

## Report from the SMHI monitoring cruise with M/V Aura



<b>Survey period:</b>	2018-04-15 - 2018-04-21
<b>Principal:</b>	Swedish Meteorological and Hydrological Institute (SMHI), Swedish Agency for Marine and Water Management (SwAM).
<b>Cooperation partners:</b>	Finnish Environment Institute (SYKE), VG-Shipping.

### SUMMARY

The March cruise, which is part of the Swedish national marine monitoring program, covered the Skagerrak, the Kattegat, the Sound and the Baltic Proper.

The spring bloom was ongoing in almost the whole area and large peaks in fluorescence was measured with the CTD.

The deep water in large parts of the Baltic Proper has oxygen concentrations near zero. Completely oxygen free areas, when toxic hydrogen sulphide is formed, were measured in the Bornholm Basin and Western Gotland Basin from 85 meters depth. In the Eastern Gotland Basin was hydrogen sulphide measured from depth exceeding 125 meters. Acute hypoxia (oxygen < 2ml/l) was found in the whole area from 60-80 meters depth, except in the Arkona Basin where the whole water column was well oxygenated.

The surface concentrations of dissolved inorganic nitrogen (DIN) and dissolved inorganic phosphorus (DIP) was normal for the season in the whole area. The silicate concentrations in the surface were higher than normal in the Bornholm Basin, Eastern and Western Gotland Basin, the other parts showed values normal for the season.

The next cruise will start in the middle of May.

## **RESULTS**

The April cruise was conducted aboard the Finnish vessel Aura, it started in Gothenburg on the 15<sup>th</sup> of April and ended in the same port on the 21<sup>th</sup>. The winds during the expedition were weak from southeast to west. The air temperature varied from 5 to 12°C

This report is based on data that have passed a first quality control. When data are published at the National Oceanographic Data Centre some values might have changed after further quality controls have been performed. Data from this cruise will be published as soon as possible on the data center's webpage, normally within a week after the cruise.

Download data here: <http://www.smhi.se/klimatdata/oceanografi/havsmiljodata> (only available in Swedish).

### **The Skagerrak**

The surface water temperature in the Skagerrak was slightly below normal for the season, between 3.2-4.8 °C, warmer in the coastal areas. The salinity in the surface was also slightly below normal and was measured to 21.1-24.8 psu. Thermocline and halocline coincided at all stations, and was more or less developed between 10 and 20 meters depth.

The nutrients were influenced by the current spring bloom and were partially or almost completely consumed. Nutrients in the form of dissolved inorganic nitrogen, DIN (the sum of nitrate, nitrite and ammonia), were on normal levels for the season and varied between 0.3–1.3 µmol/l, the highest levels near the coastal areas. Concentrations of dissolved inorganic phosphorus, DIP, were also on normal levels. Values in the surface water ranged from 0.05 – 0.07 µmol/l. Silicate concentrations were normal for the season at all stations, with values around 0.1 – 1.6 µmol/l, highest close to the coast.

The spring bloom was ongoing in the offshore parts and large peaks in fluorescence were found at 10 to 20 meters depth at these sampling points. For more information on species composition see separate report "AlgAware" that will be available one to two weeks after completion of the expedition.

Oxygen conditions were good at all visited stations with normal to higher than normal concentrations for the season in the surface water due to the ongoing spring bloom and normal to below normal in the bottom water. The concentration in the bottom water varied between 5 and 6 ml/l which is high above the limit for acute hypoxia (<2 ml/l).

### **The Kattegat and the Sound**

The water temperature was slightly below normal for the season and varied between 4.7-5.5°C in the surface layer, highest level near the coastal area. The salinity was normal and was in the Kattegat surface water 19.4-21.8 psu and in the Sound the salinity was about 14.7 psu. Thermocline and halocline coincided at all stations and was found at 6-15 meters depth.

The concentration of nutrient in the surface water showed low levels due to the ongoing spring bloom which is normal for the season.

The concentration of DIN showed normal values for the season and was 0.3 µmol/l in the Kattegat and 0.7 µmol/l in the Sound. The DIP concentrations in the surface water in the Kattegat were

found to be between 0.06 and 0.09  $\mu\text{mol/l}$  and in the Sound, 0.20  $\mu\text{mol/l}$ . The amounts of silicate were lower than normal in the area with concentrations between 0.4 and 3.5, highest in the Sound.

The spring bloom was still ongoing in the Kattegatt and had also begun in the Sound. Fluorescence measurements with the CTD showed that the activity was in depth between 10 and 20 meters.

The deep water was well oxygenated in the whole area which is normal for the season. The oxygen concentrations near the bottom were generally above 5.5ml/l.

### **The Baltic Proper**

The surface water temperature was slightly below normal for the season and varied between 3.0-4.5°C. Surface salinity varied between 6.9 and 7.7, which is normal levels. There was a weak stratification at 8-20 meters depth where the spring bloom was ongoing. A stronger stratification was found at depths between 55-75 meters.

Surface concentrations of DIN were normal for the season in the whole area except at BCS III-10 where it was higher than normal, and ranged from 0.3 and 2.8  $\mu\text{mol/l}$ . Phosphate concentrations were under normal in the Arkona Basin and normal to above normal in the other investigated area, and varied between 0.19-0.67  $\mu\text{mol/l}$ . The silicate concentration in the surface were higher than normal in the Bornholm Basin, Eastern and Western Gotland Basin and normal for the season in the Arkona Basin and at BY20 and BY32, they varied between 7.5 and 18.8  $\mu\text{mol/l}$ .

The deep water in large parts of the Baltic Proper has oxygen concentrations near zero. Completely oxygen free areas, when toxic hydrogen sulphide is formed, were measured in the Bornholm Basin and Western Gotland Basin from 85 meters depth. In the Eastern Gotland Basin was hydrogen sulphide measured from depth exceeding 125 meters. Acute hypoxia (oxygen < 2ml/l) was found in the whole area from 60-80 meters depth, except in the Arkona Basin where the whole water column was well oxygenated.

Fluorescence measurements from the CTD showed that the spring bloom was ongoing in almost the whole area above the thermocline.

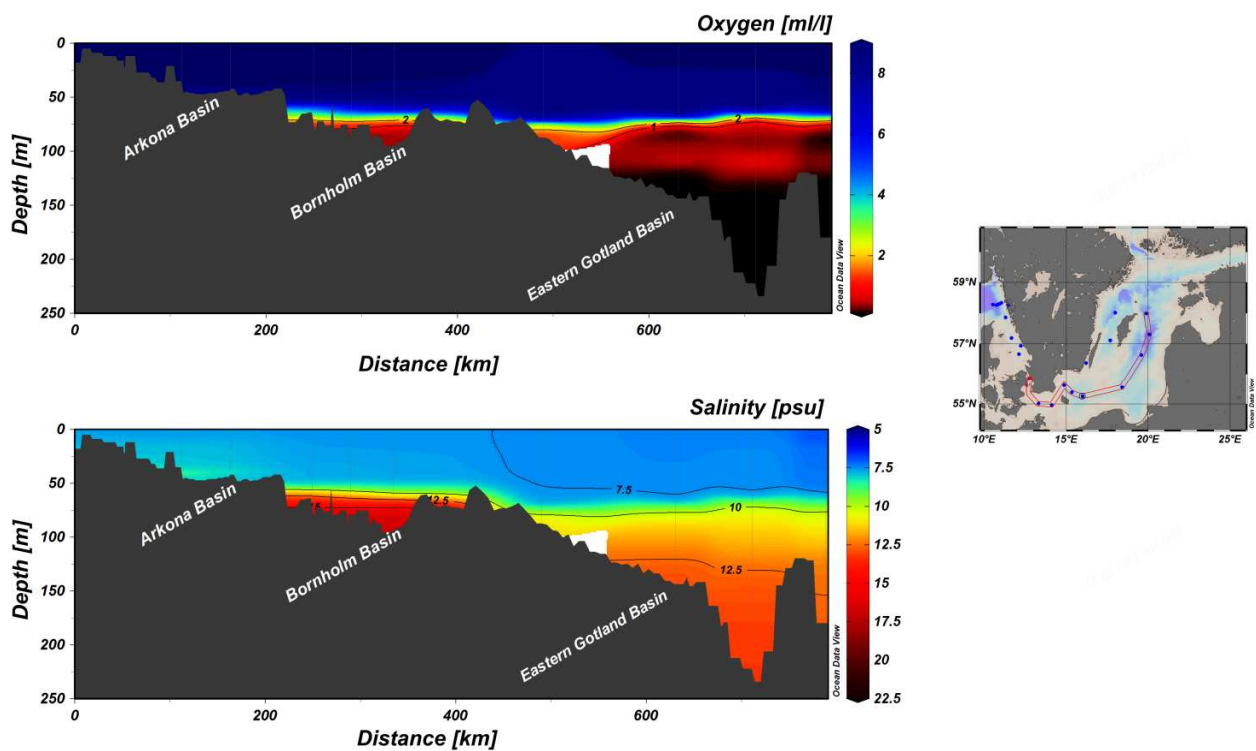


Figure 1. Transect showing dissolved oxygen and salinity from the Sound, through the Baltic Proper, to the Western Gotland Basin.

