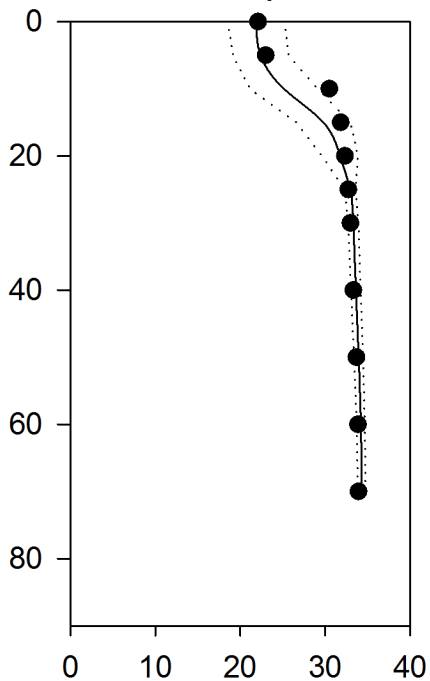
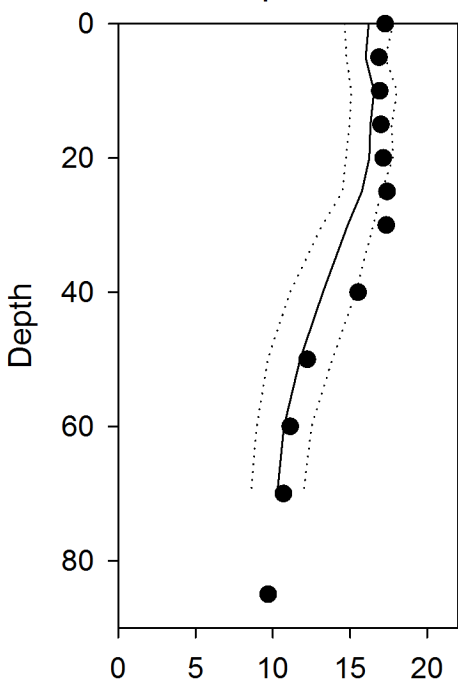
Vertical profiles Fladen September

— Mean 1996-2010 St.Dev. ● 2014

Temperature

Salinity

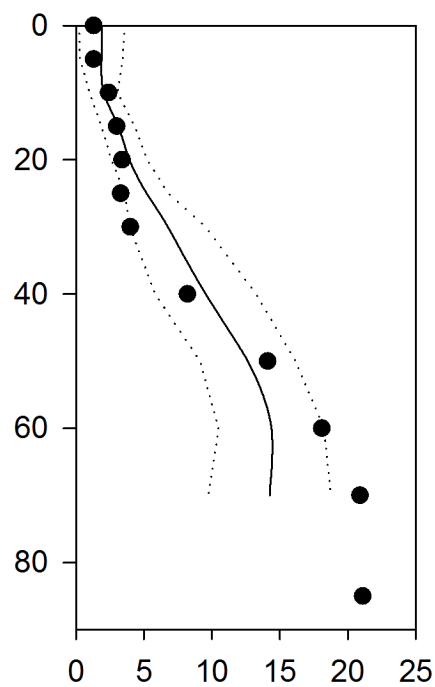
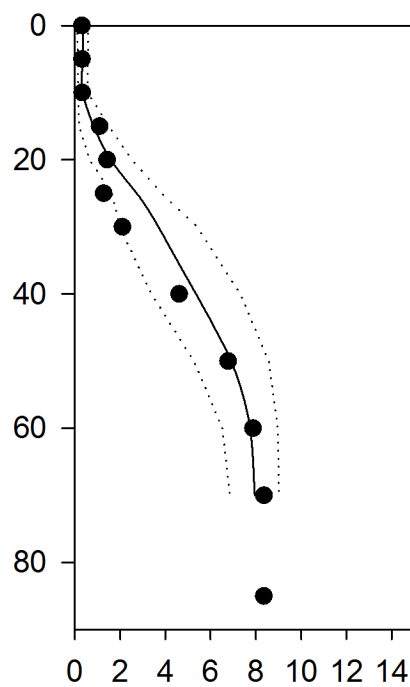
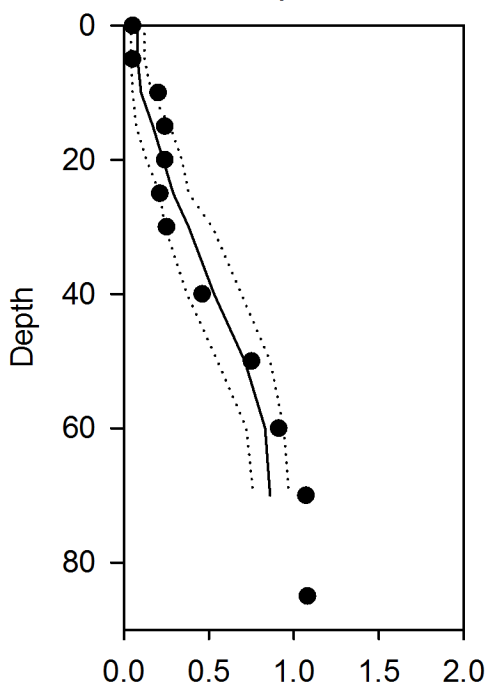
Oxygen



Phosphate

Inorganic Nitrogen

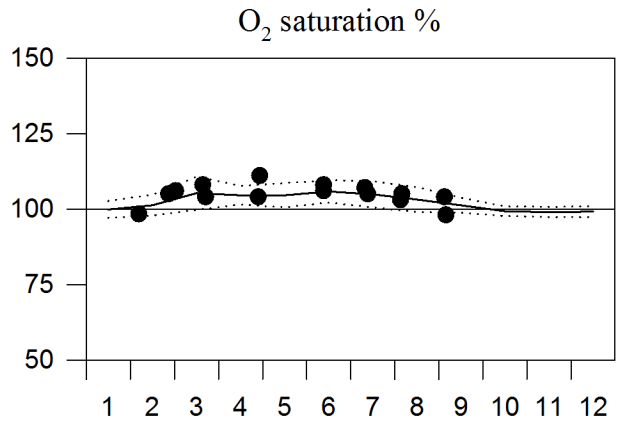
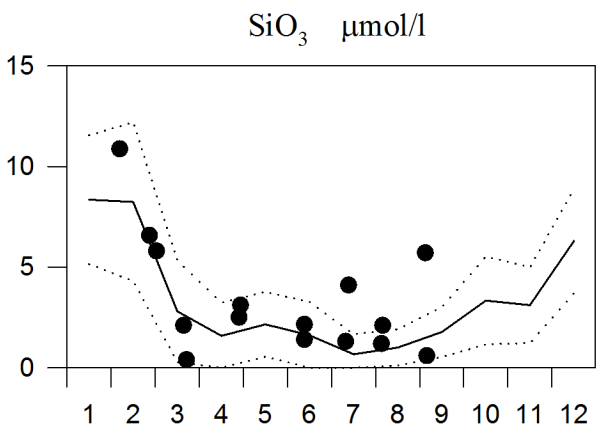
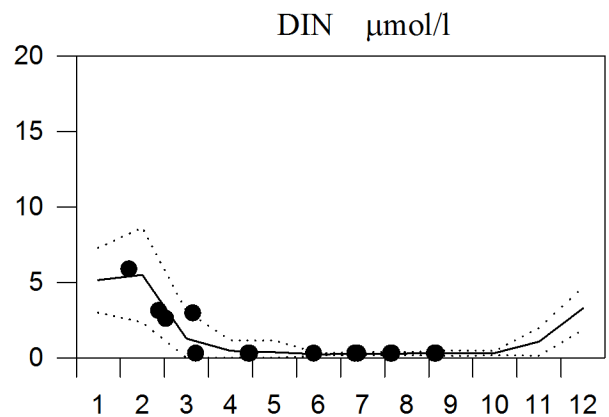
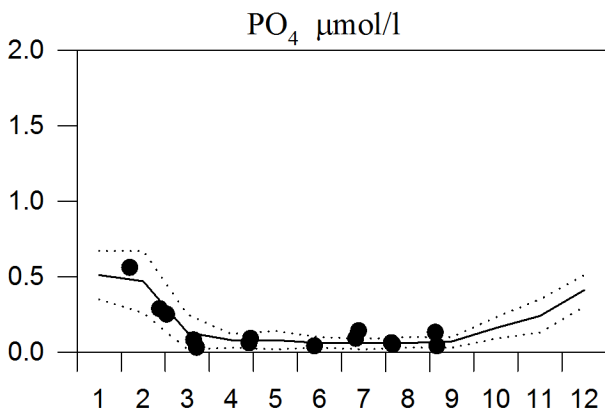
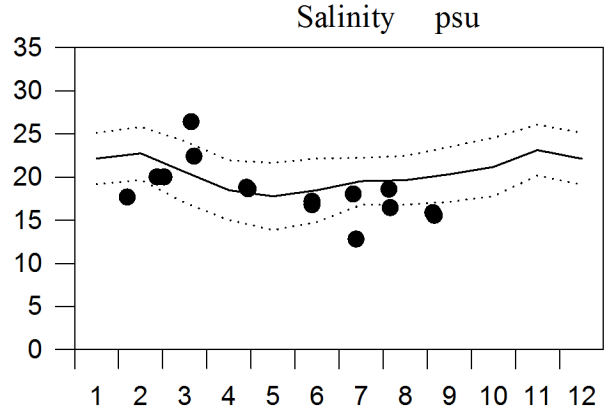
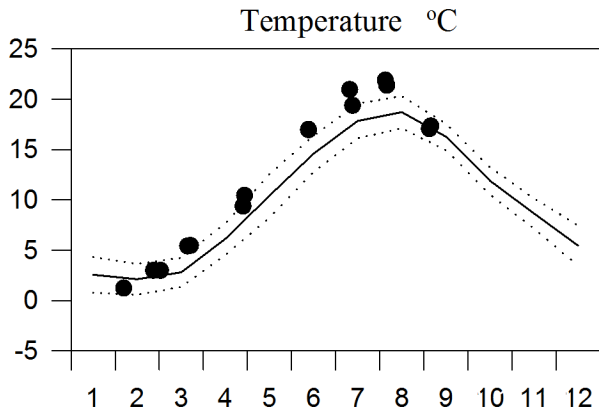
Silicate



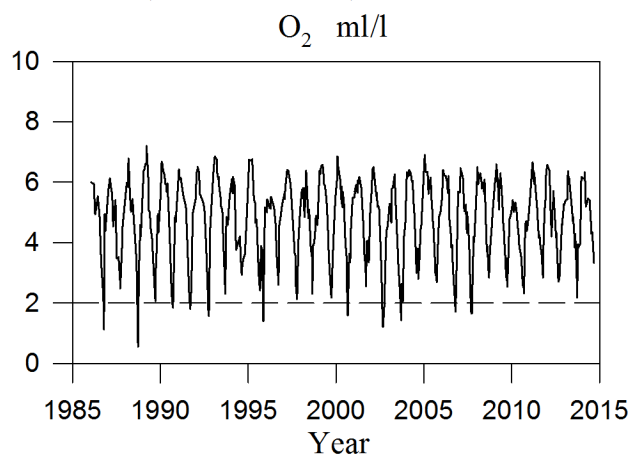
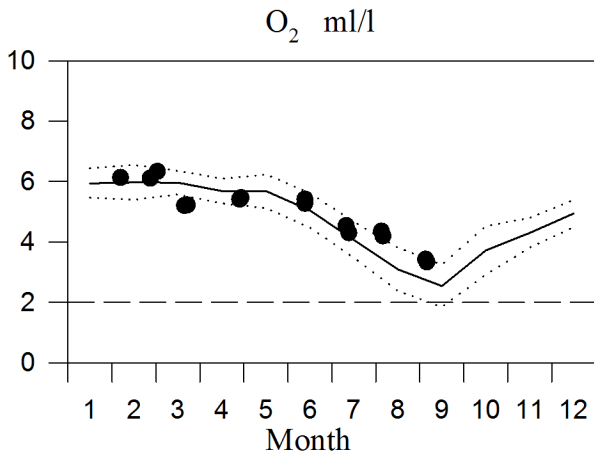
STATION ANHOLT E SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2014

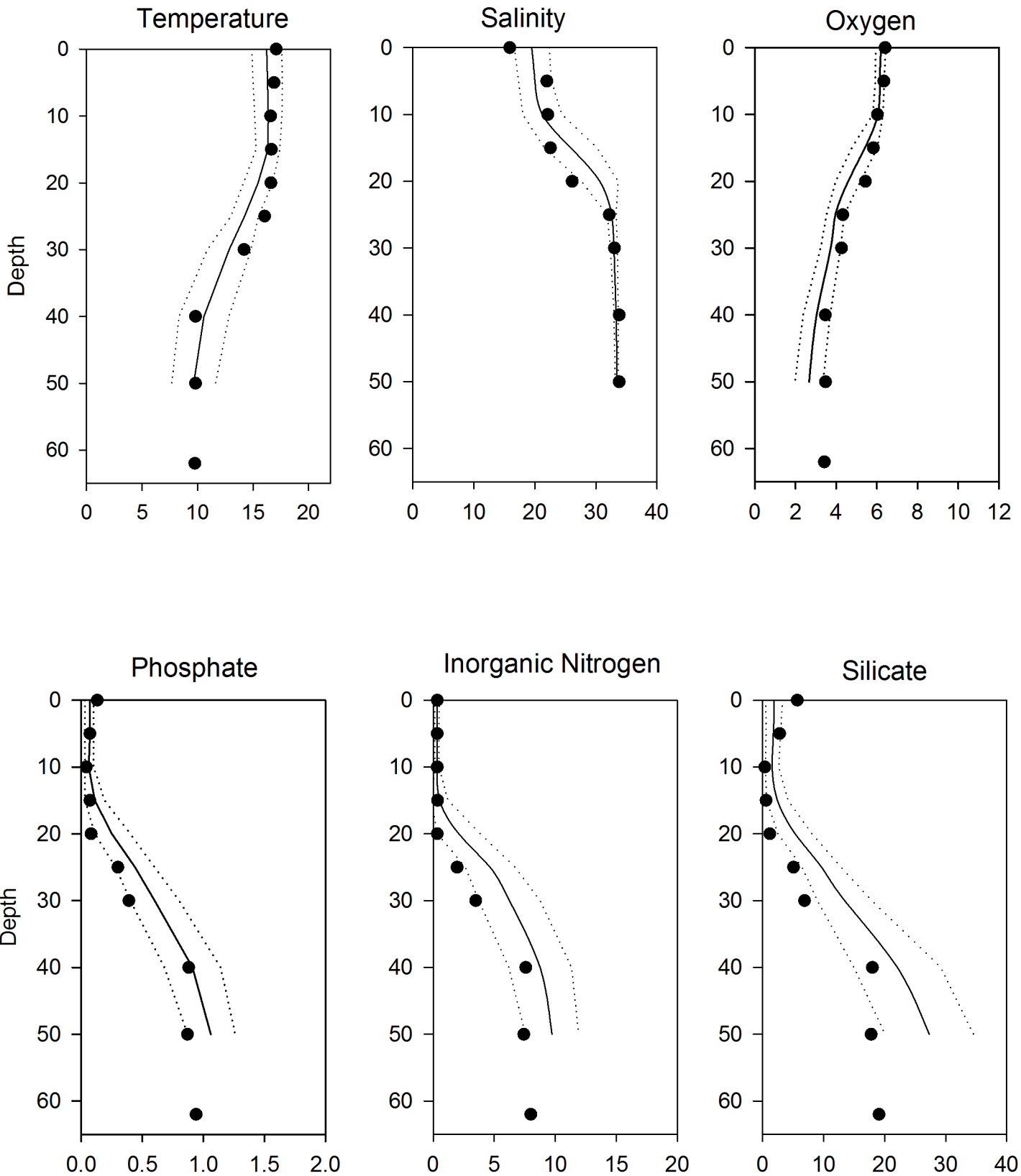


OXYGEN IN BOTTOM WATER (depth > 50m)



Vertical profiles Anholt E September

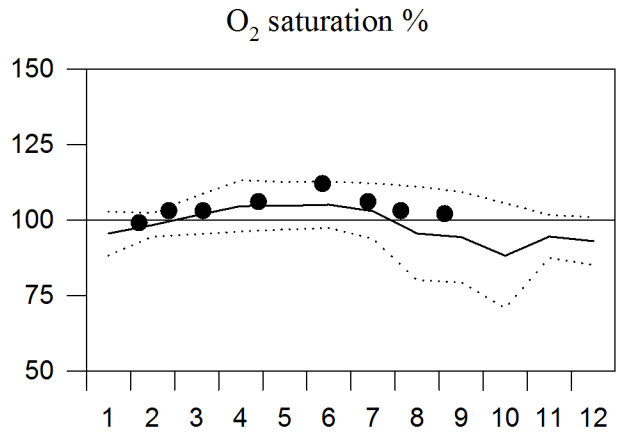
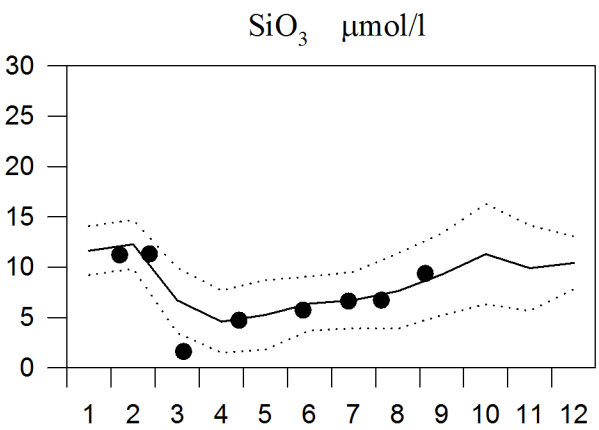
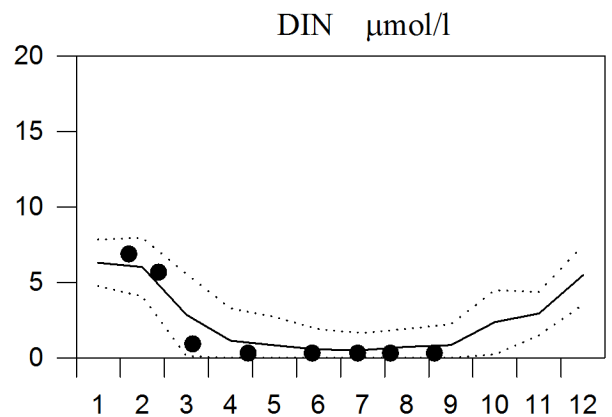
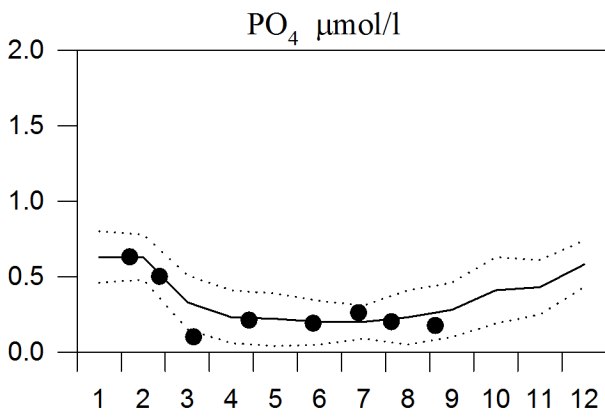
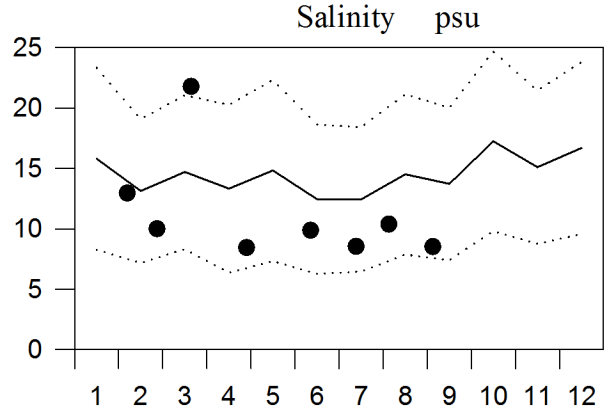
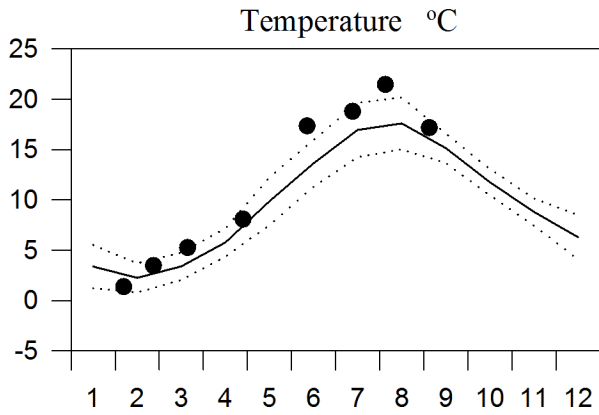
— Mean 1996-2010 St.Dev. ● 2014