## PARTICIPANTS

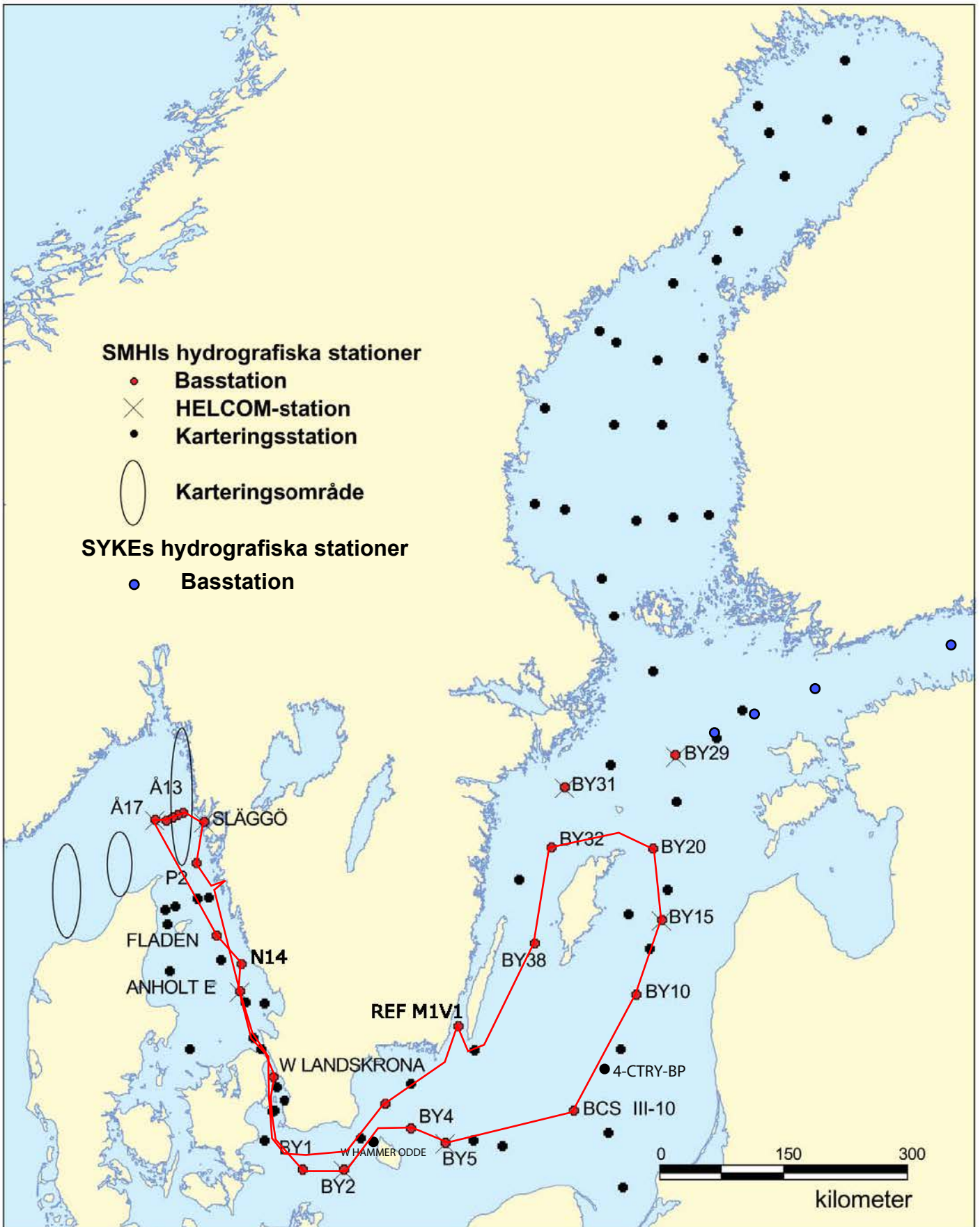
Name		From
Anna-Kerstin Thell	Chief Scientist	SMHI
Sara Johansson		SMHI
Johanna Linders		SMHI
Jenny Lycken		SMHI
Sari Sipilä		SMHI

## APPENDICES

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

TRACKCHART

Country: Sweden  
Ship: M/V AURA  
Date: 20180415-20180421  
Series: 0001-0025



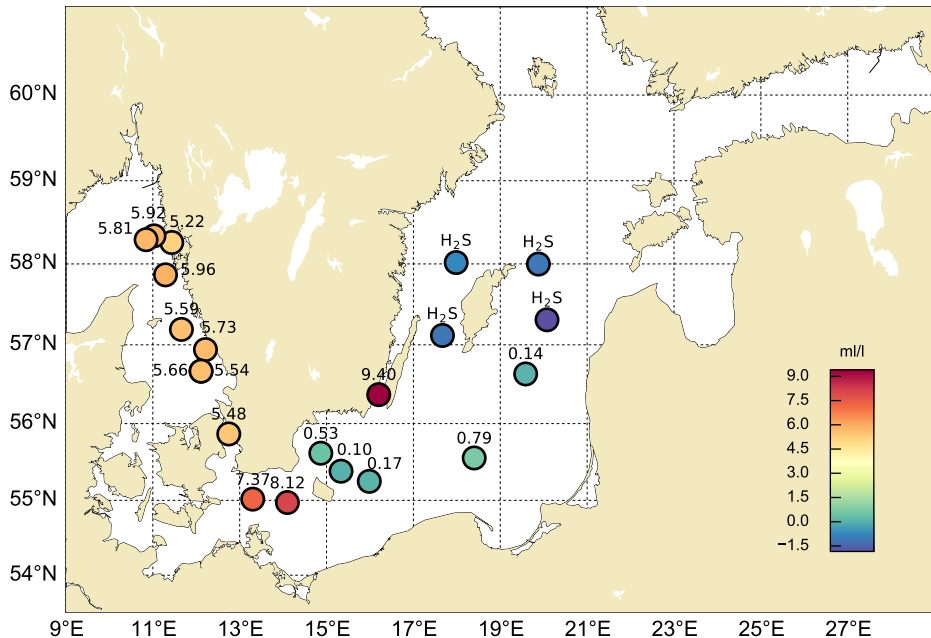


# Bottom water oxygen concentration (ml/l)

Ship: Aura

Date: 20180415-20180421

Series: 0001-0025

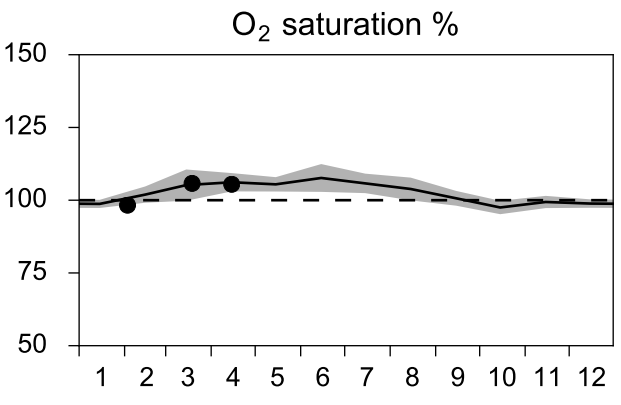
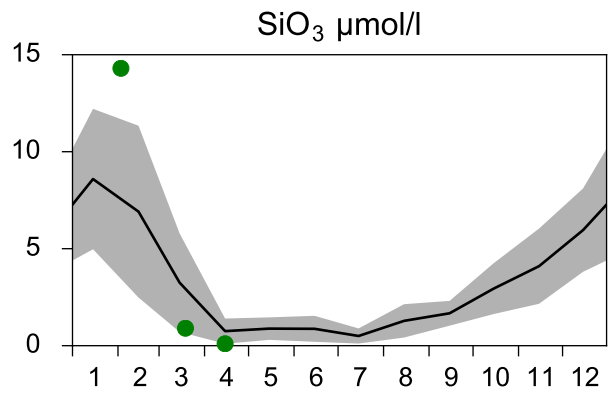
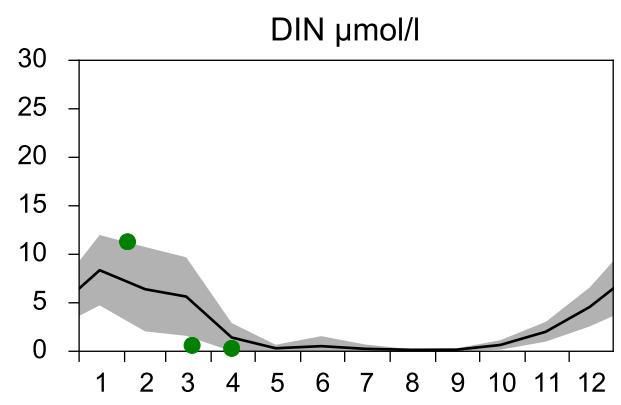
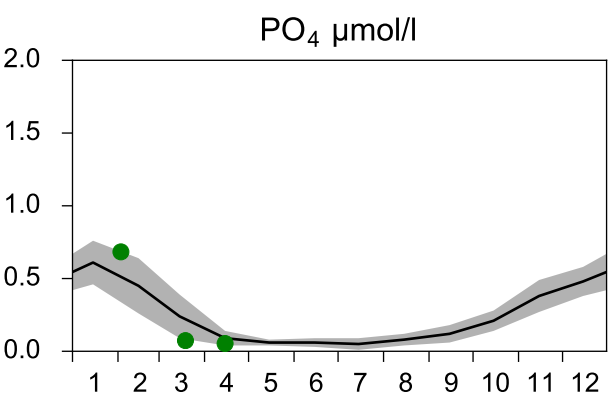
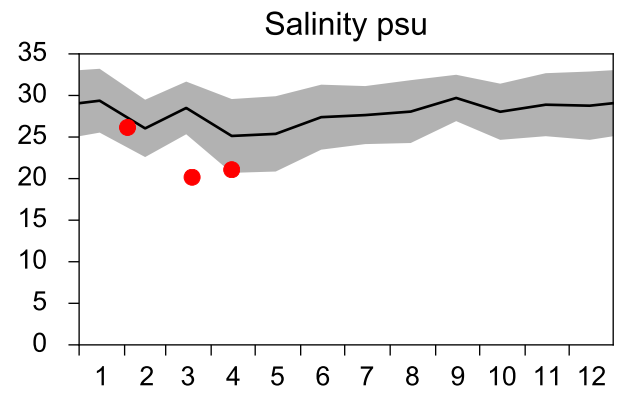
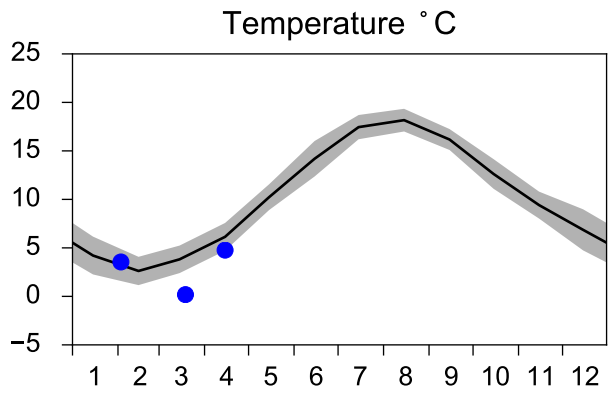




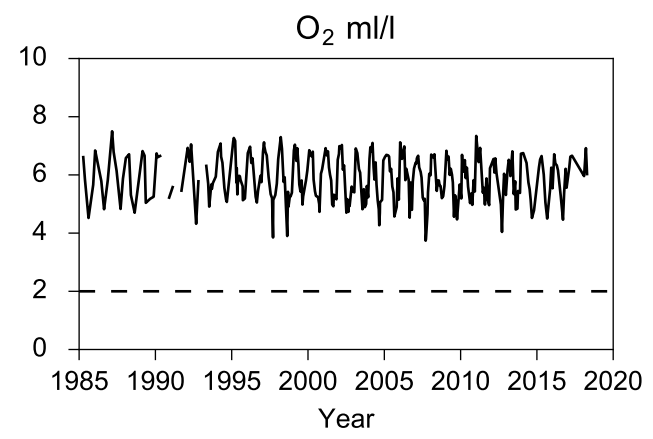
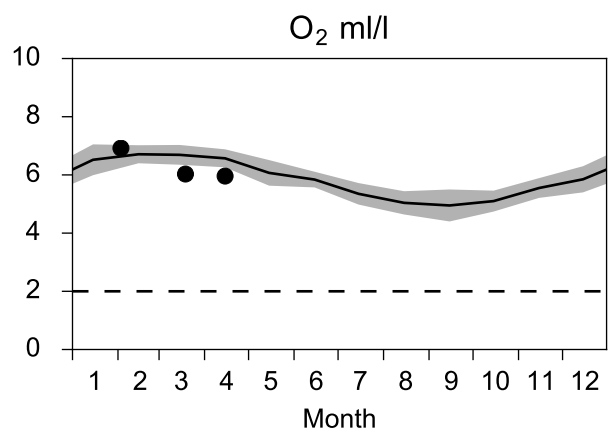
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Annual Cycles