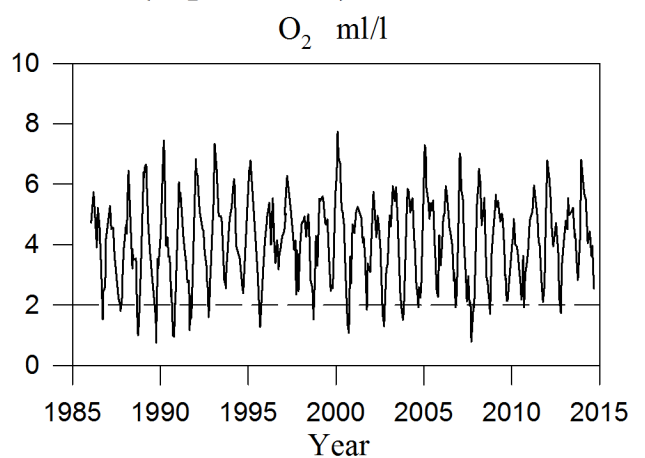
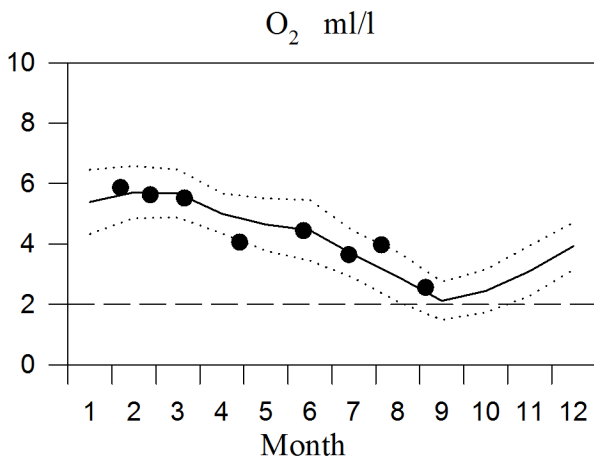
STATION W LANDSKRONA SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2014

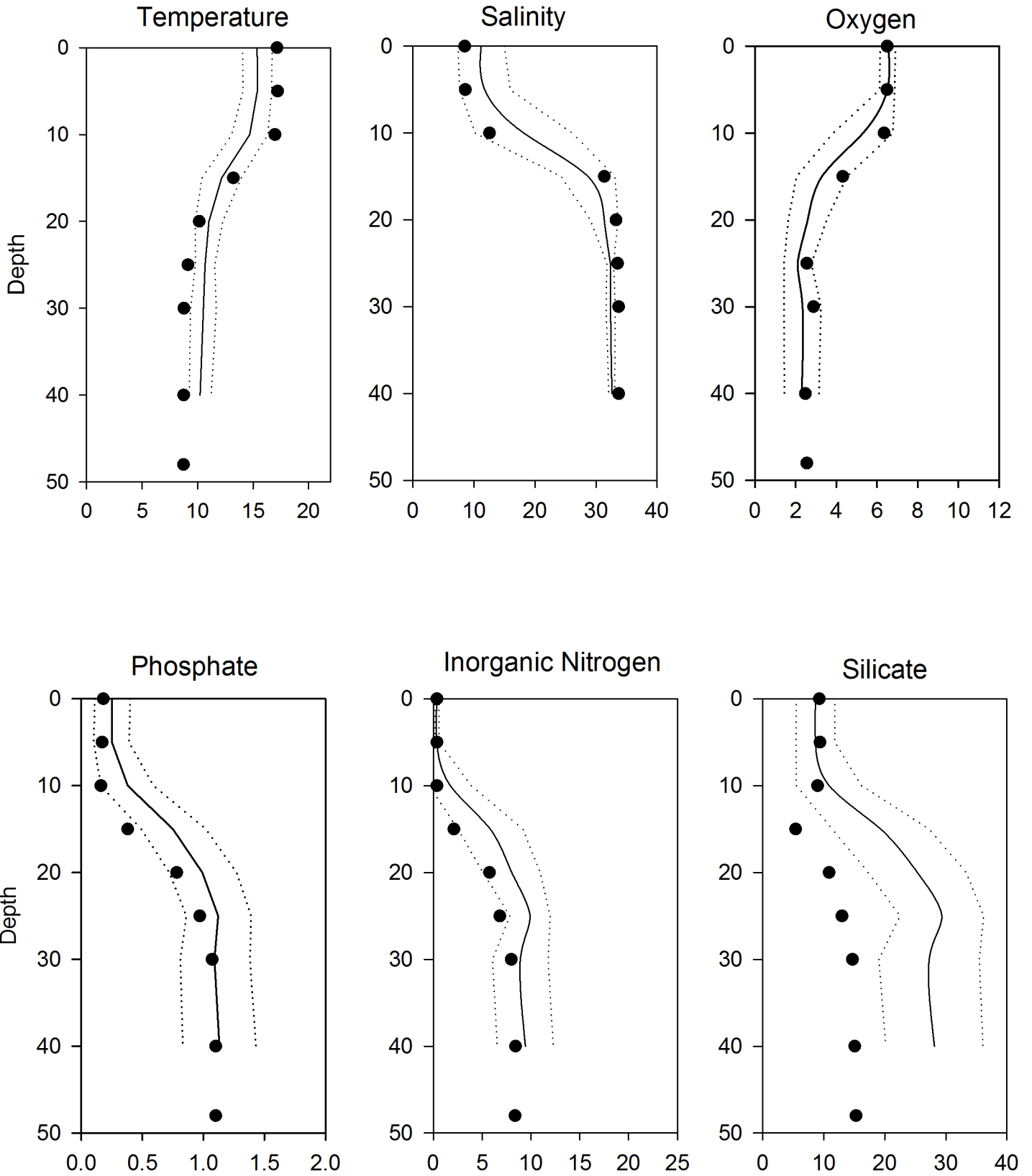


OXYGEN IN BOTTOM WATER (depth >40m)



Vertical profiles W Landskrona September

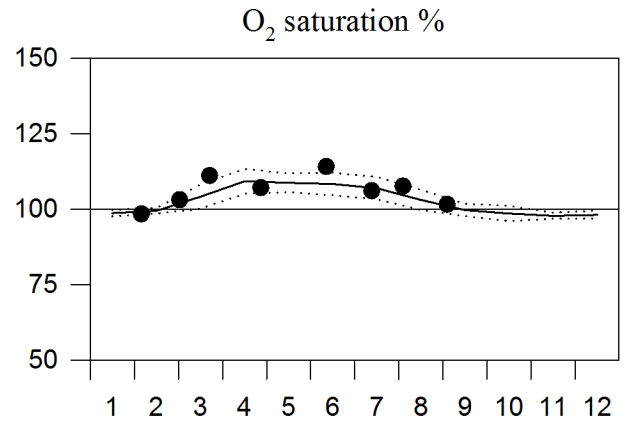
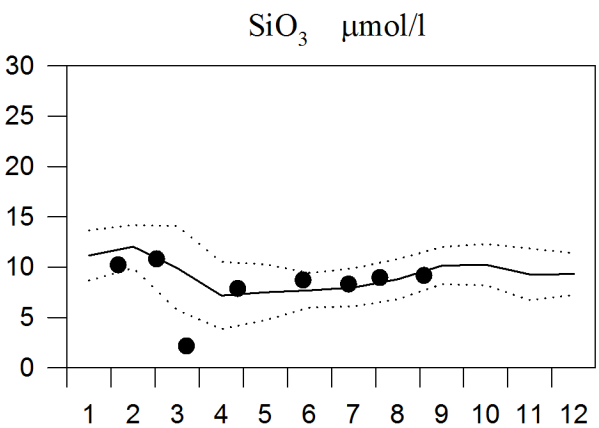
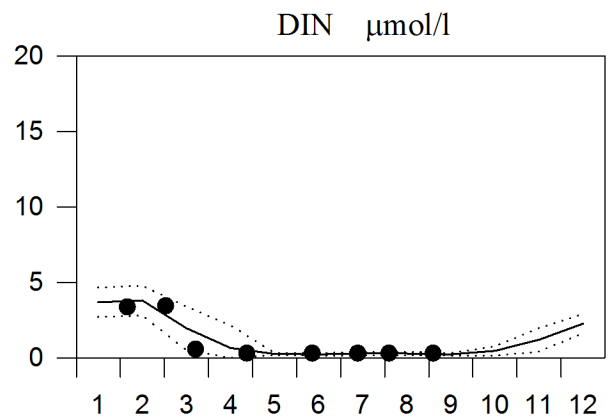
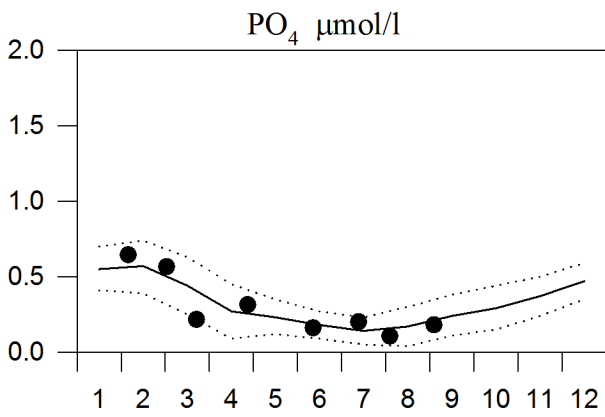
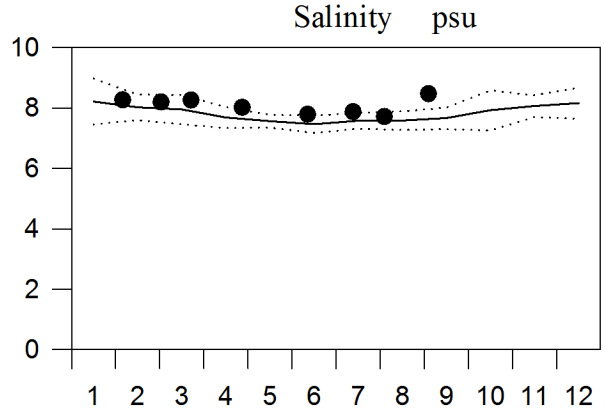
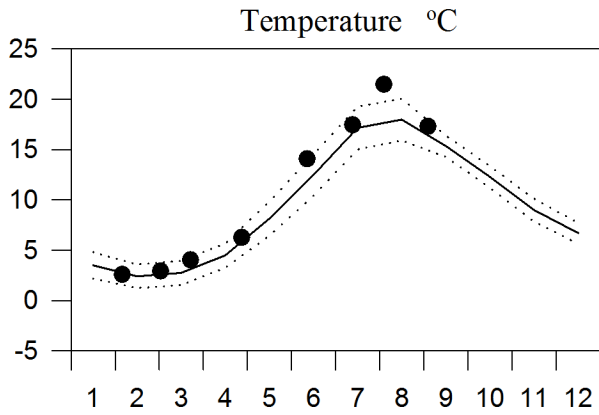
— Mean 1996-2010 St.Dev. ● 2014



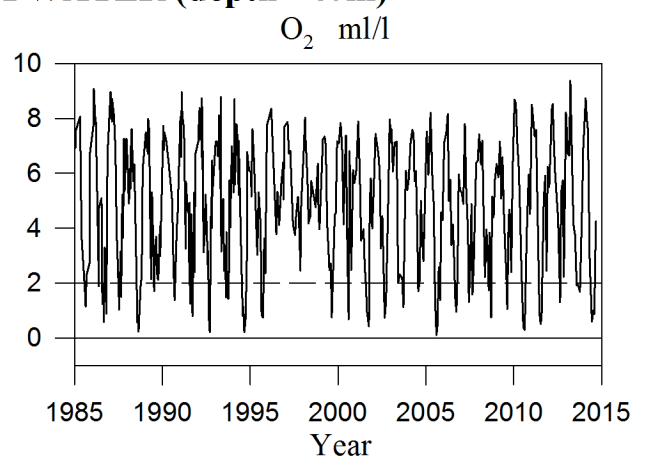
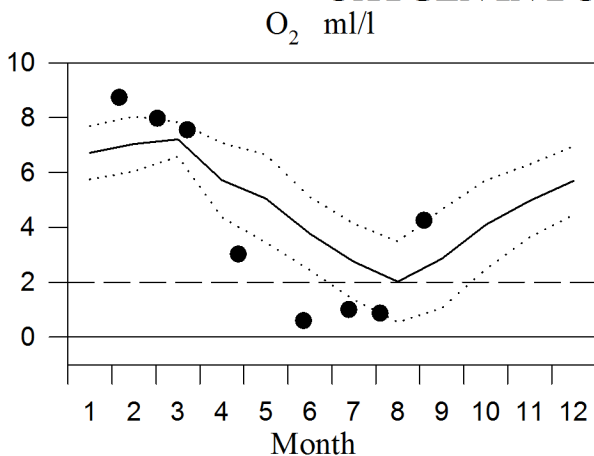
STATION BY1 SURFACE WATER

Annual Cycles

— Mean 1996-2010 ····· St.Dev. ● 2014

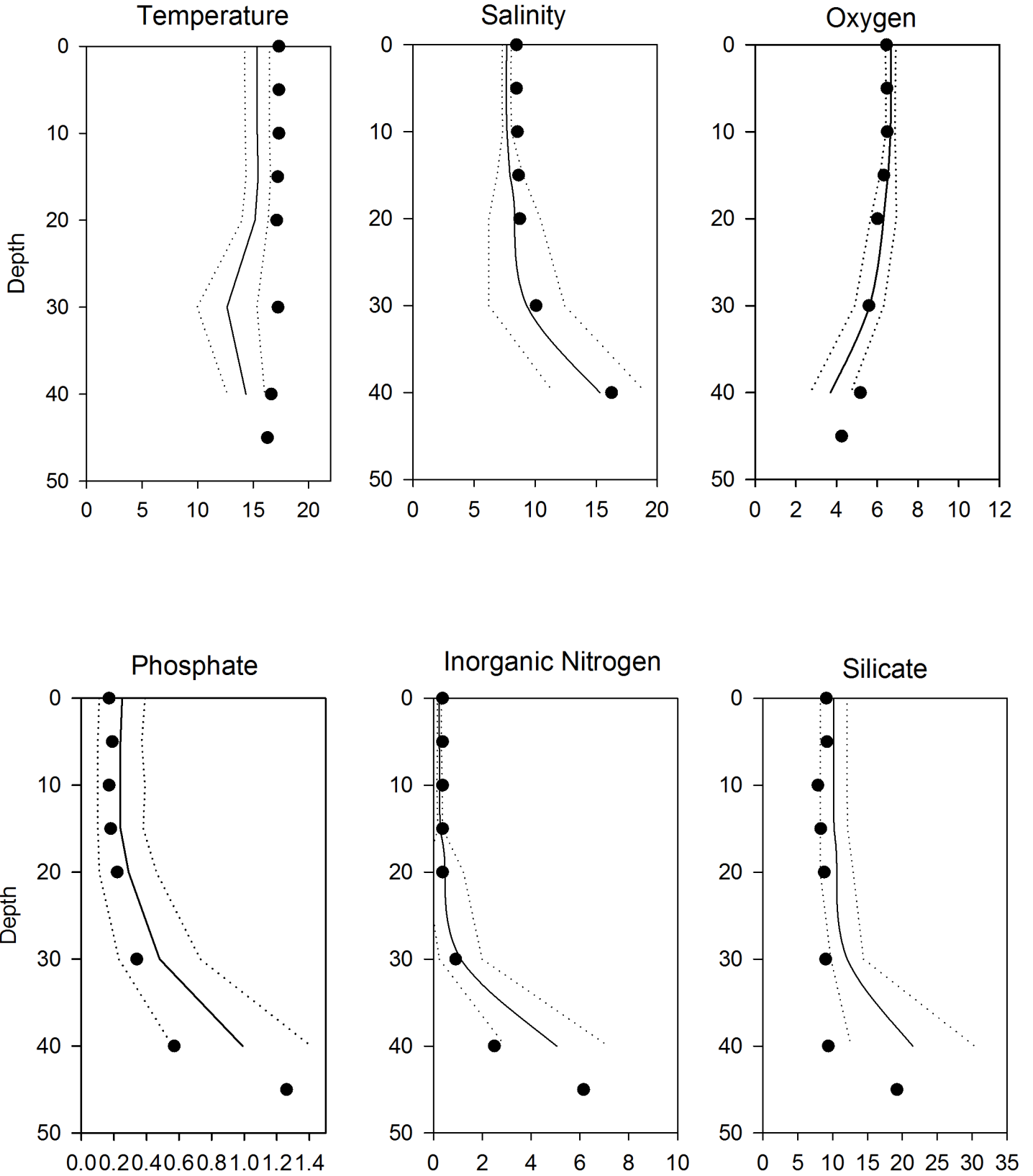


OXYGEN IN BOTTOM WATER (depth >40m)



Vertical profiles BY1 September

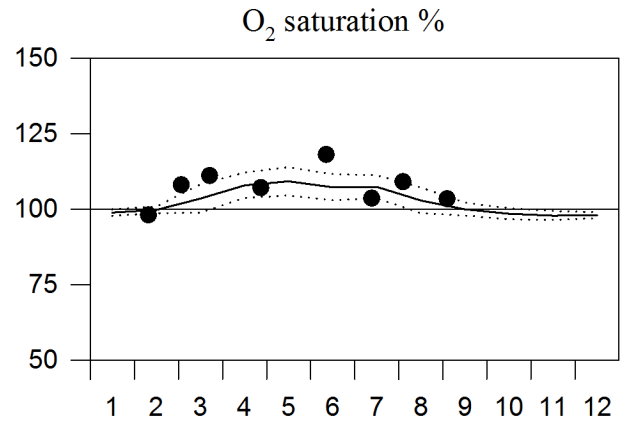
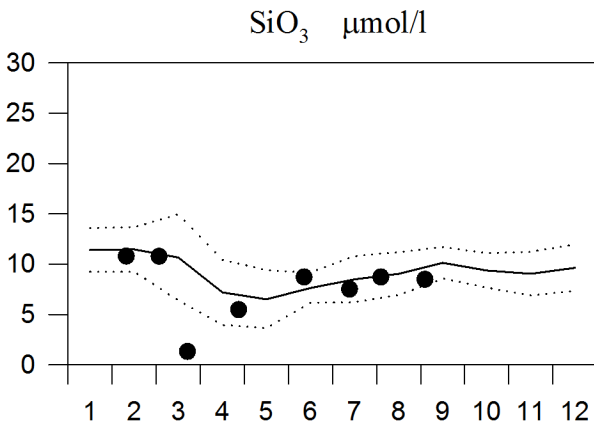
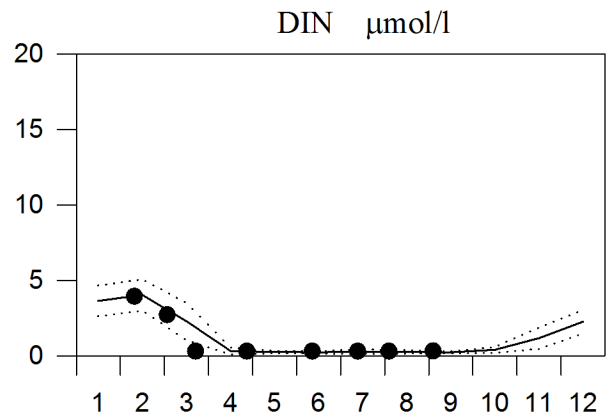
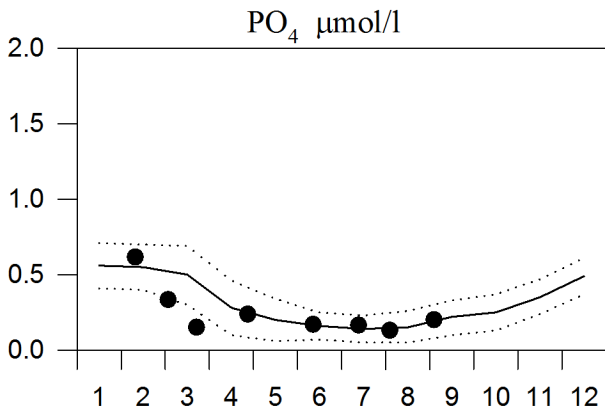
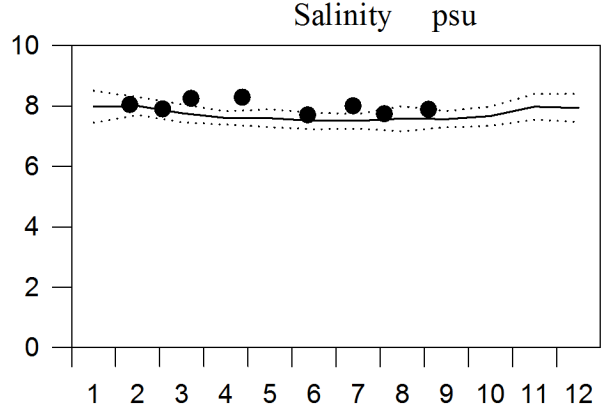
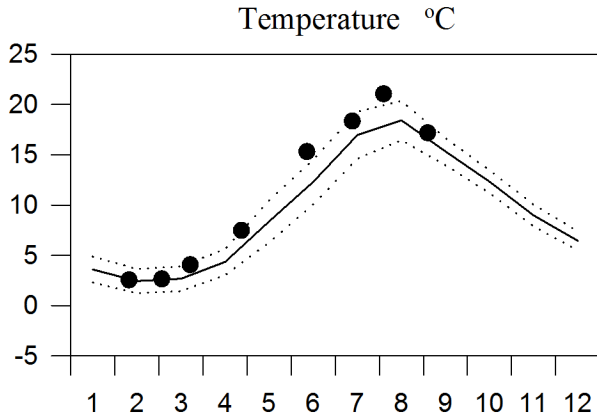
— Mean 1996-2010 ····· St.Dev. ● 2014