— Mean 2001-2015    ■ St.Dev.    ● 2018



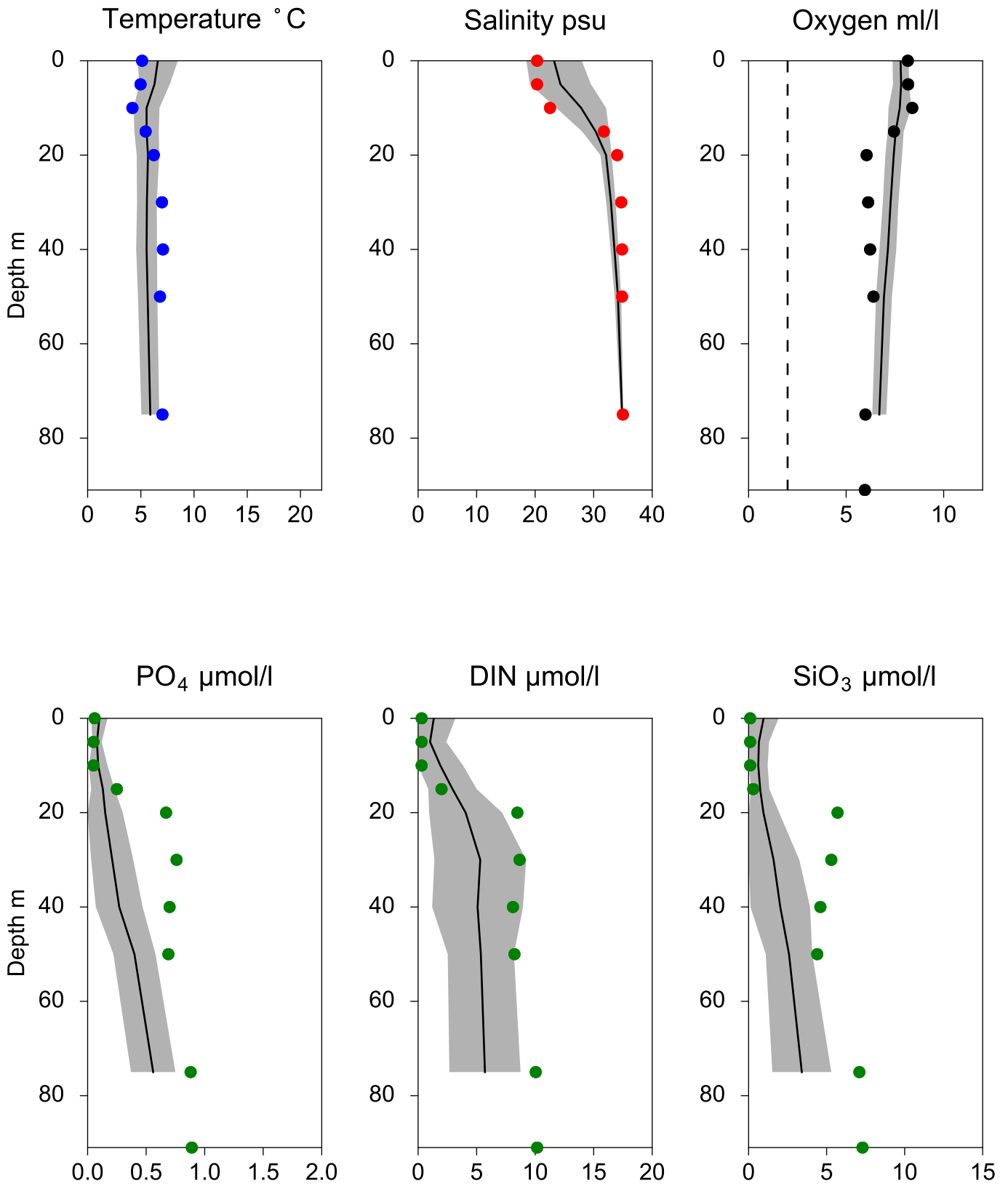
## OXYGEN IN BOTTOM WATER (depth >= 75 m)





# Vertical profiles P2 April

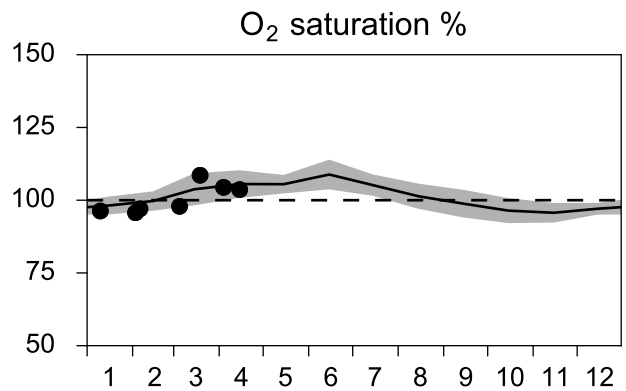
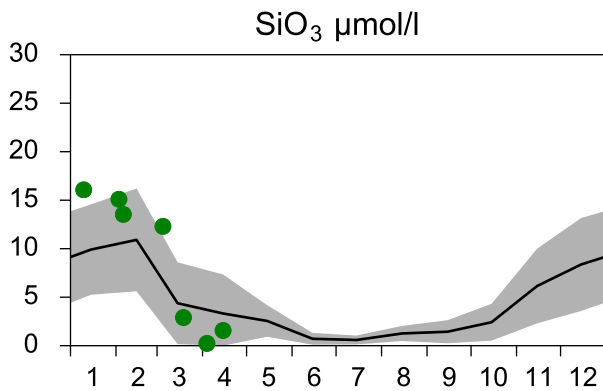
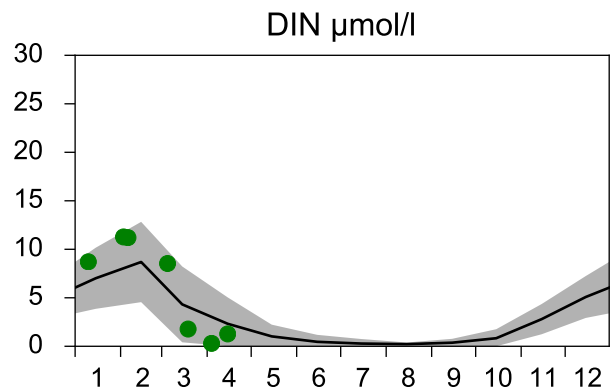
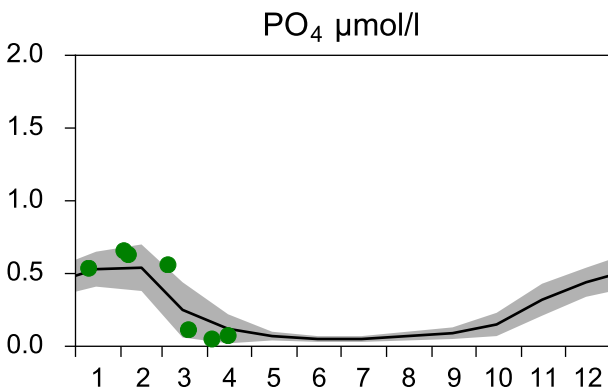
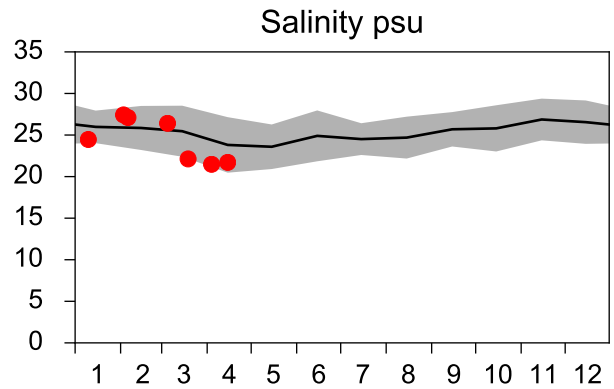
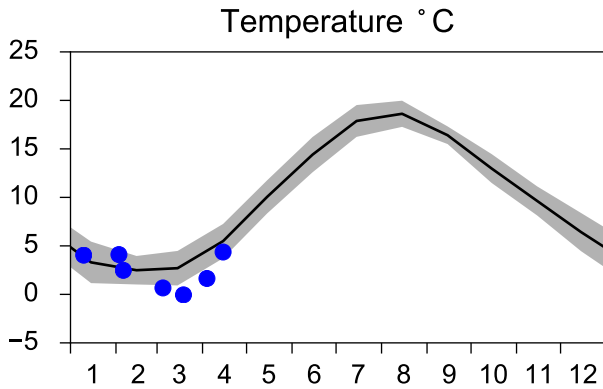
— Mean 2001-2015    ■ St.Dev.    ● 2018-04-15



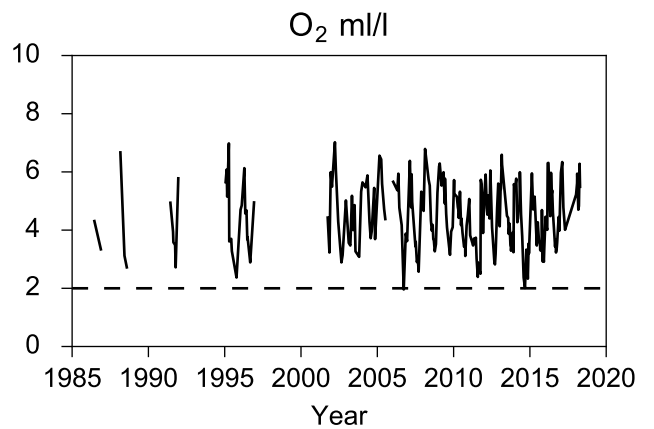
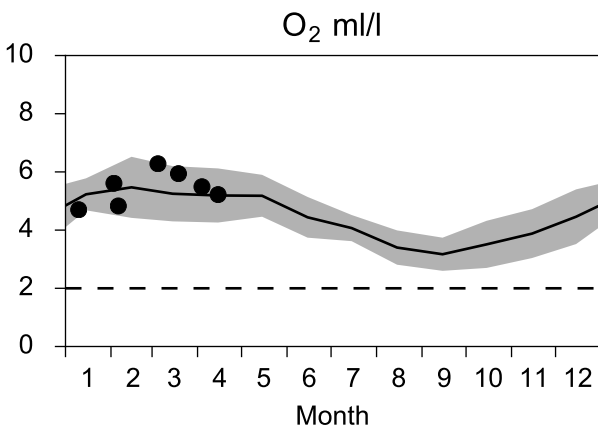
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## Annual Cycles

— Mean 2001-2015    ■ St.Dev.    ● 2018

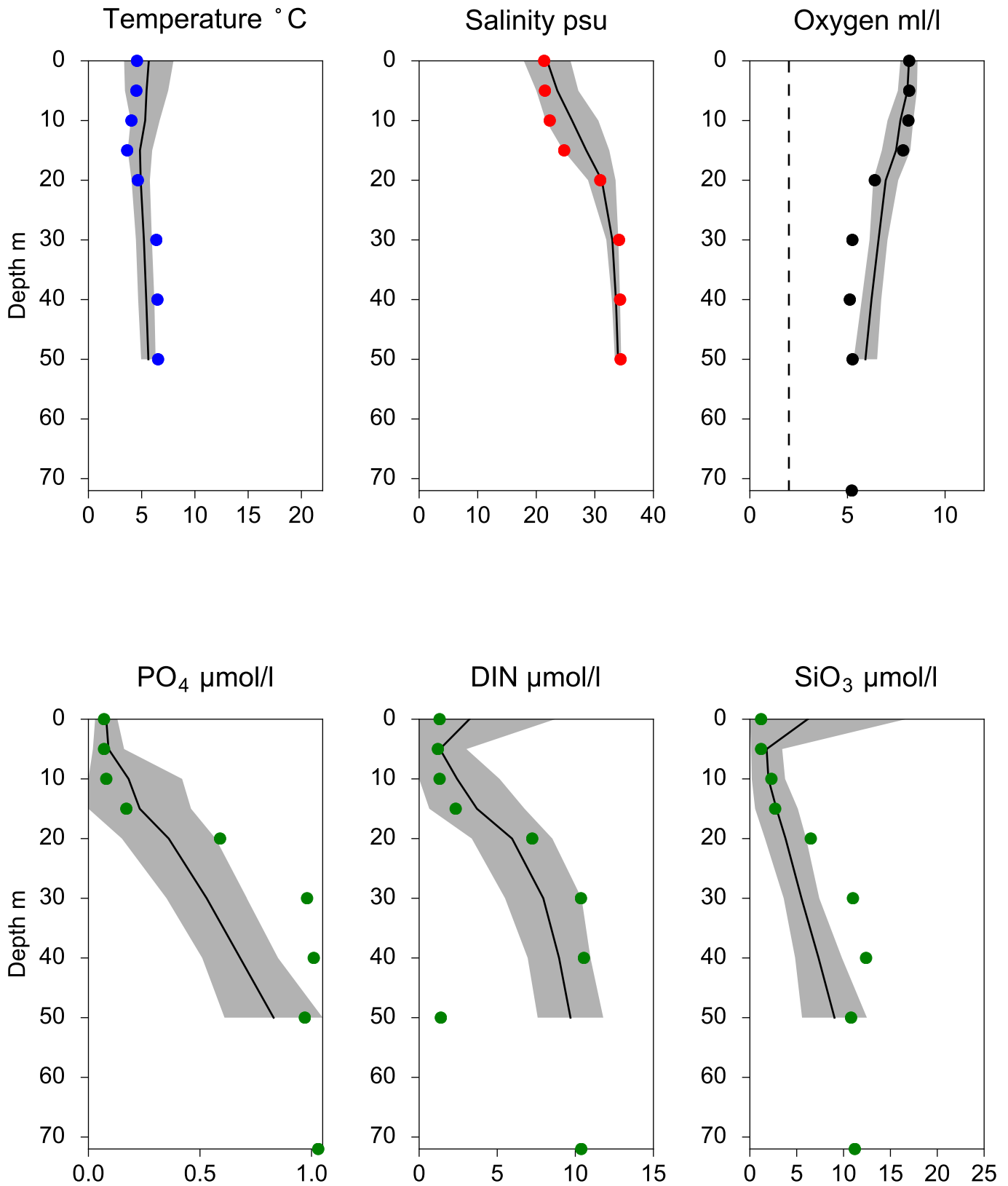


## OXYGEN IN BOTTOM WATER (depth >= 64 m)



# Vertical profiles SLÄGGÖ April

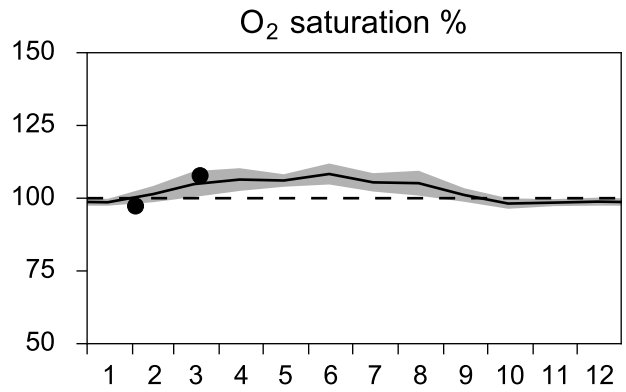
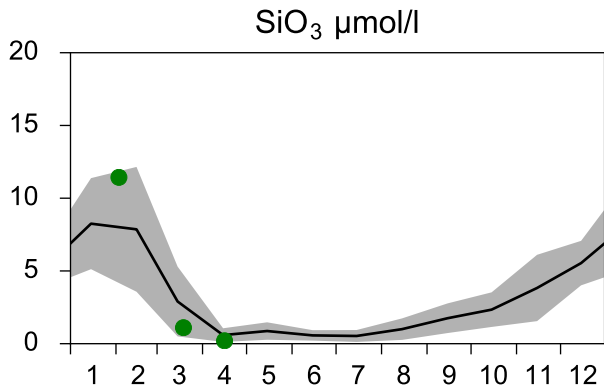
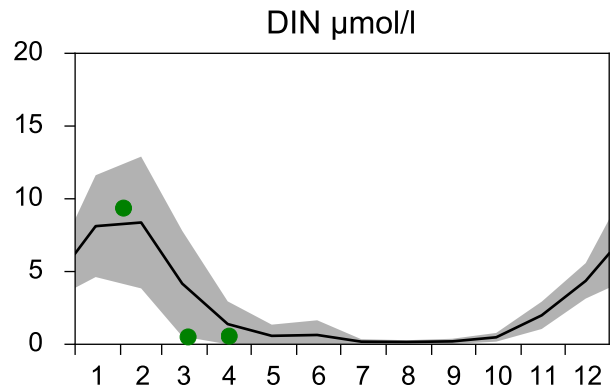
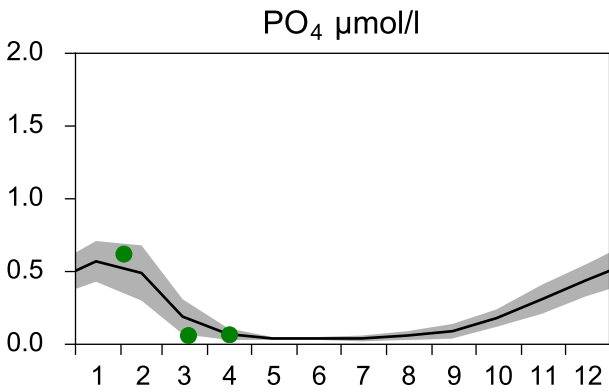
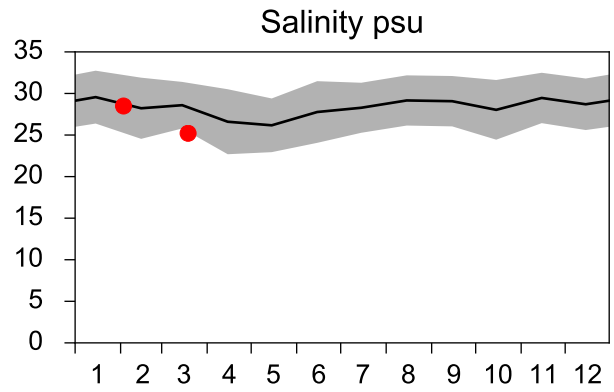
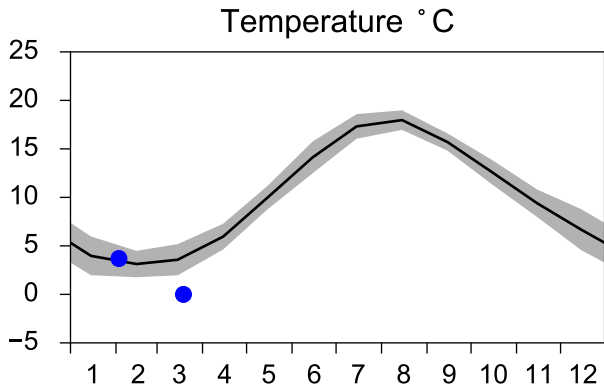
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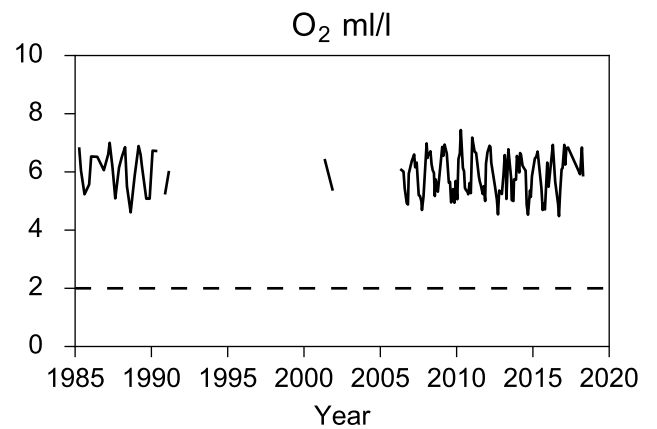
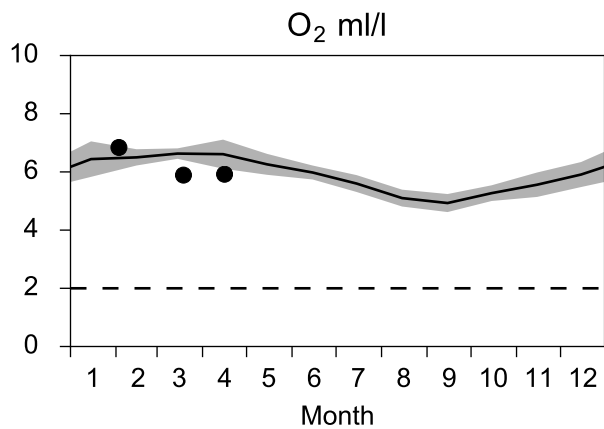
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Annual Cycles