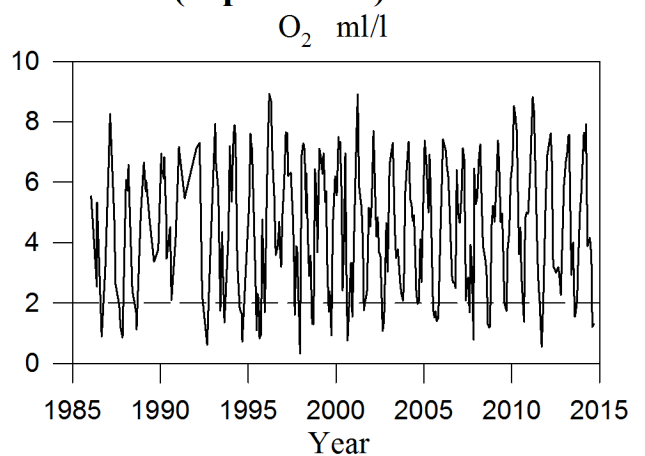
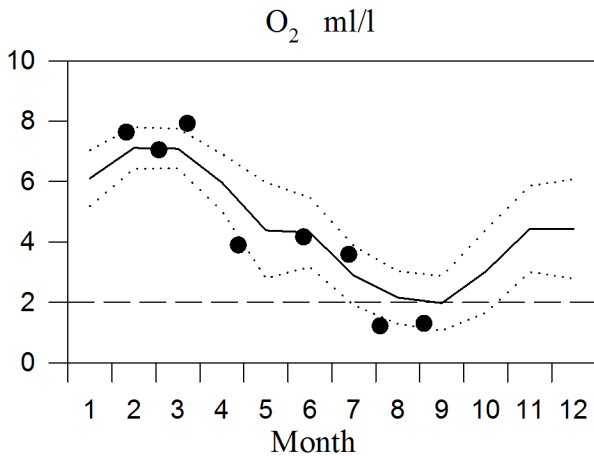
STATION BY2 SURFACE WATER

Annual Cycles

— Mean 1996-2010 ····· St.Dev. ● 2014

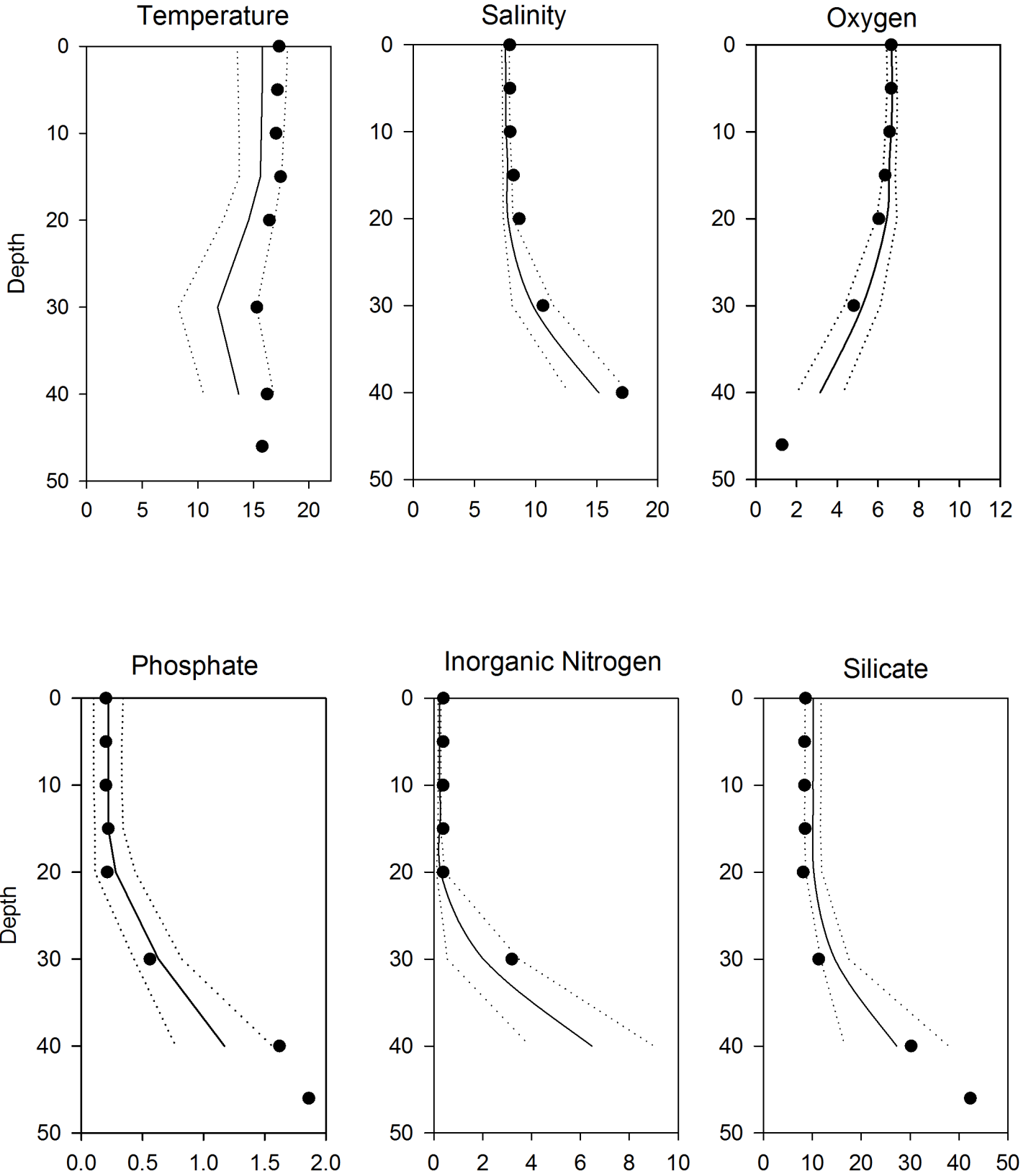


OXYGEN IN BOTTOM WATER (depth >40m)



Vertical profiles BY2 September

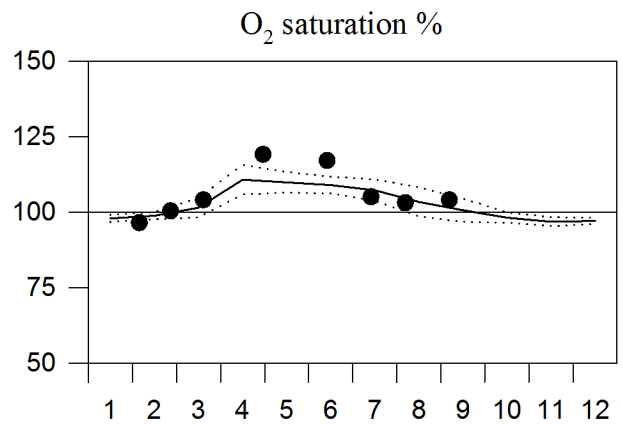
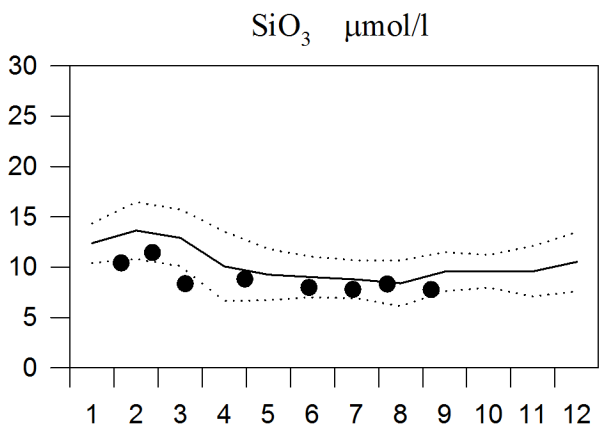
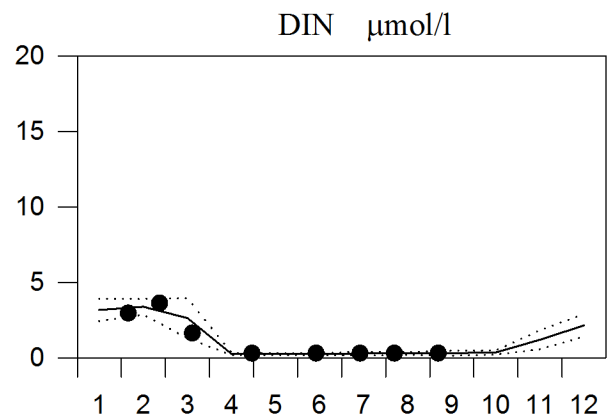
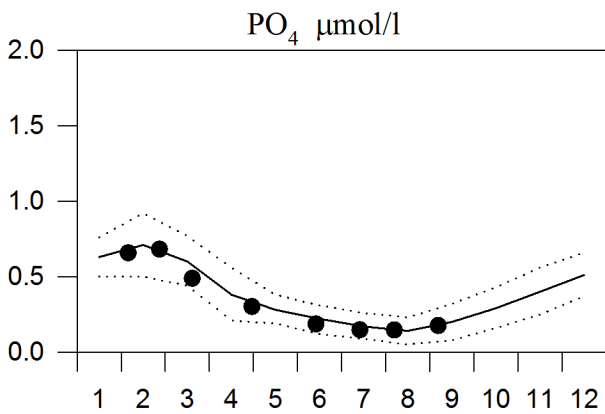
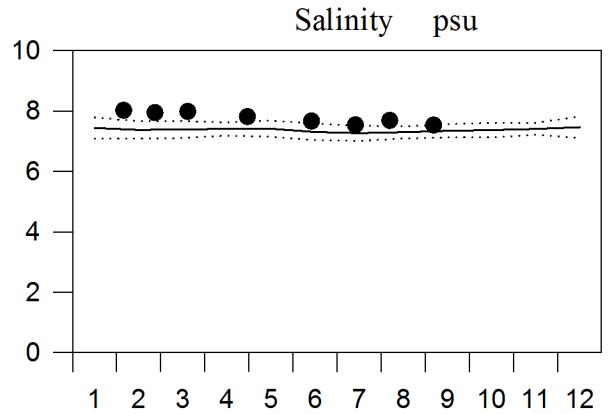
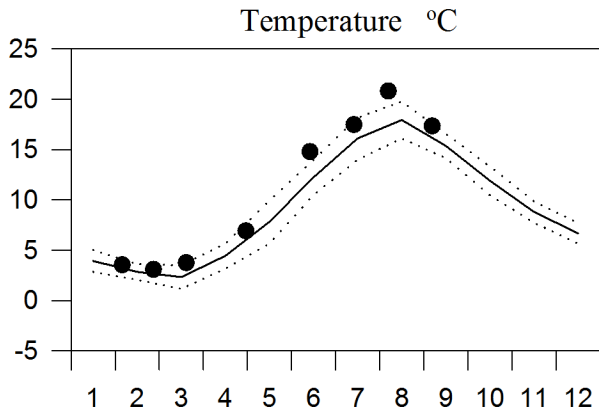
— Mean 1996-2010 ····· St.Dev. ● 2014



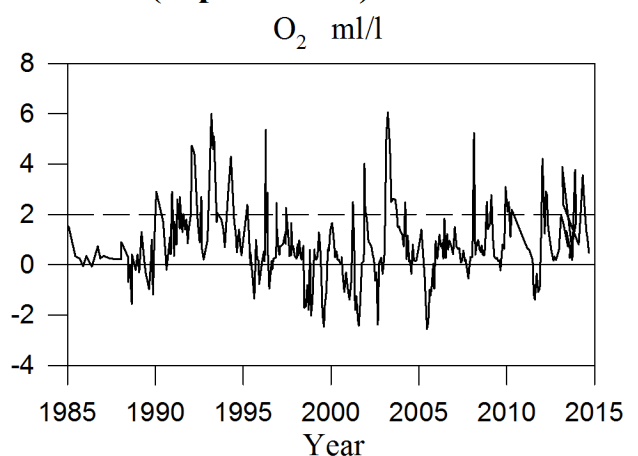
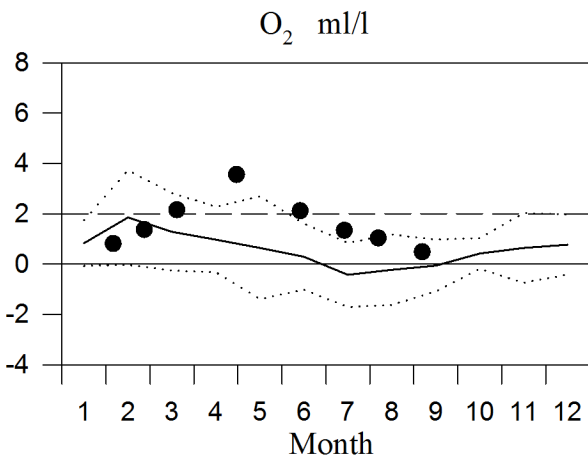
STATION HANÖBUKTEN SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2014

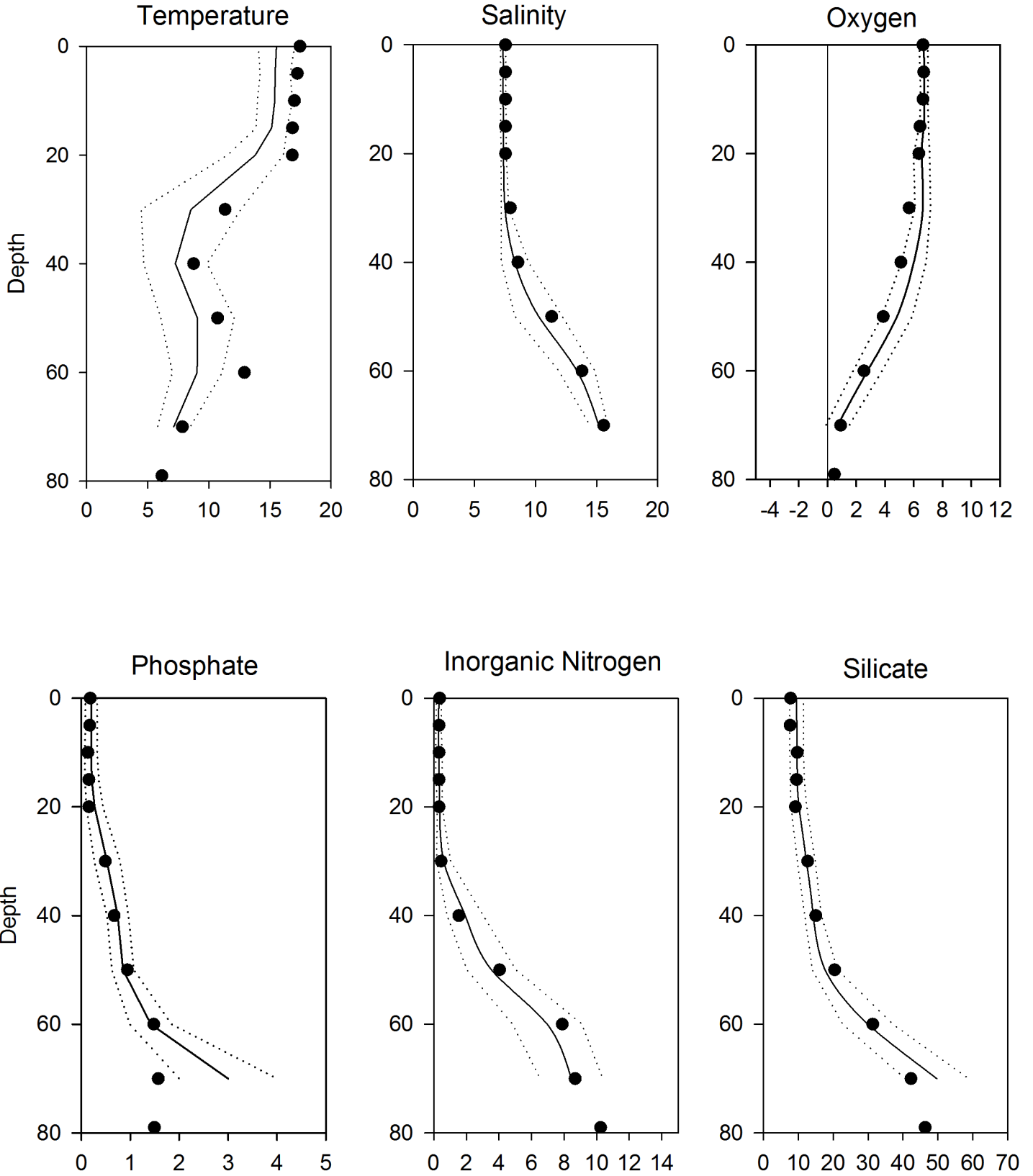


OXYGEN IN BOTTOM WATER (depth > 70m)