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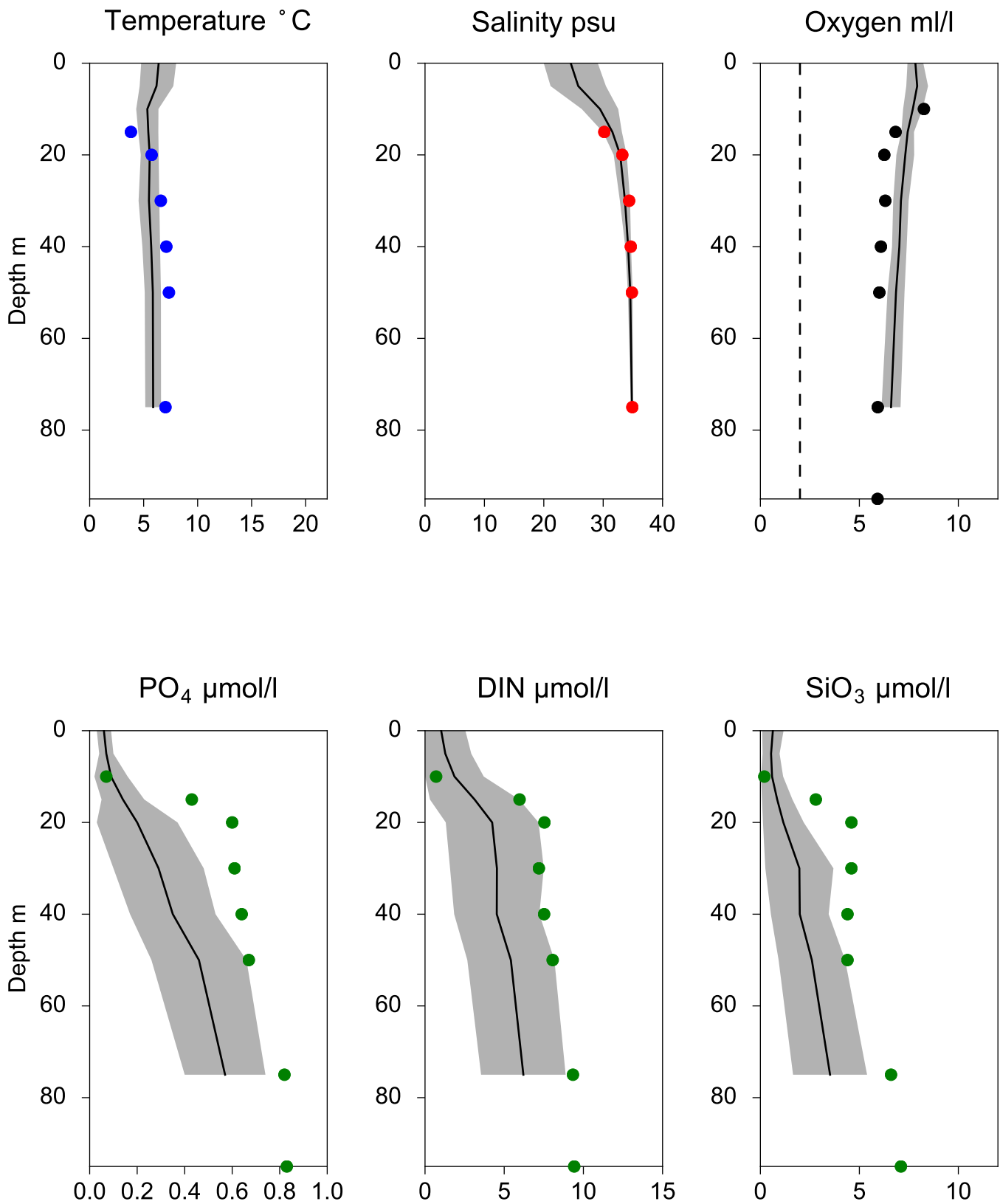