Vertical profiles Hanöbukten September

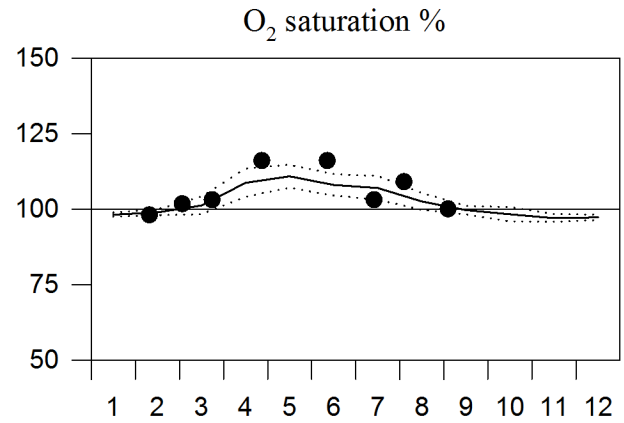
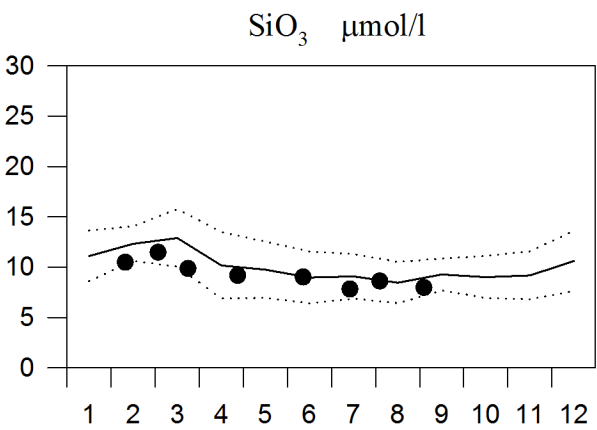
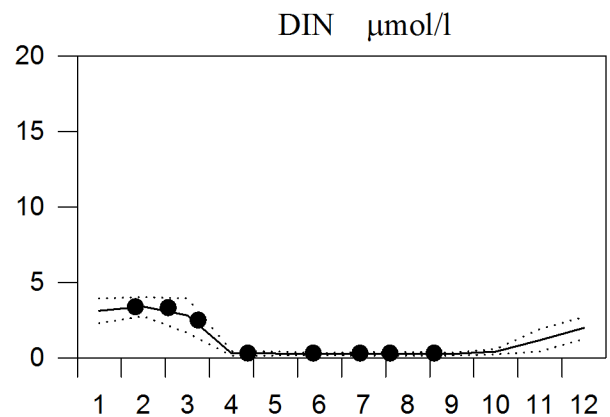
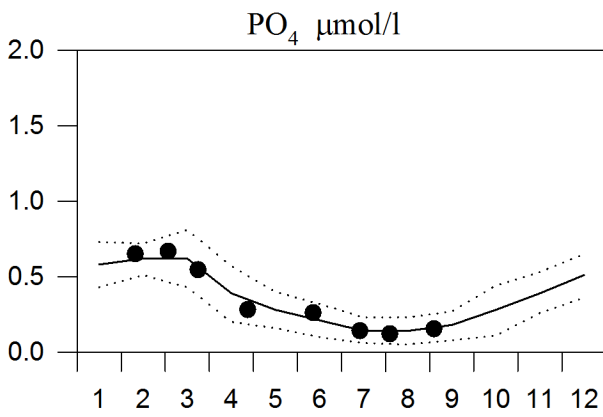
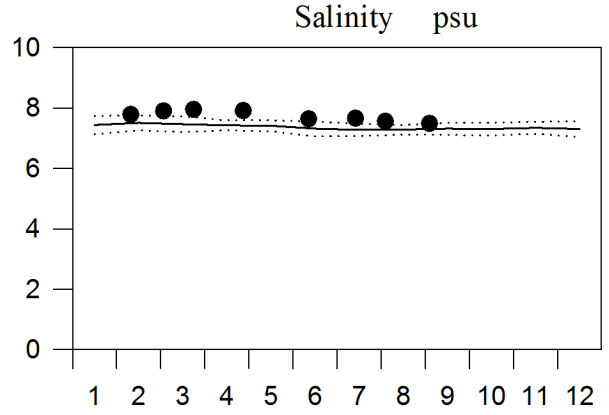
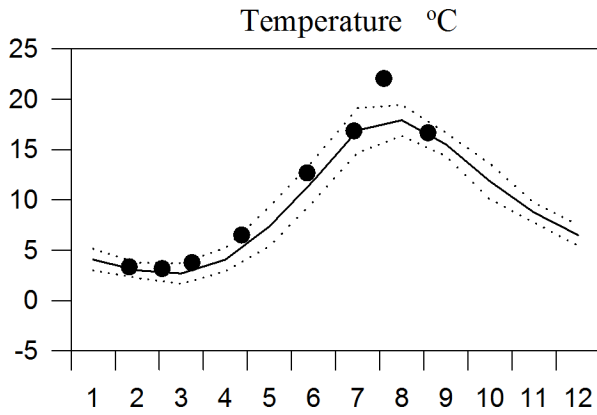
— Mean 1996-2010 ····· St.Dev. ● 2014



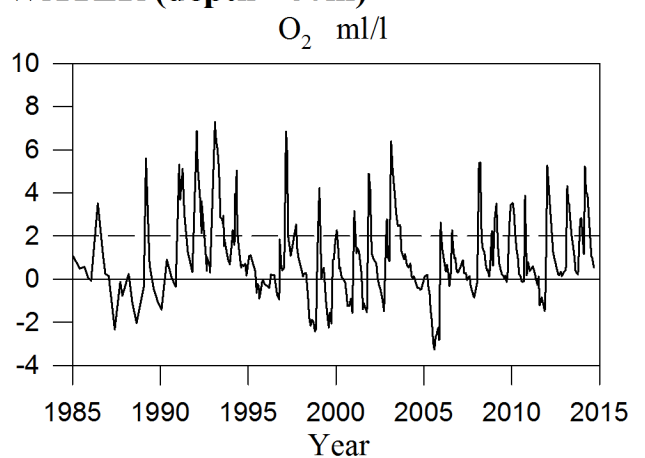
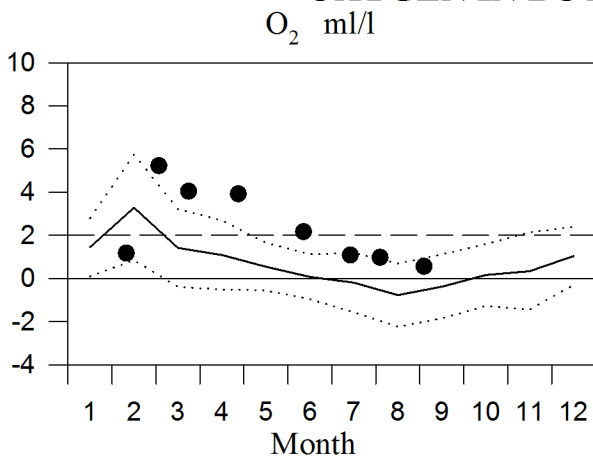
STATION BY4 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2014

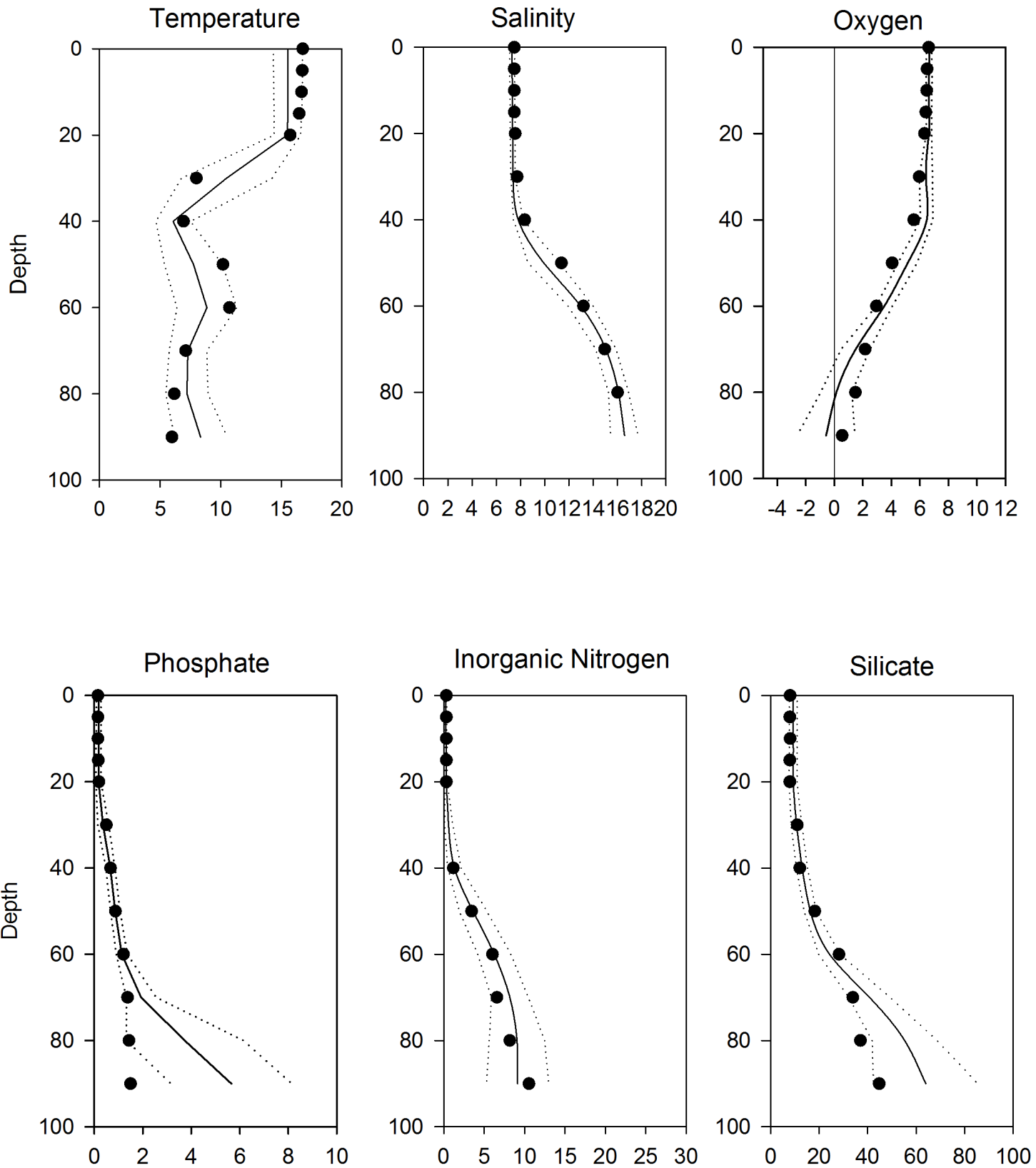


OXYGEN IN BOTTOM WATER (depth >80m)



Vertical profiles BY4 September

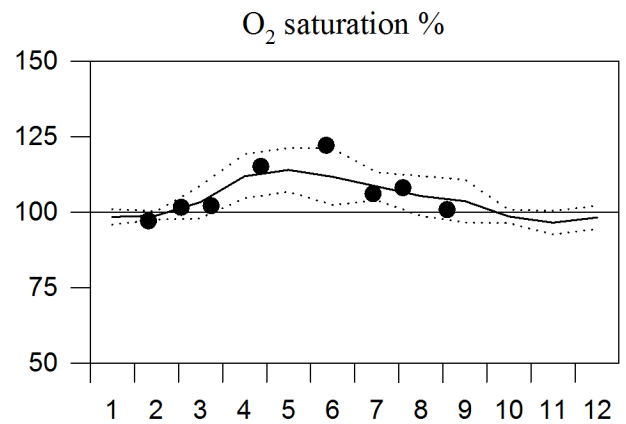
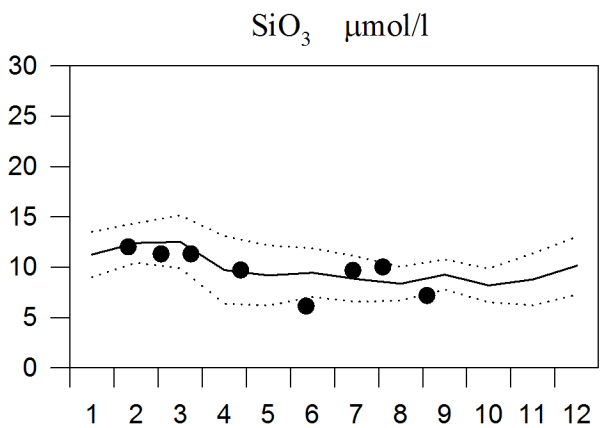
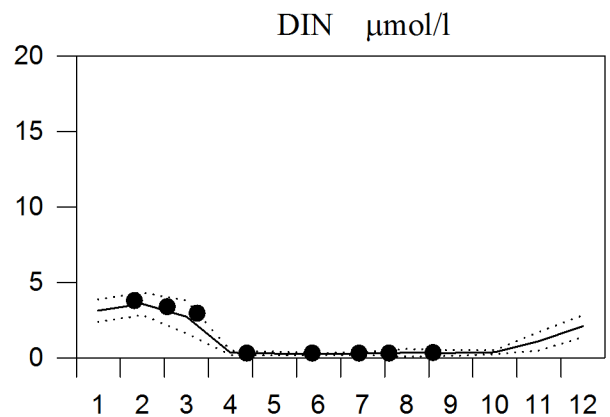
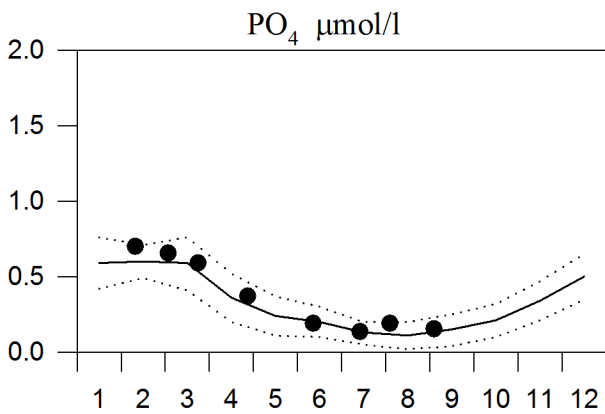
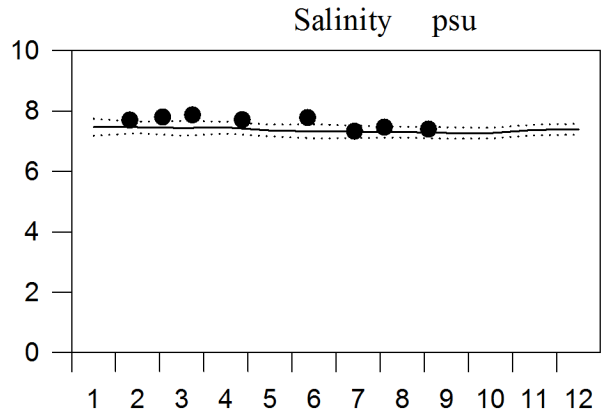
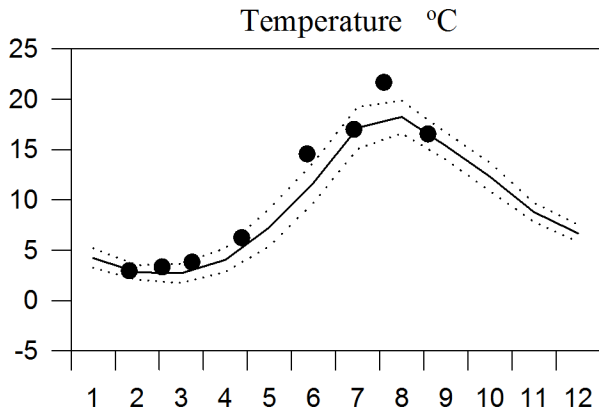
— Mean 1996-2010 ····· St.Dev. ● 2014



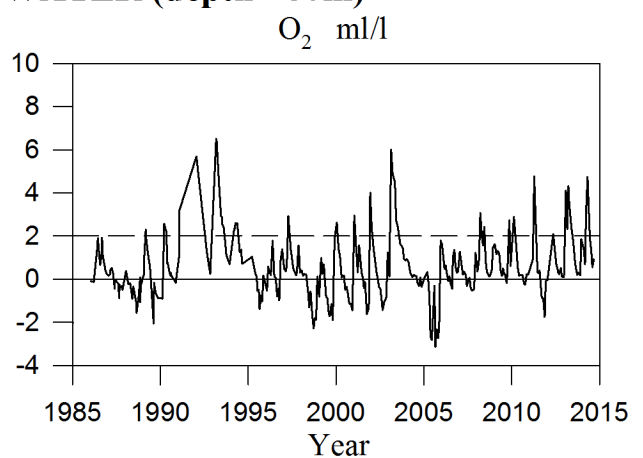
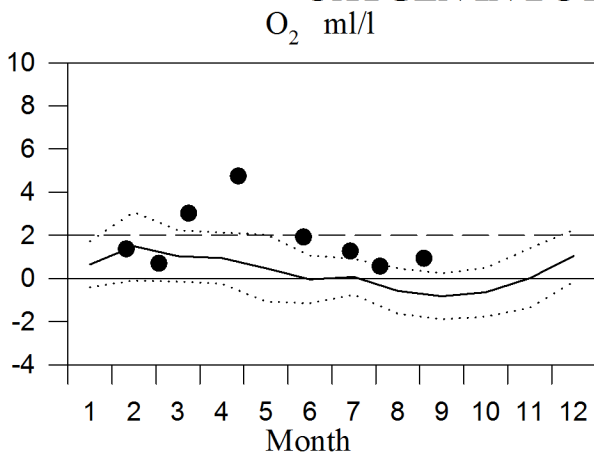
STATION BY5 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2014

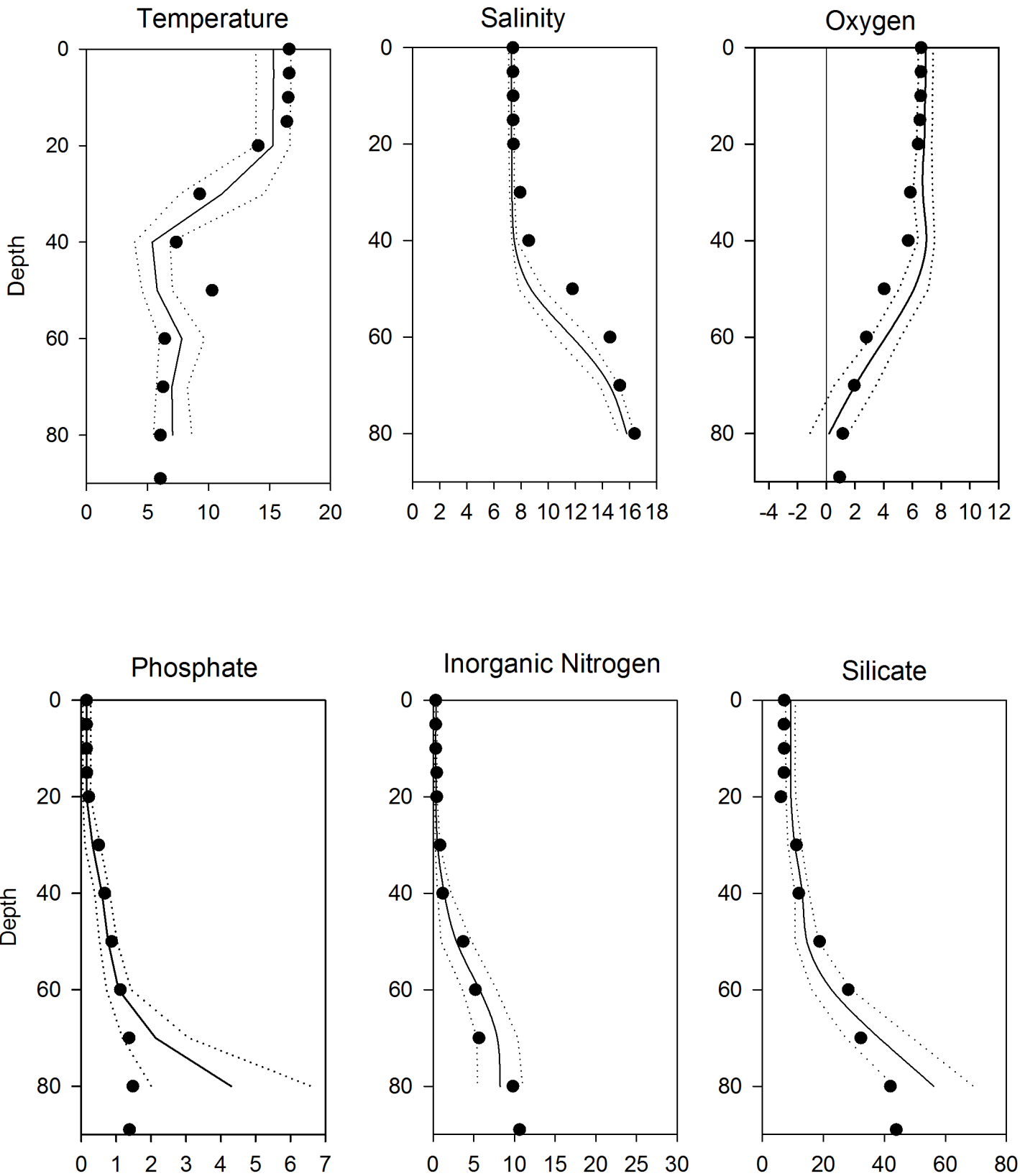


OXYGEN IN BOTTOM WATER (depth >80m)