## OXYGEN IN BOTTOM WATER (depth >= 80 m)



# Vertical profiles Å13 April

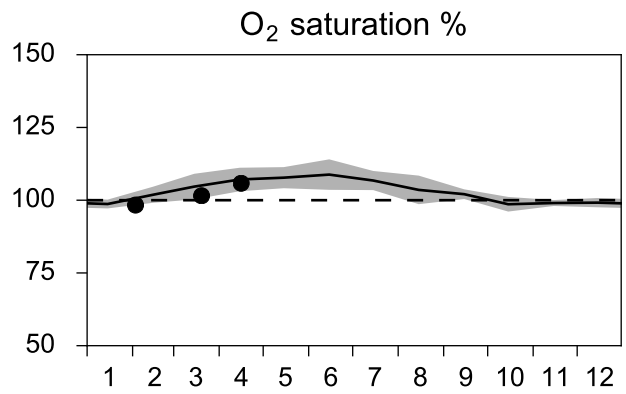
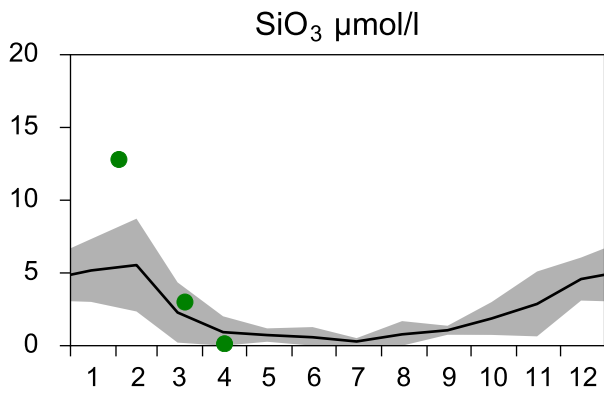
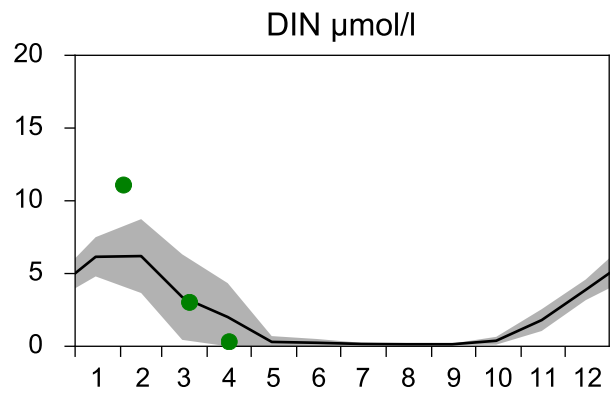
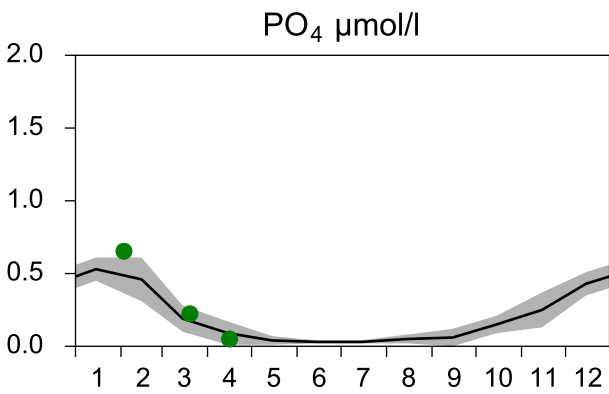
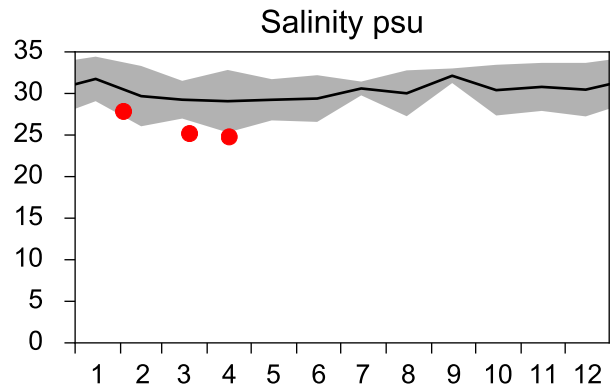
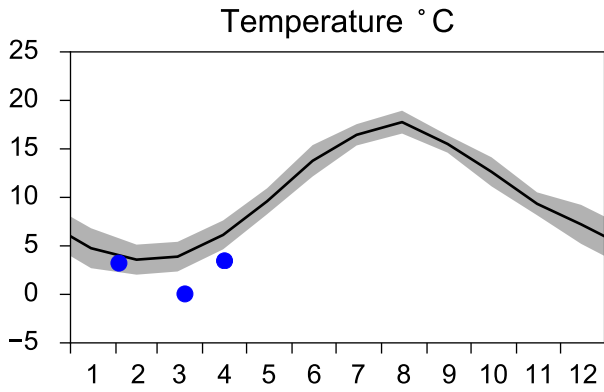
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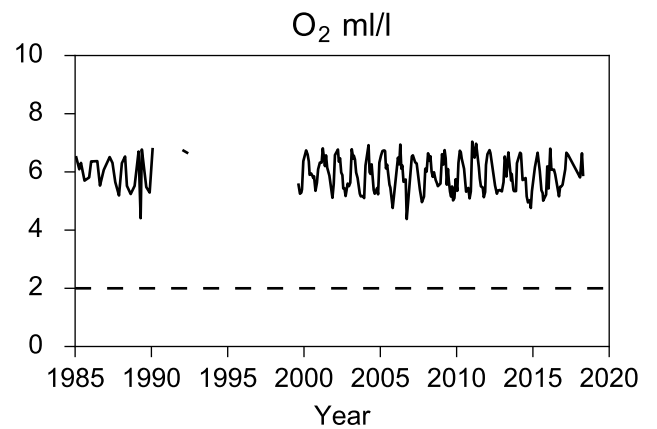
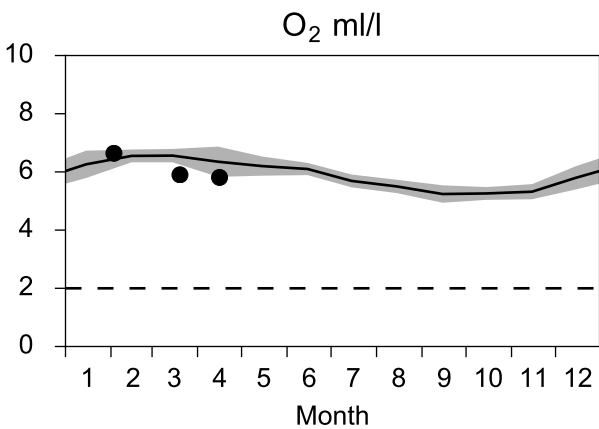
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Annual Cycles

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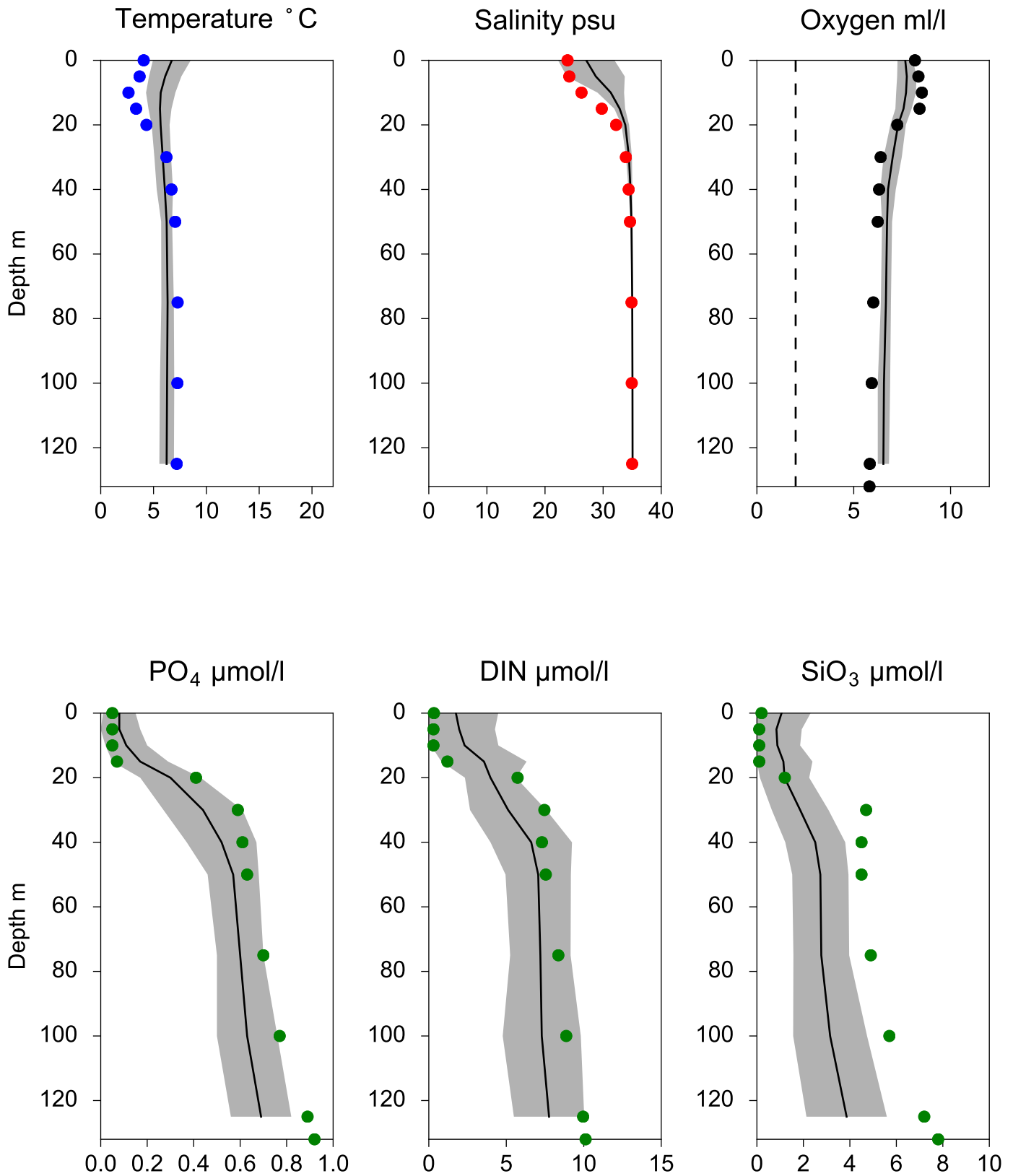