Vertical profiles BY5 September

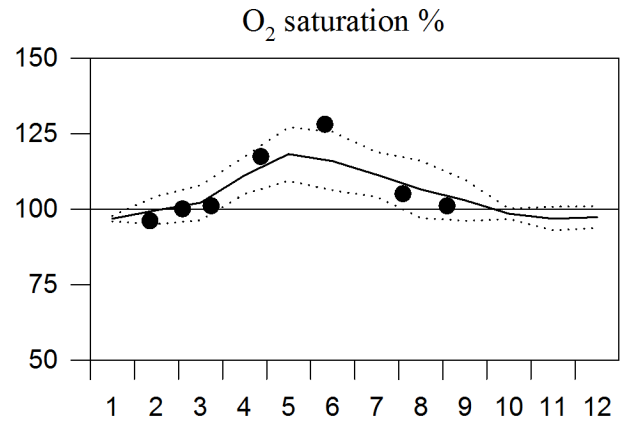
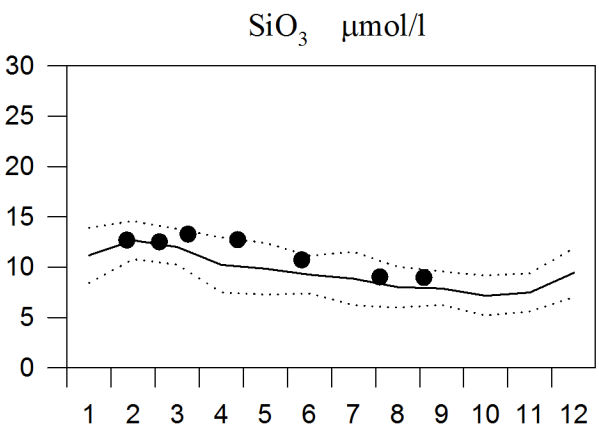
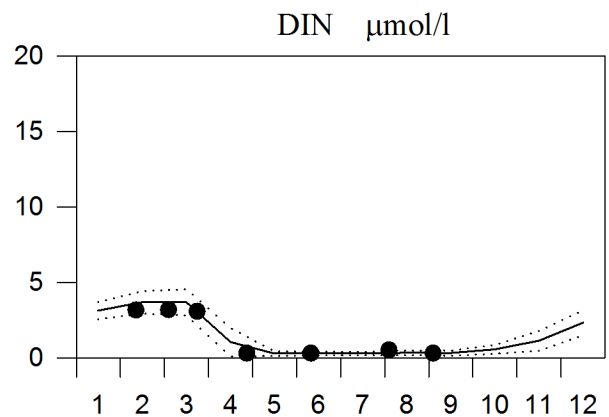
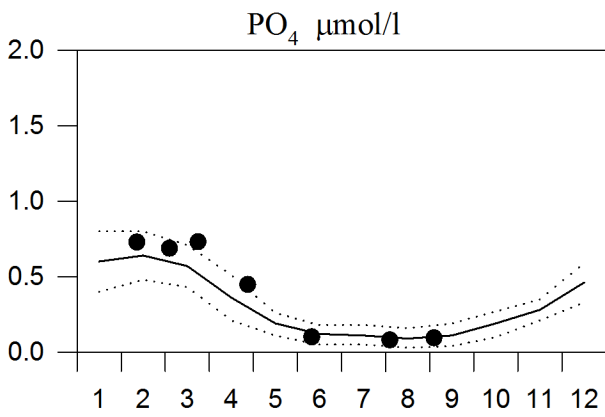
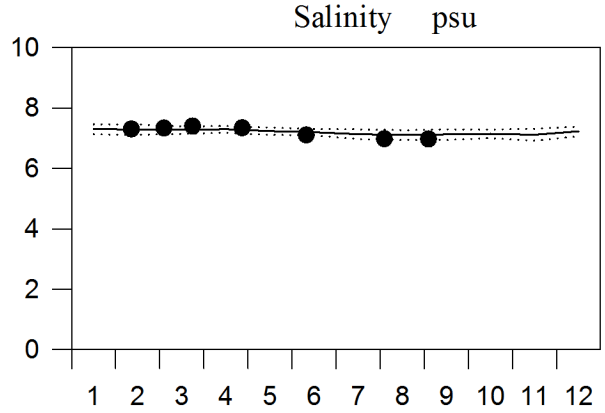
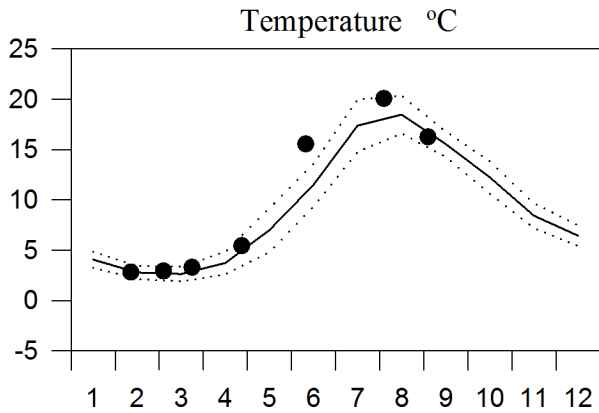
— Mean 1996-2010 ····· St.Dev. ● 2014



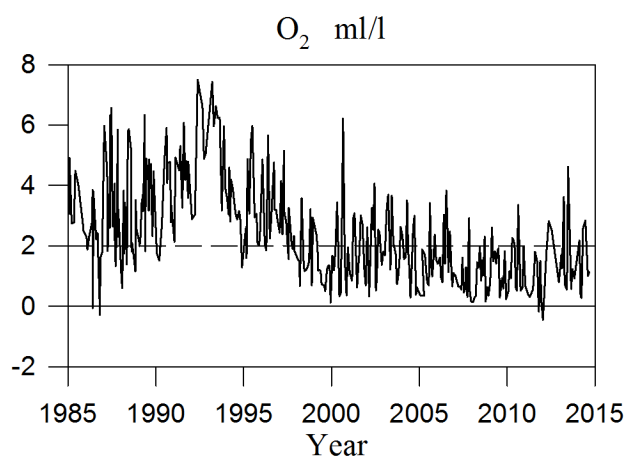
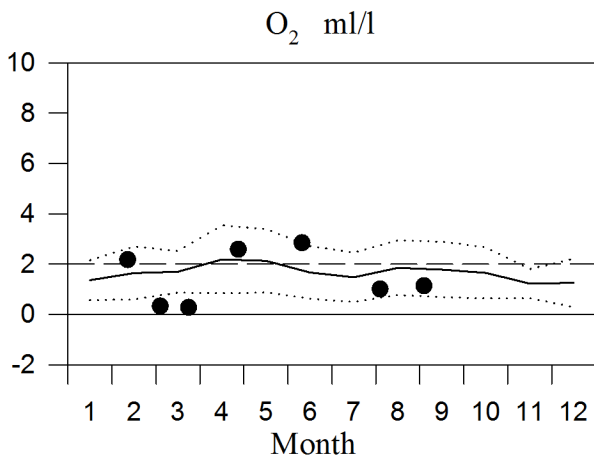
STATION BCS III-10 SURFACE WATER

Annual Cycles

— Mean 1996-2010 ····· St.Dev. ● 2014

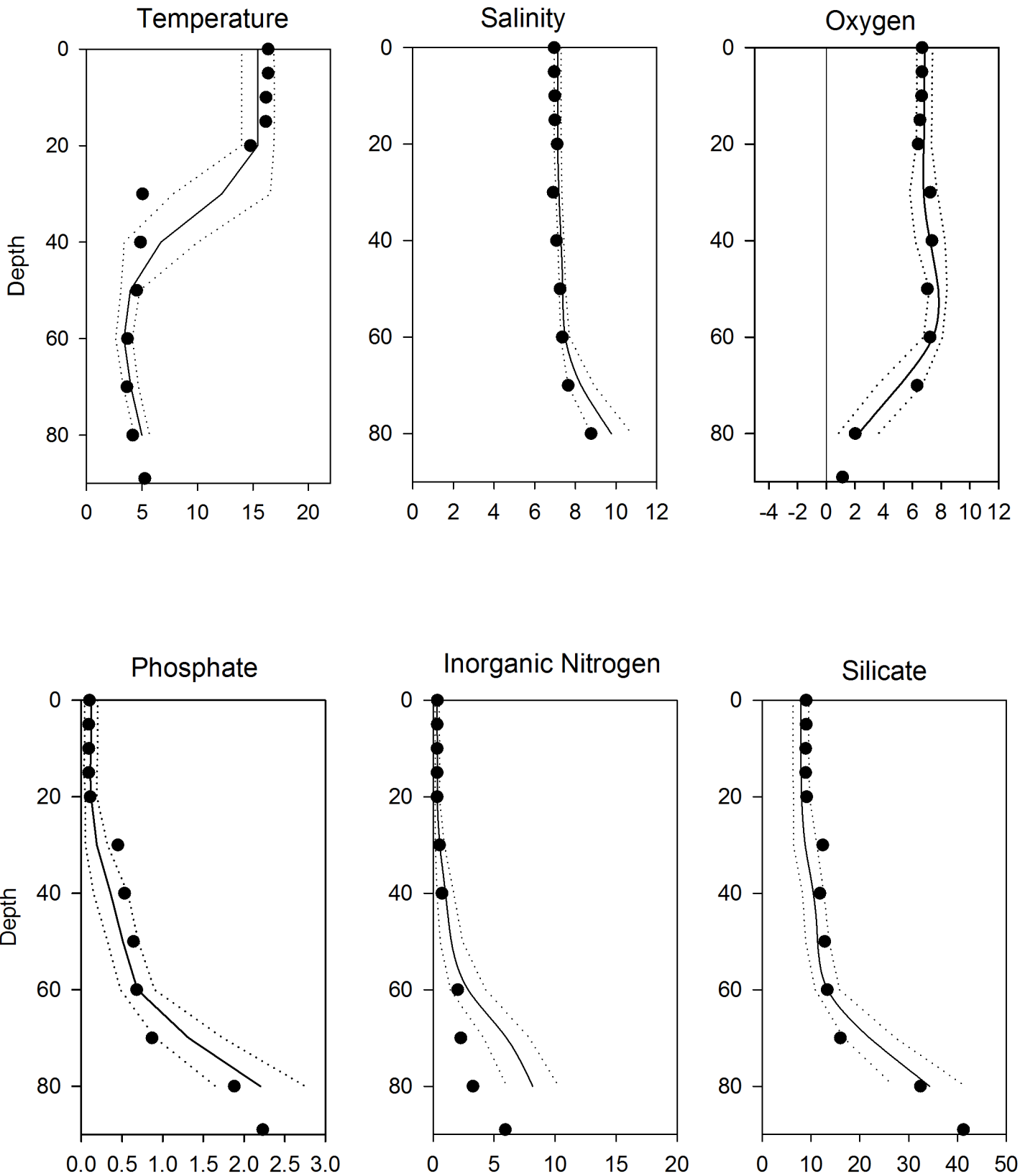


OXYGEN IN BOTTOM WATER (depth > 80m)



Vertical profiles BCS III-10 September

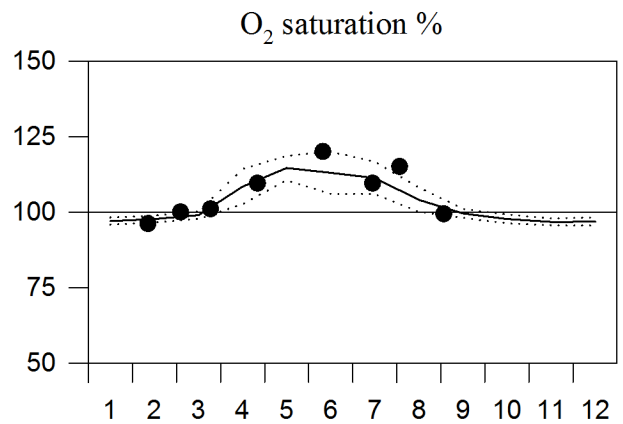
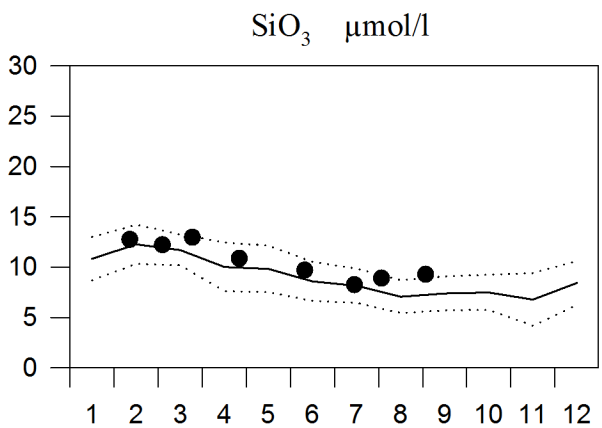
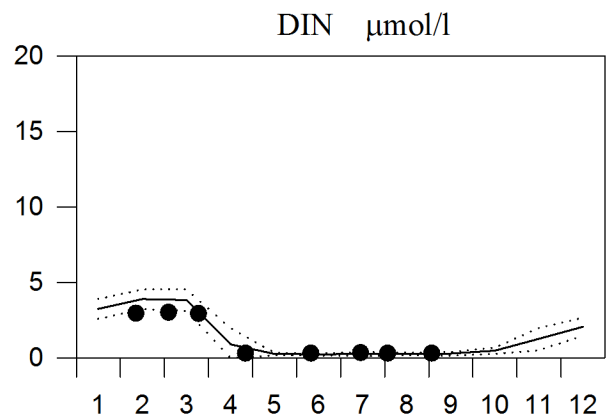
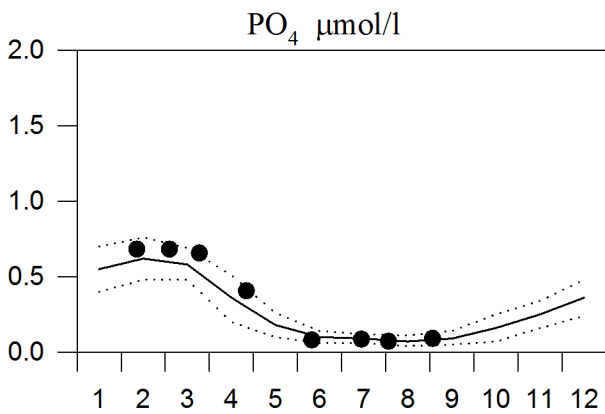
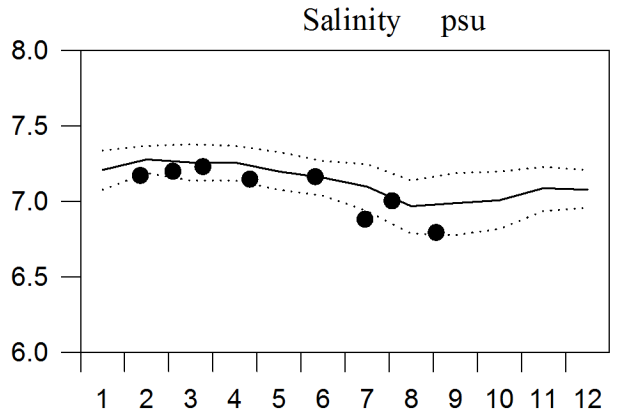
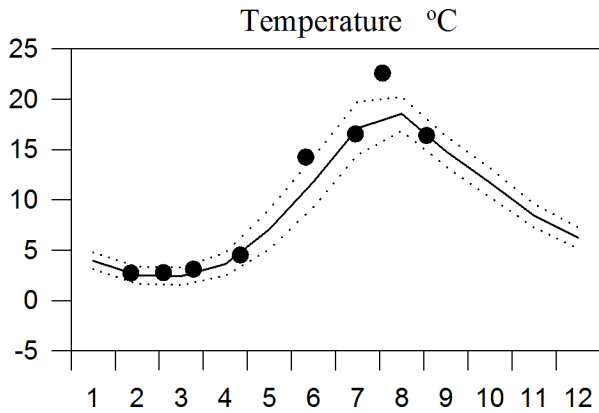
— Mean 1996-2010 ····· St.Dev. ● 2014



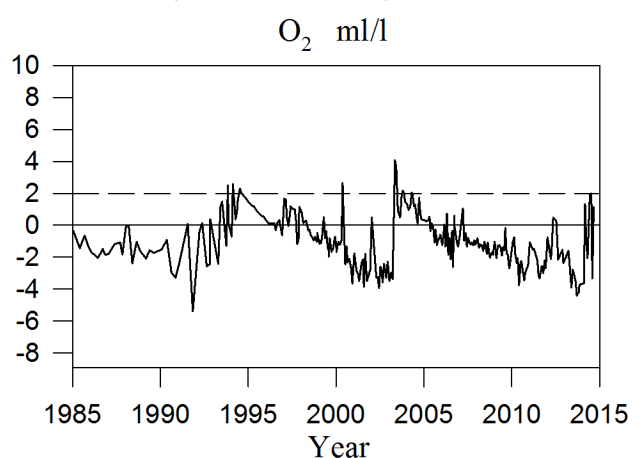
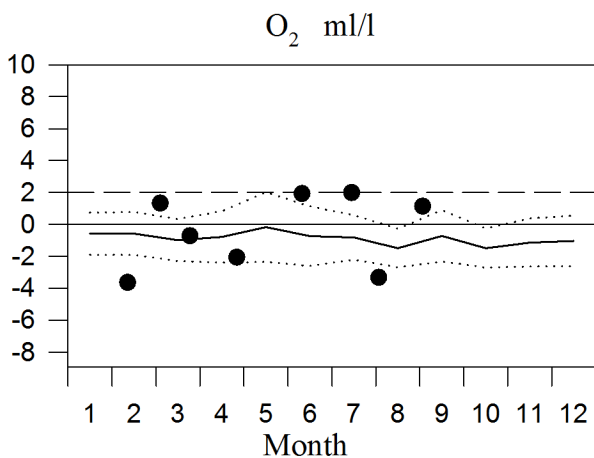
STATION BY10 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2014

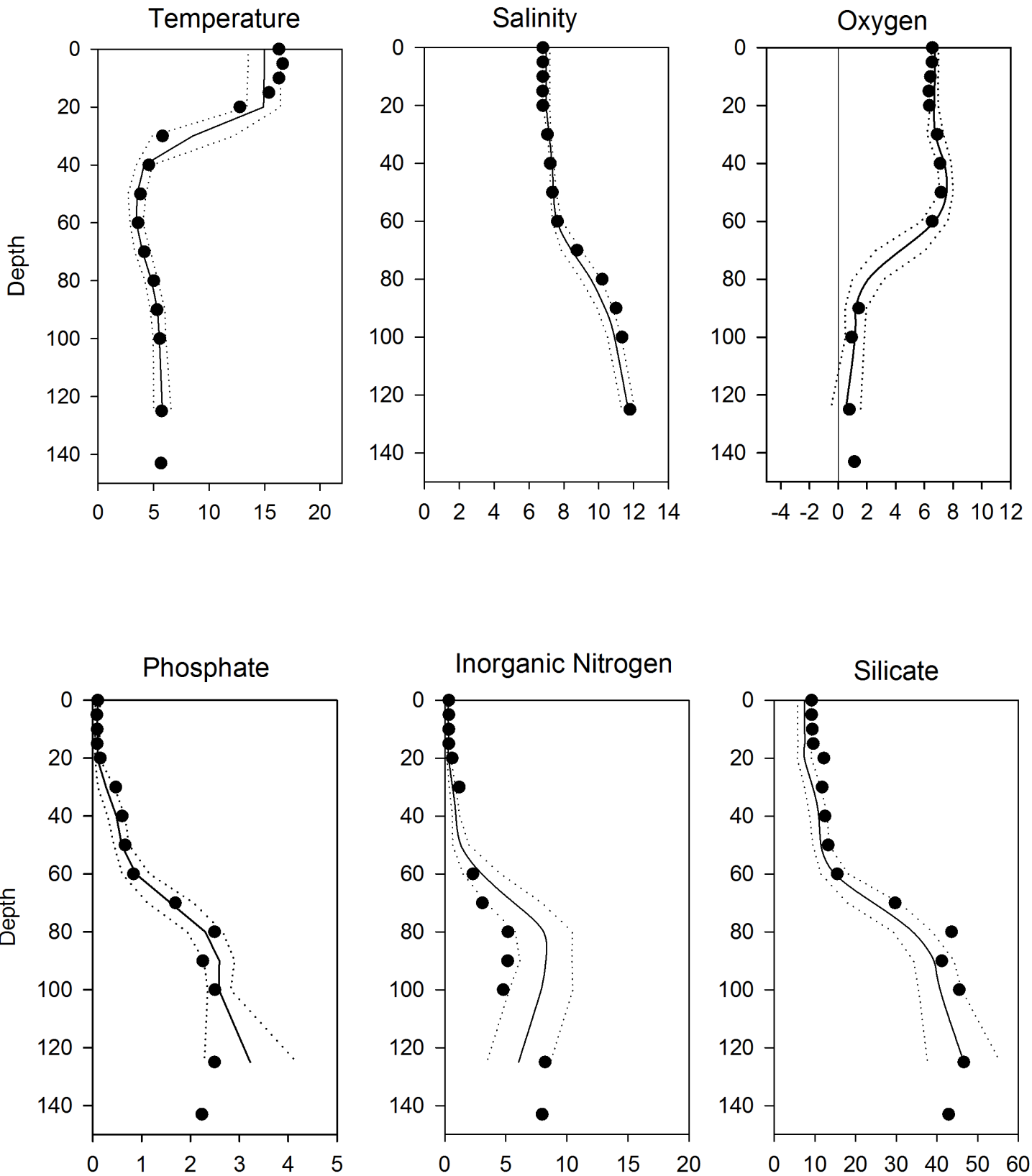


OXYGEN IN BOTTOM WATER (depth >125m)



Vertical profiles BY10 September

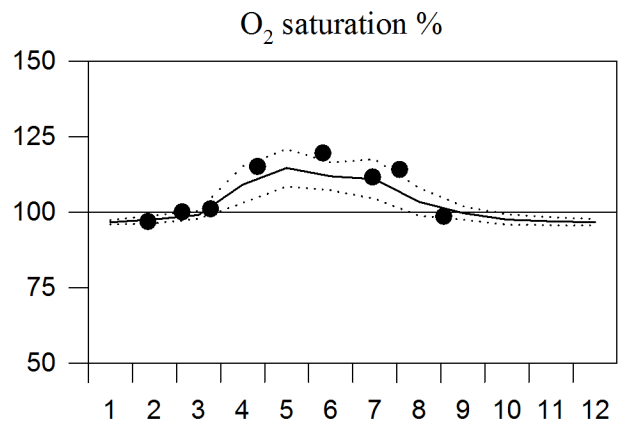
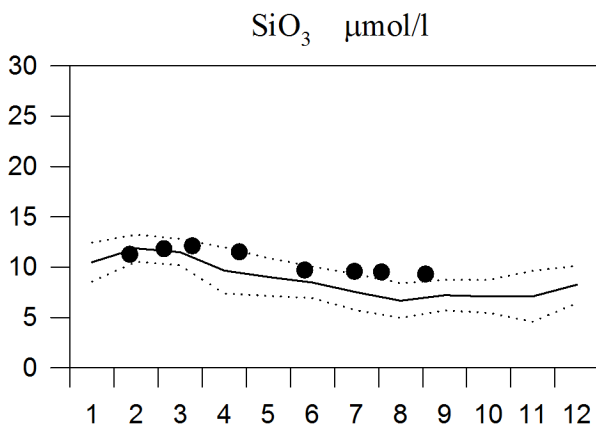
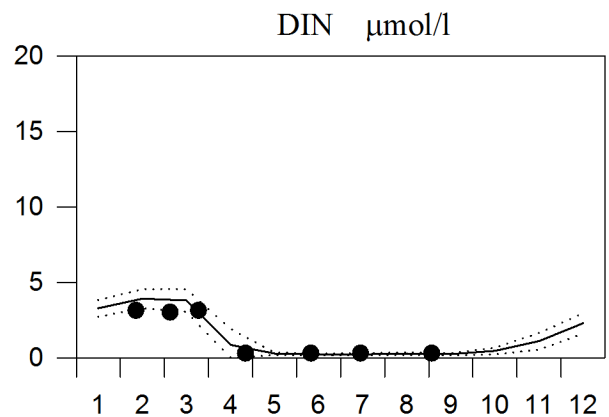
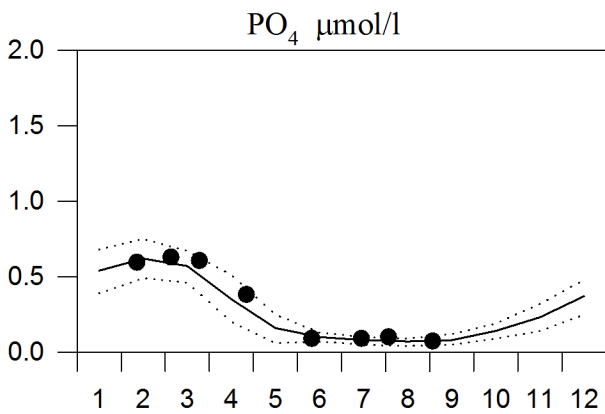
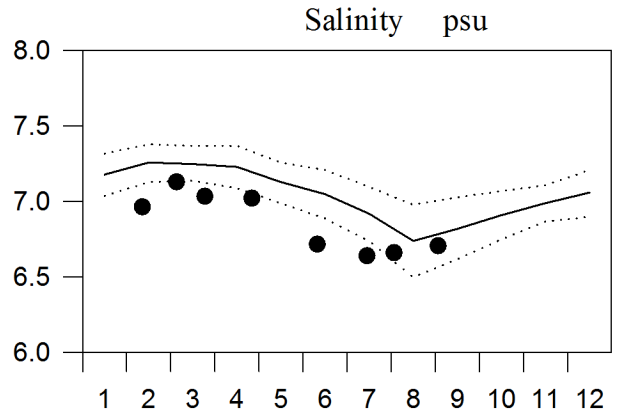
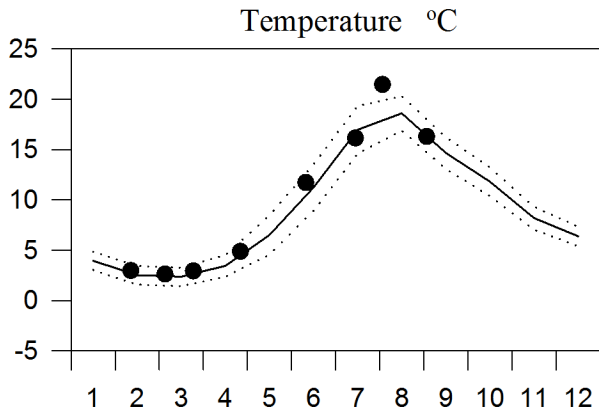
— Mean 1996-2010 ····· St.Dev. ● 2014



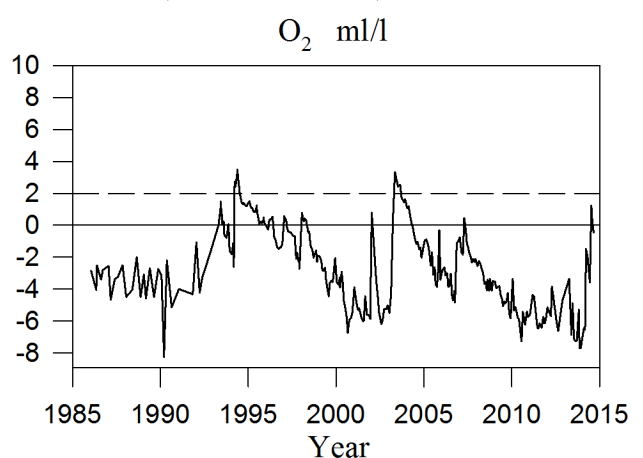
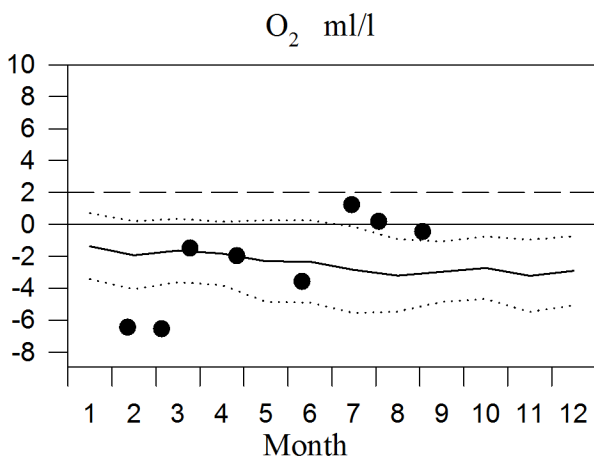
STATION BY15 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2014

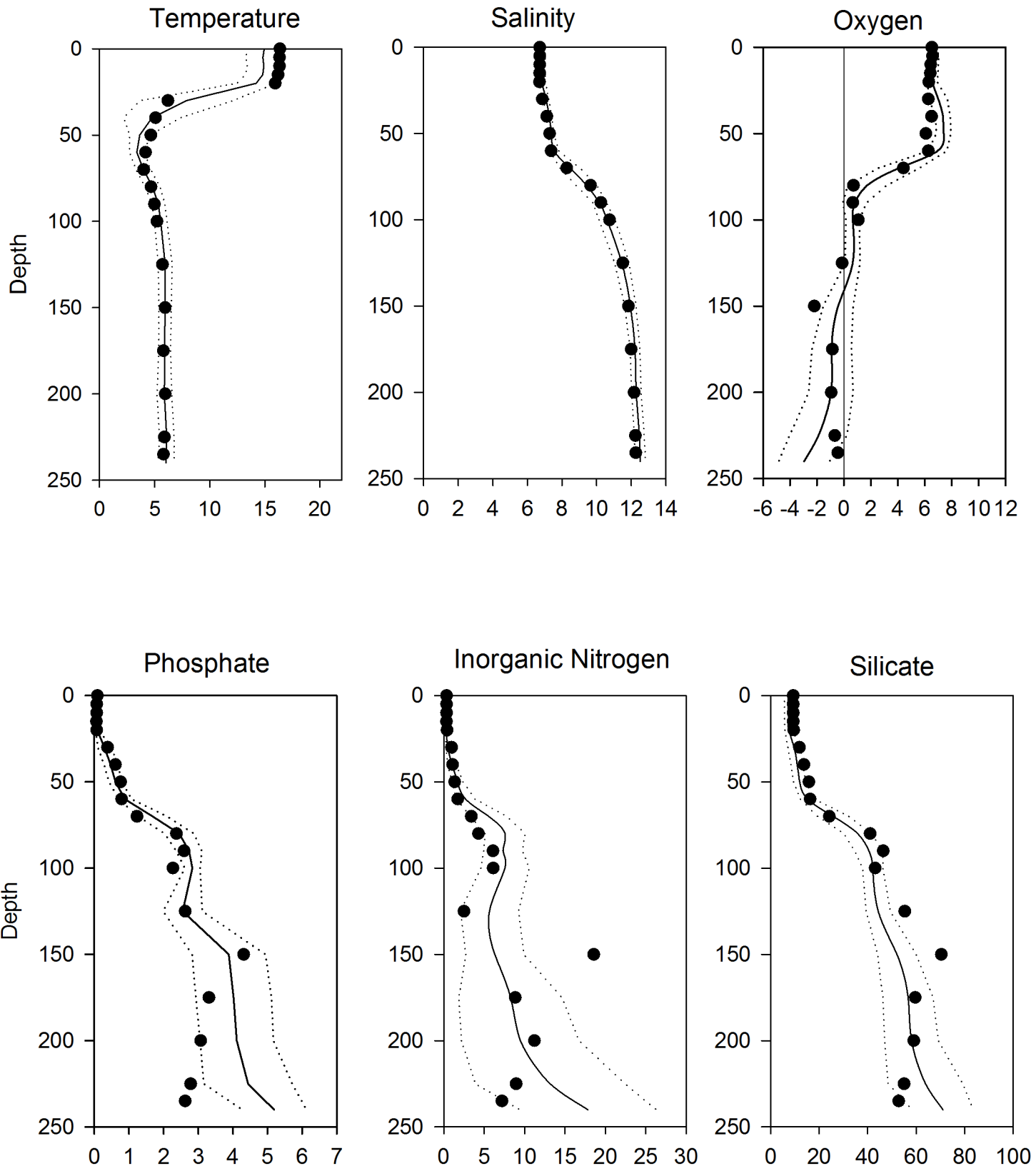


OXYGEN IN BOTTOM WATER (depth >225m)



Vertical profiles BY15 September

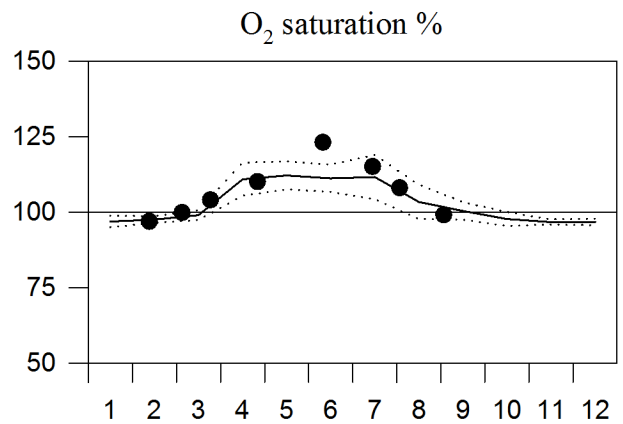
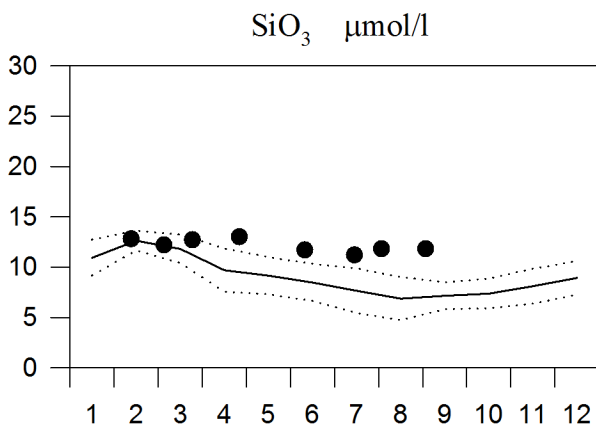
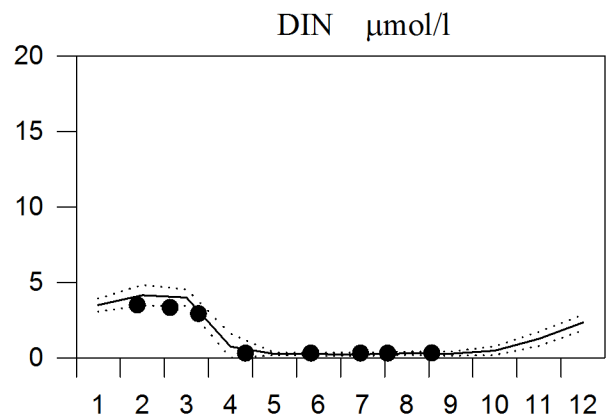
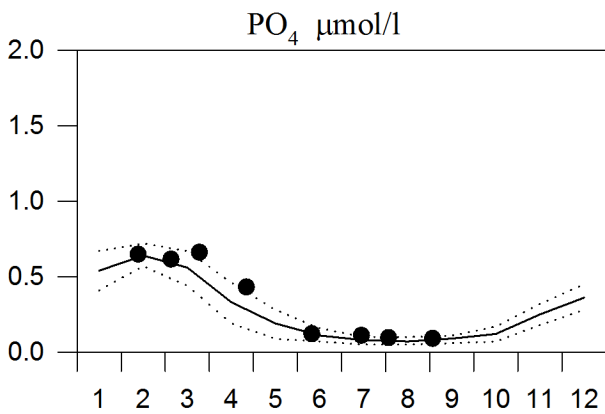
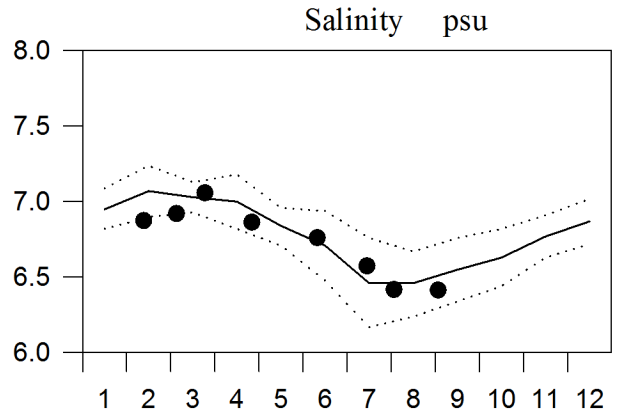
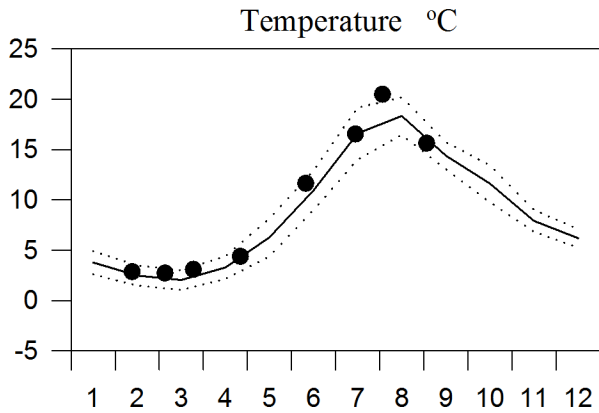
— Mean 1996-2010 ····· St.Dev. ● 2014



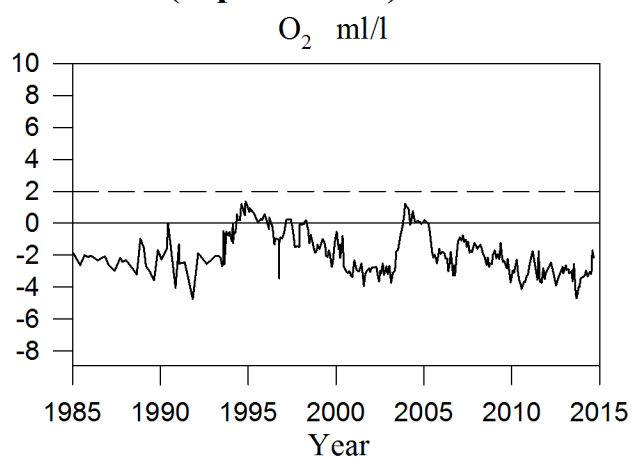
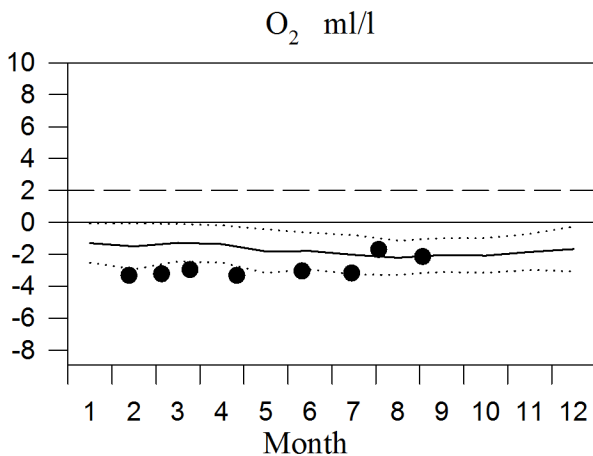
STATION BY20 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2014

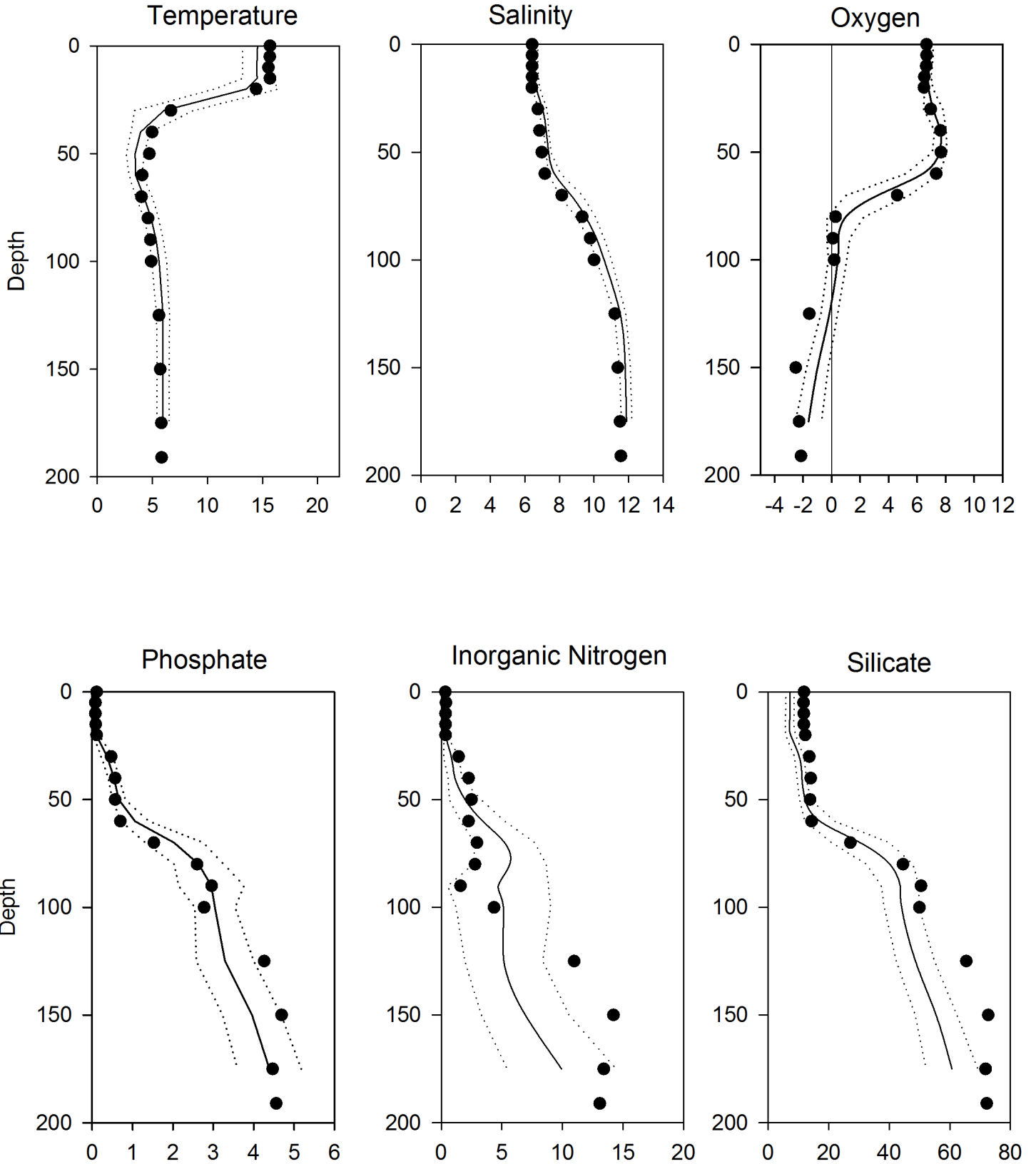


OXYGEN IN BOTTOM WATER (depth >175m)



Vertical profiles BY20 September

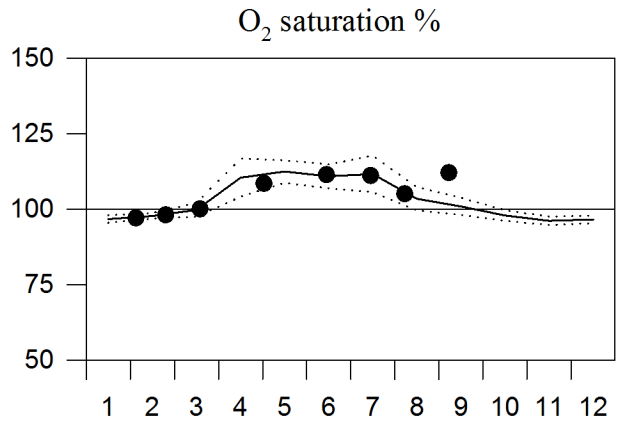
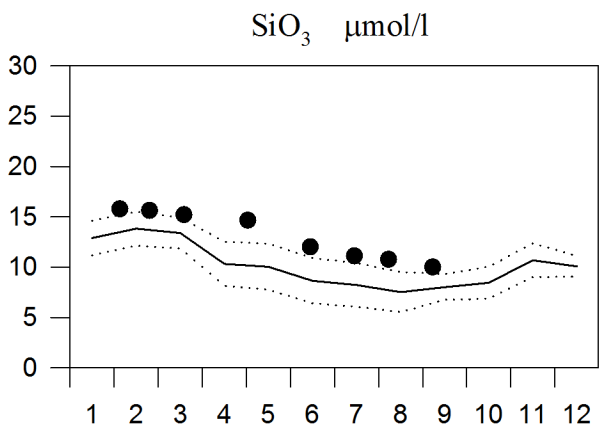
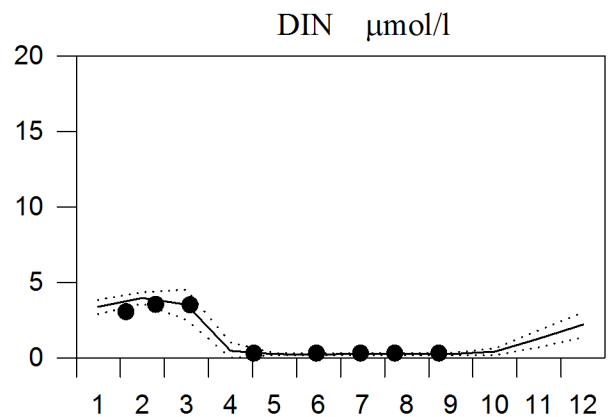
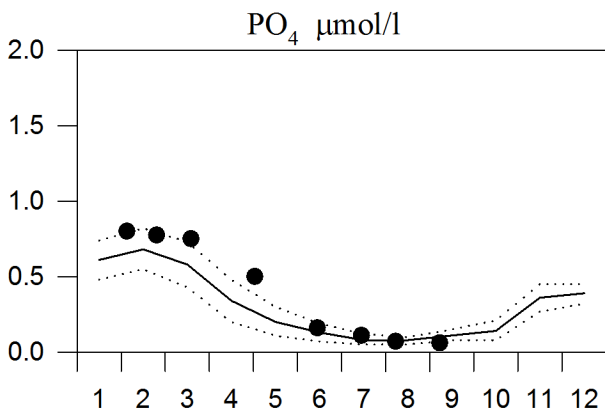
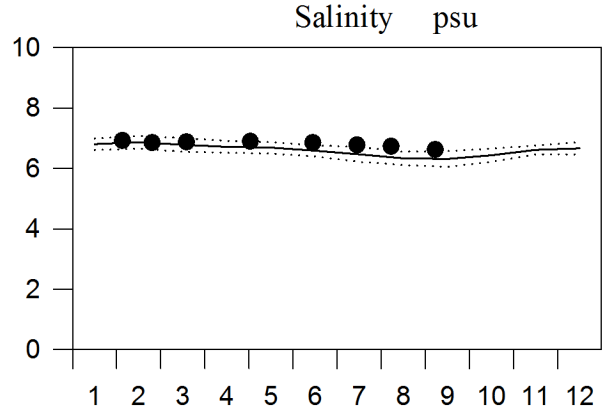
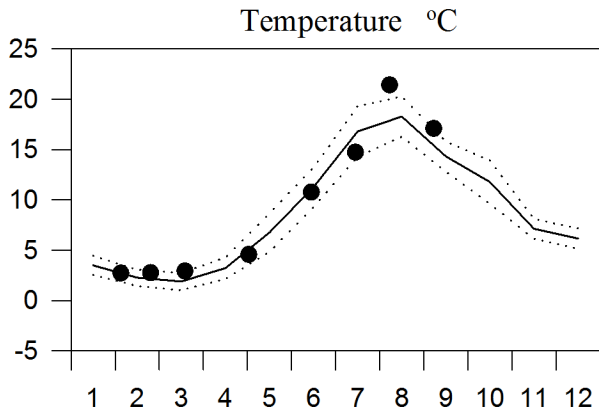
— Mean 1996-2010 ····· St.Dev. ● 2014



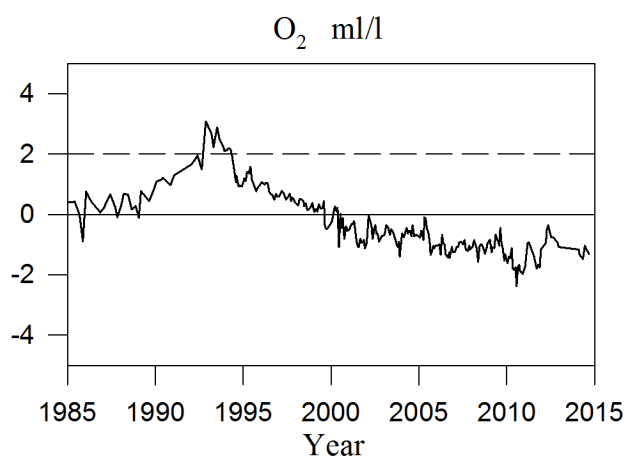
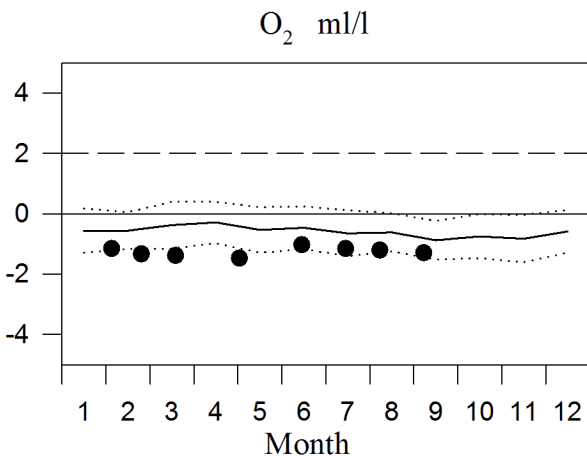
STATION BY32 SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2014

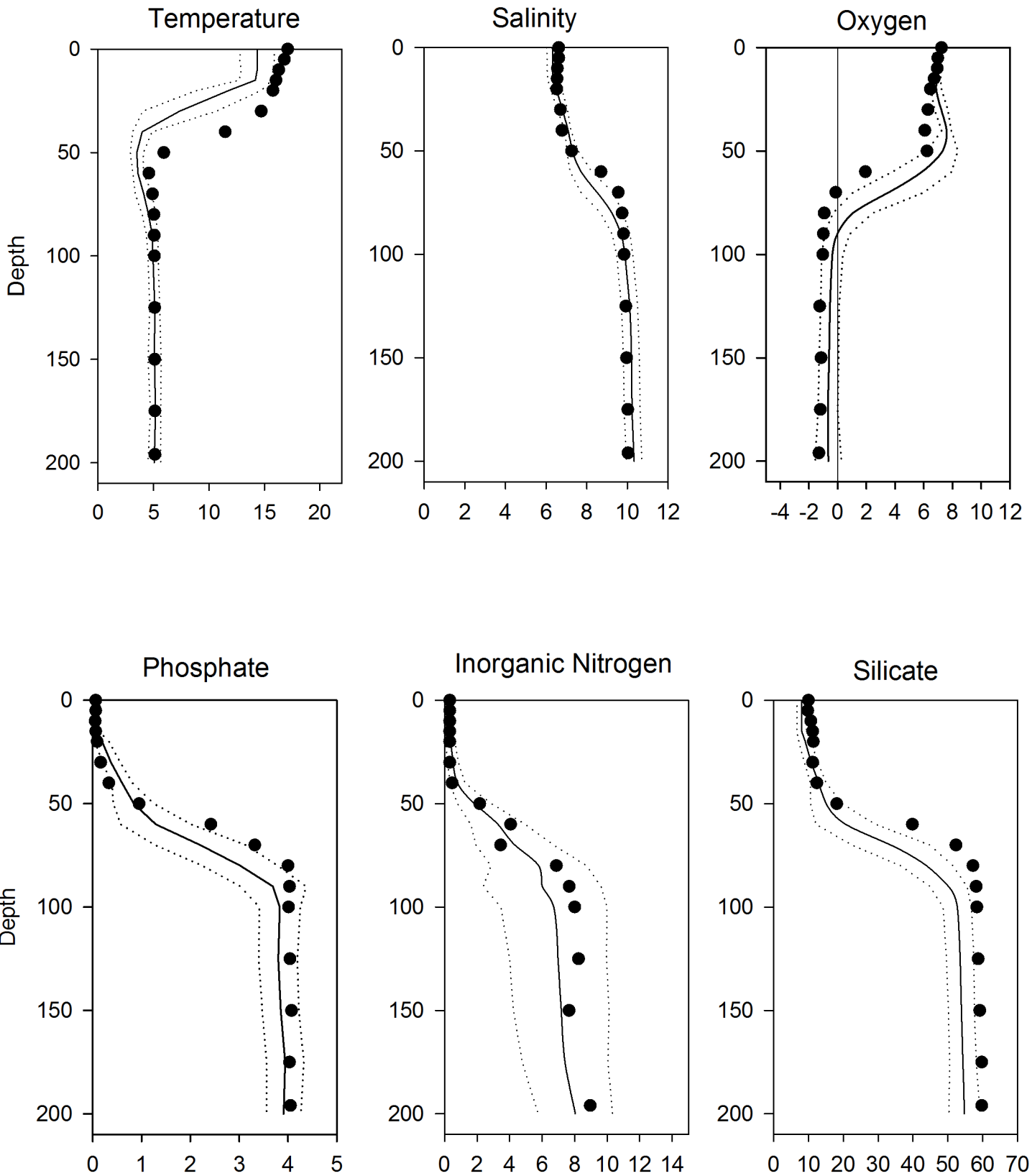


OXYGEN IN BOTTOM WATER (depth > 175m)



Vertical profiles BY32 September

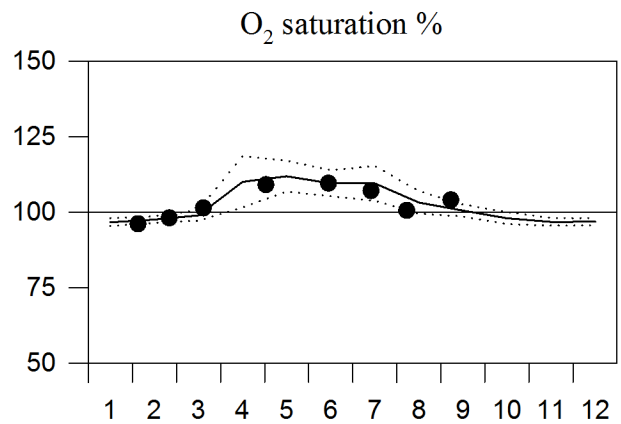
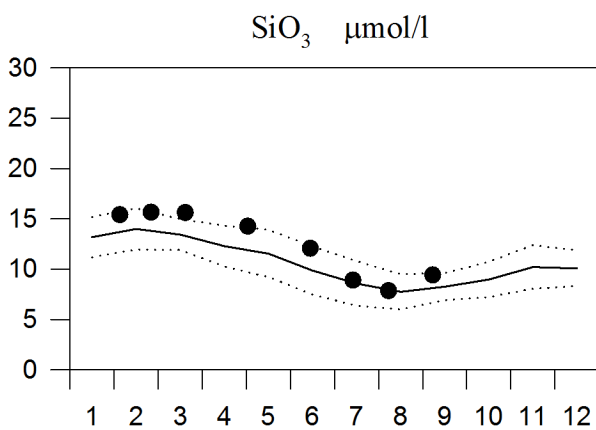
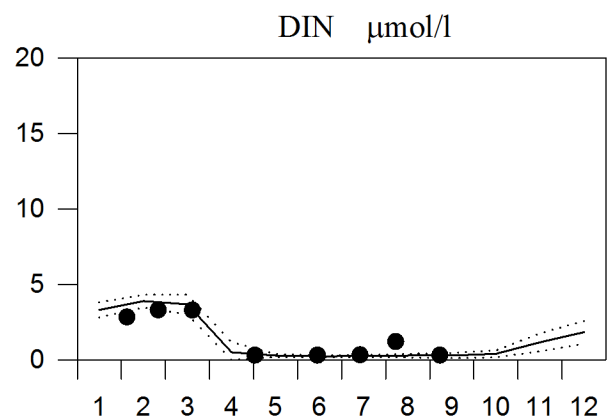
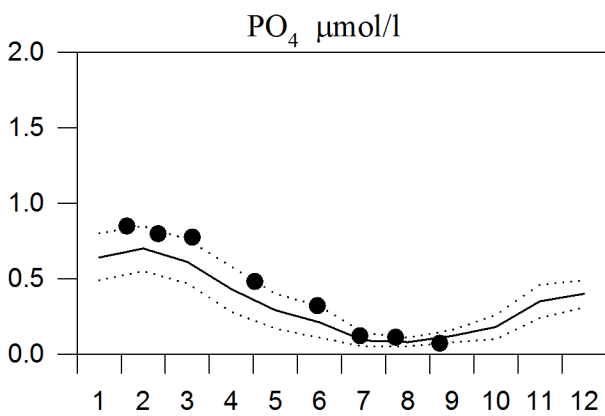
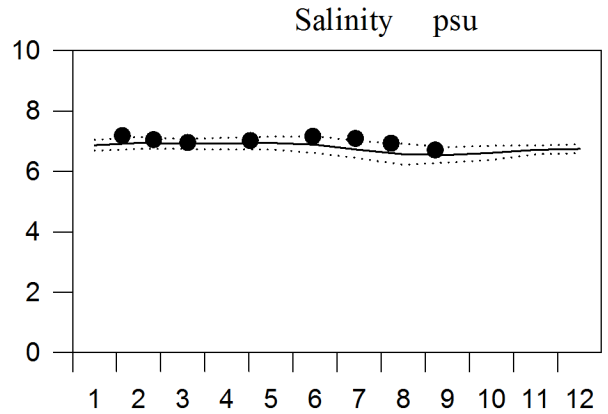
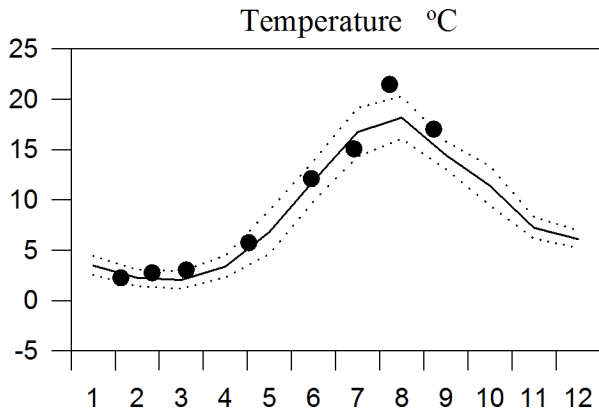
— Mean 1996-2010 ····· St.Dev. ● 2014



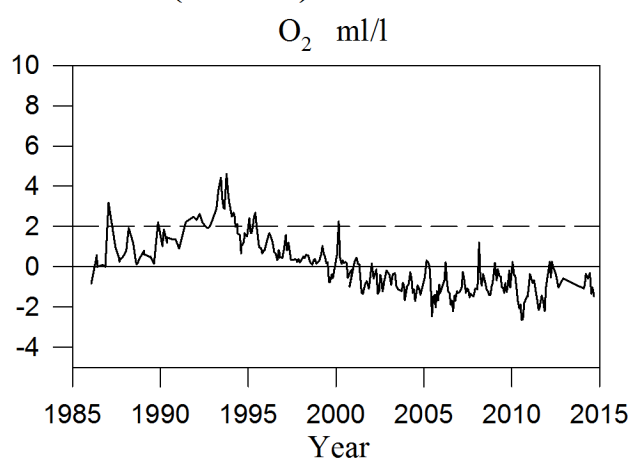
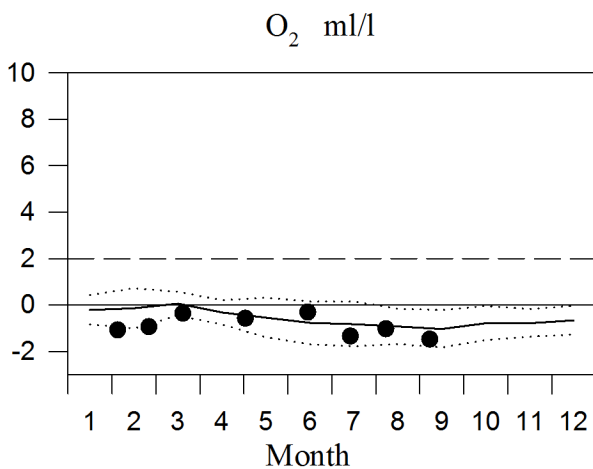
STATION BY38 SURFACE WATER

Annual Cycles

— Mean 1996-2010 ····· St.Dev. ● 2014

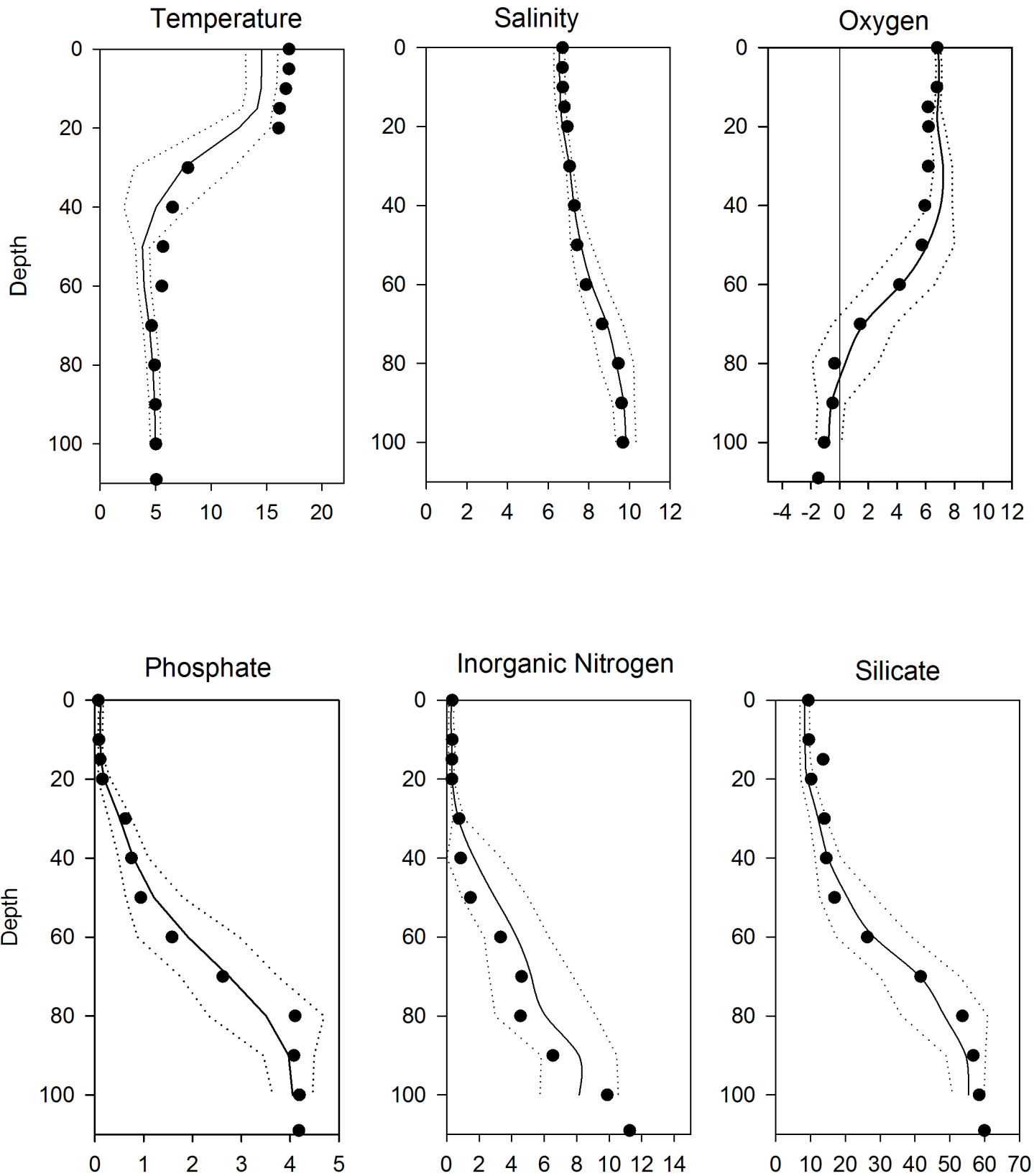


OXYGEN IN BOTTOM WATER (> 100m)



Vertical profiles BY38 September

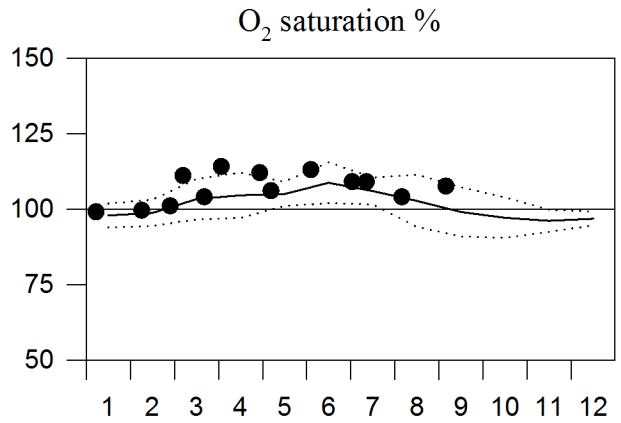
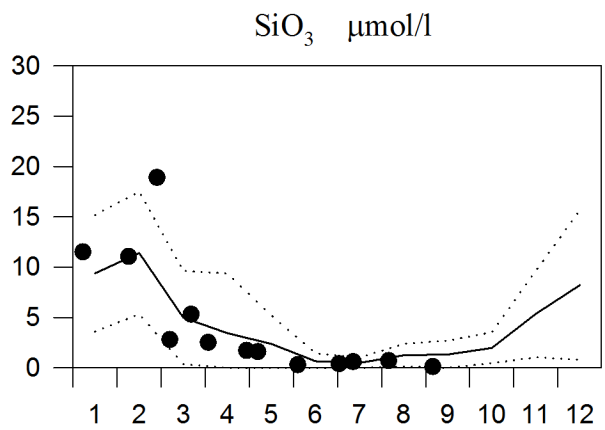
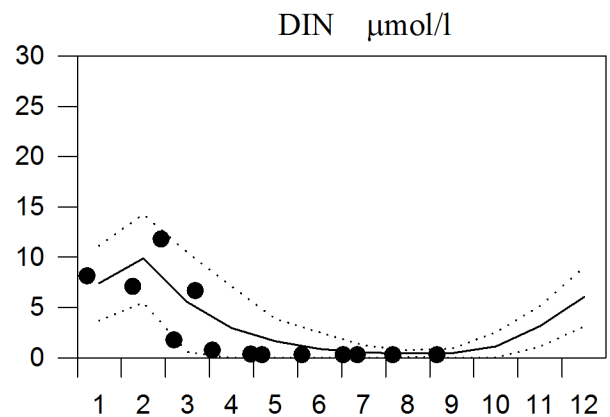
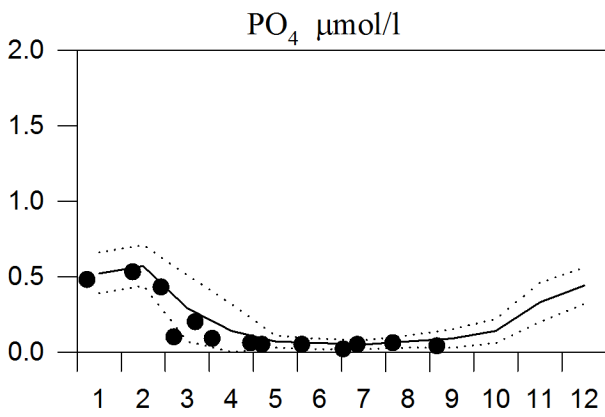
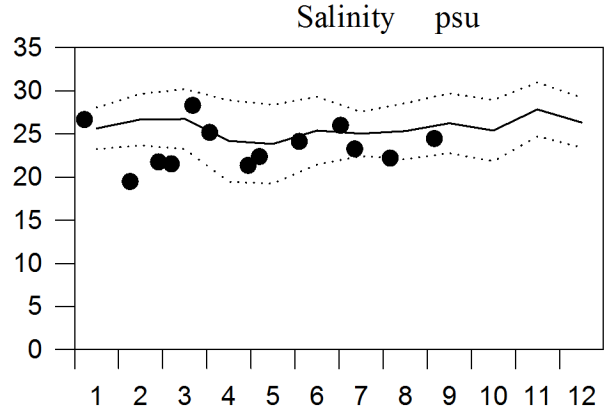
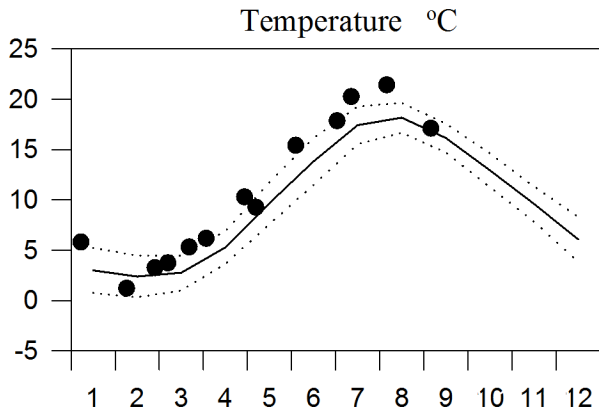
— Mean 1996-2010 ····· St.Dev. ● 2014



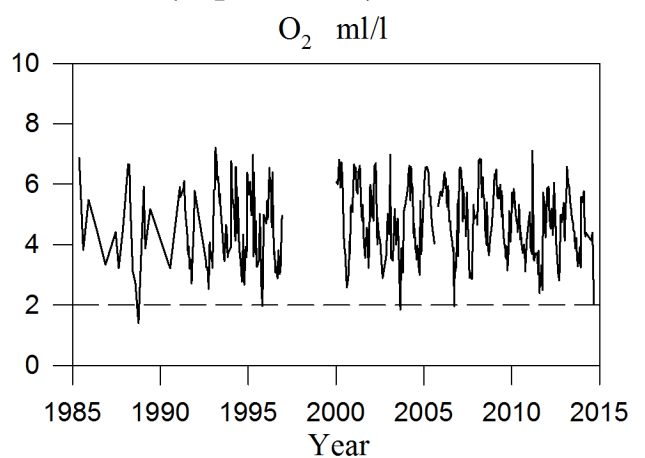
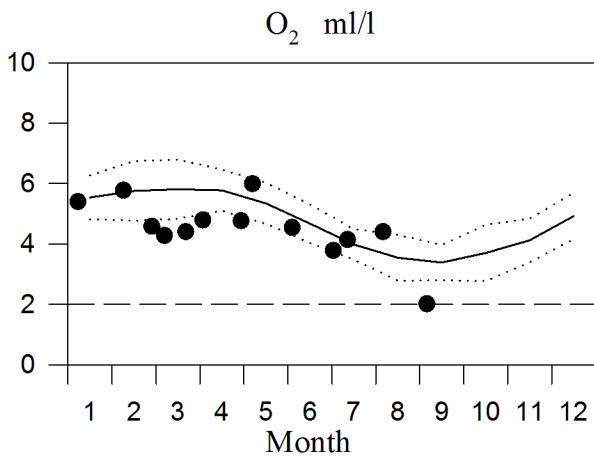
STATION SLÄGGÖ SURFACE WATER

Annual Cycles

— Mean 1996-2010 St.Dev. ● 2014

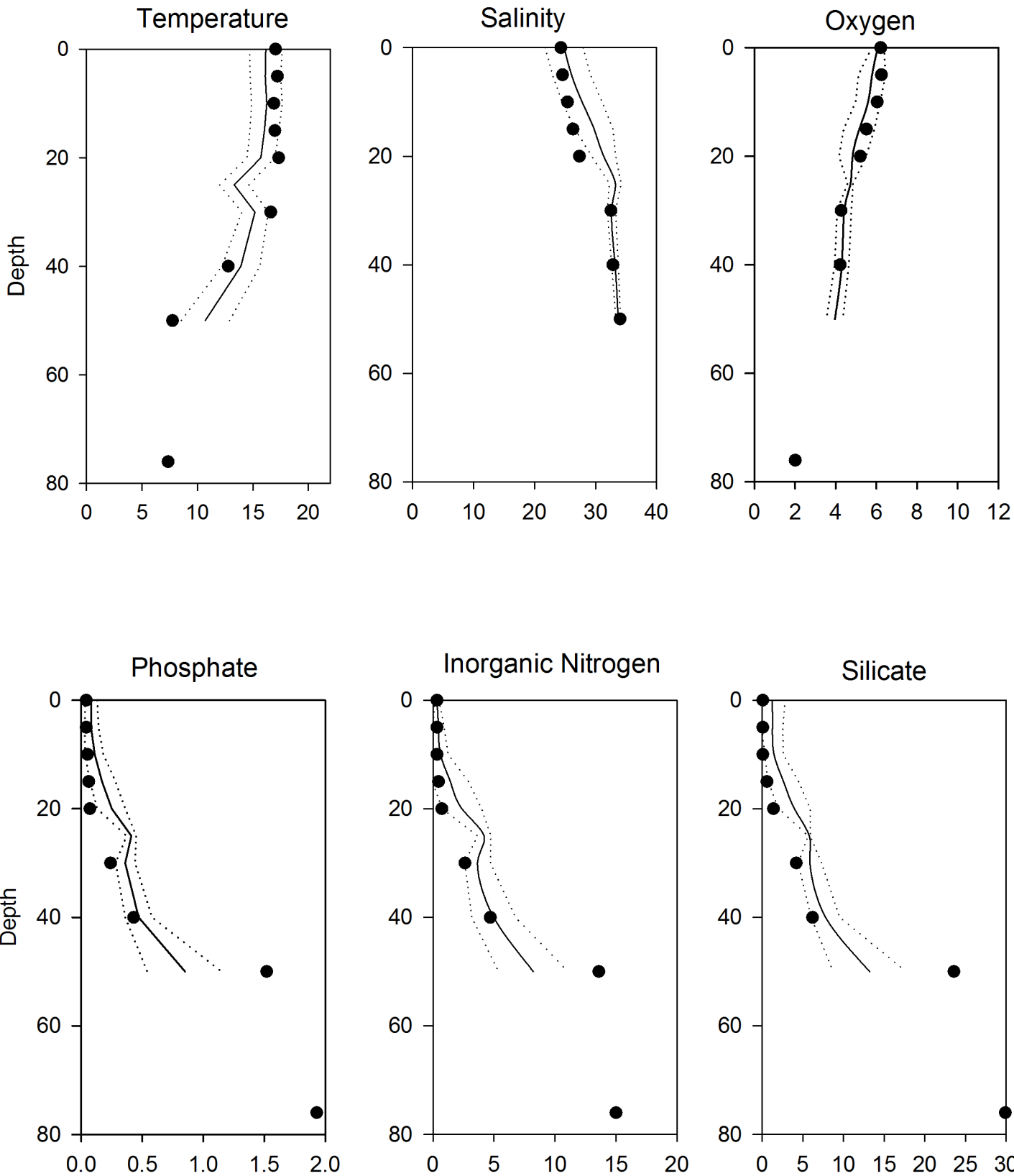


OXYGEN IN BOTTOM WATER (depth >50m)



Vertical profiles Släggö September

— Mean 1996-2010 St.Dev. ● 2014



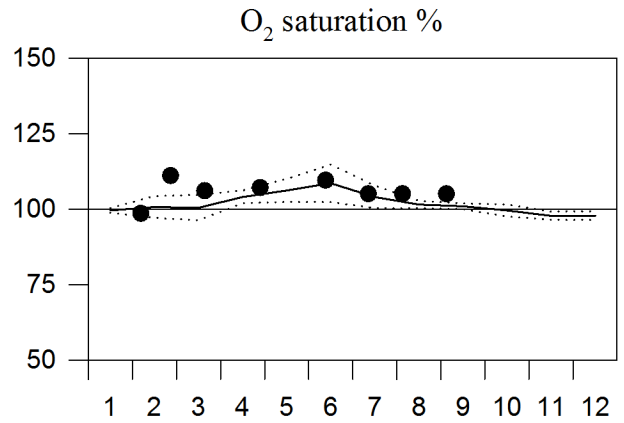
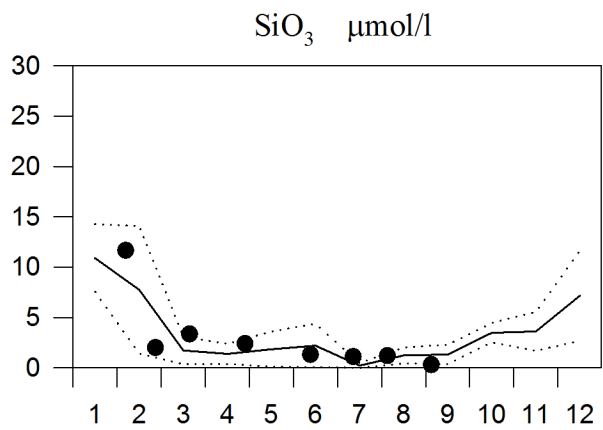
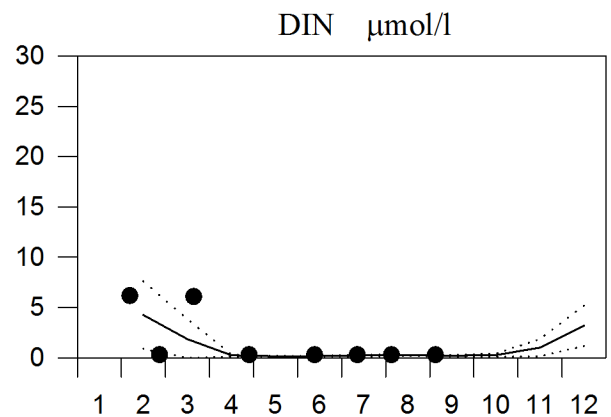
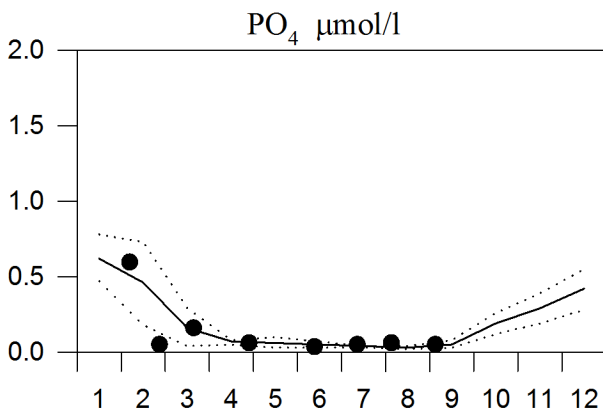
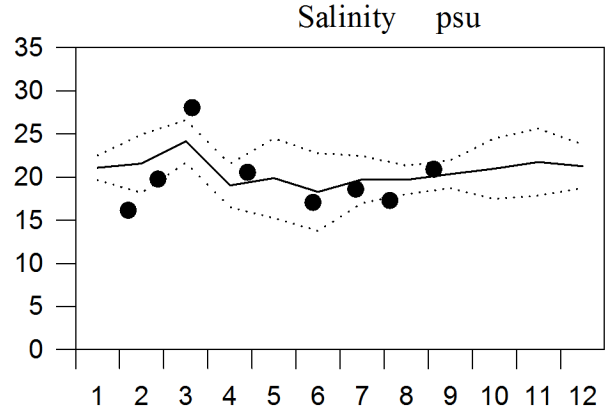
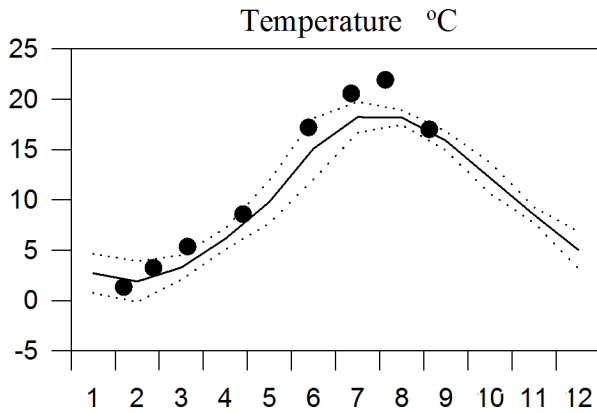
STATION N14 Falkenberg SURFACE WATER

Annual Cycles

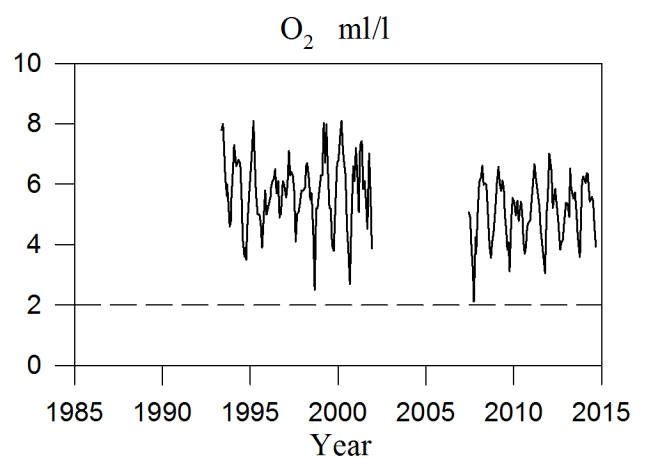
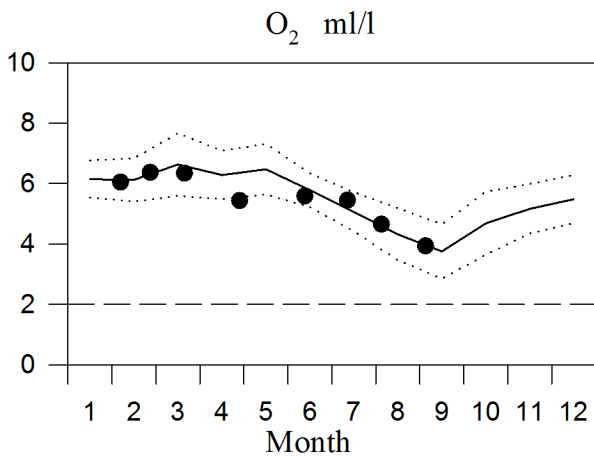
— Mean 2007-2010

..... St.Dev.

● 2014



OXYGEN IN BOTTOM WATER (depth > 25m)



Vertical profiles N14 Falkenberg September

— Mean 1996-2010 St.Dev. ● 2014