## OXYGEN IN BOTTOM WATER (depth >= 125 m)



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— Mean 2001-2015    ■ St.Dev.    ● 2018-04-16

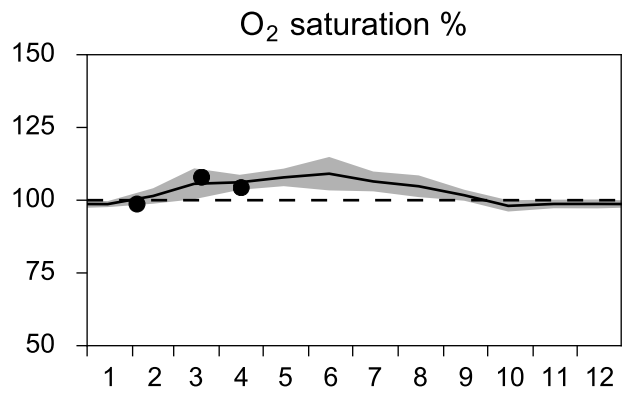
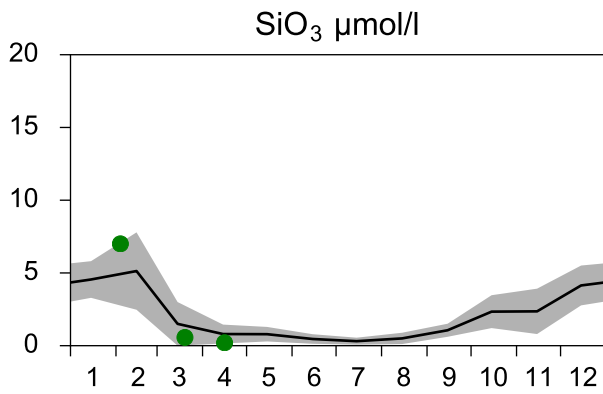
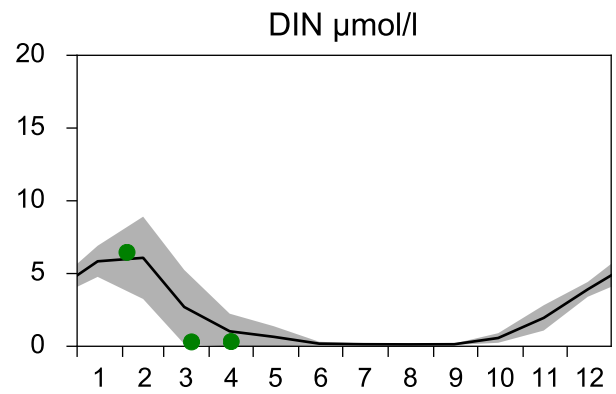
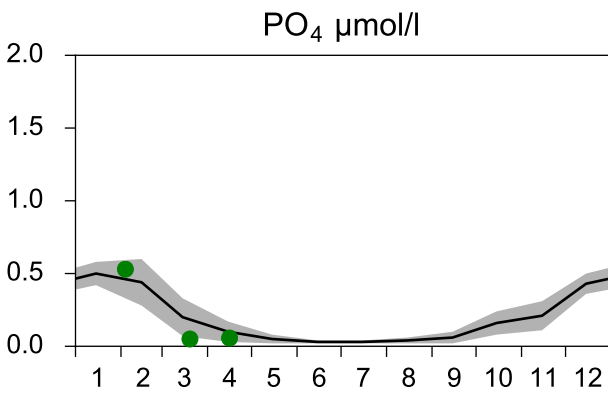
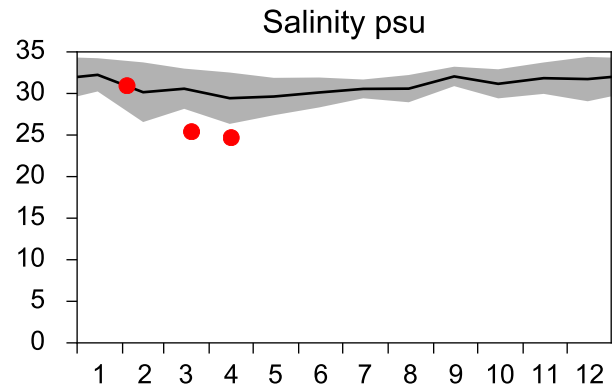
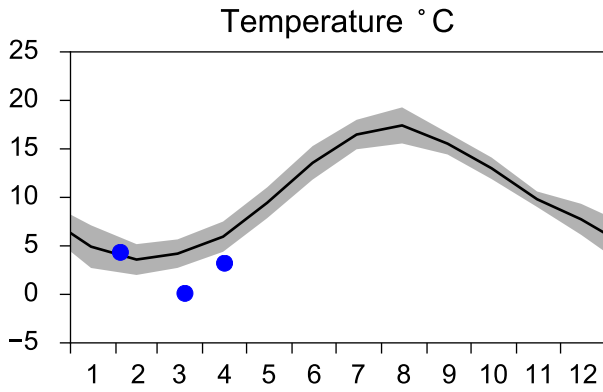




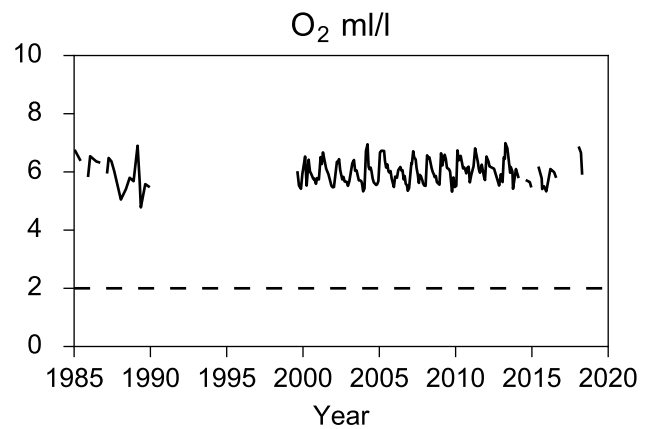
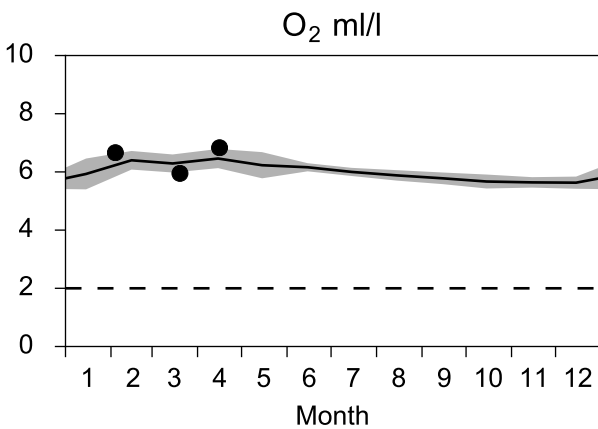
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Annual Cycles

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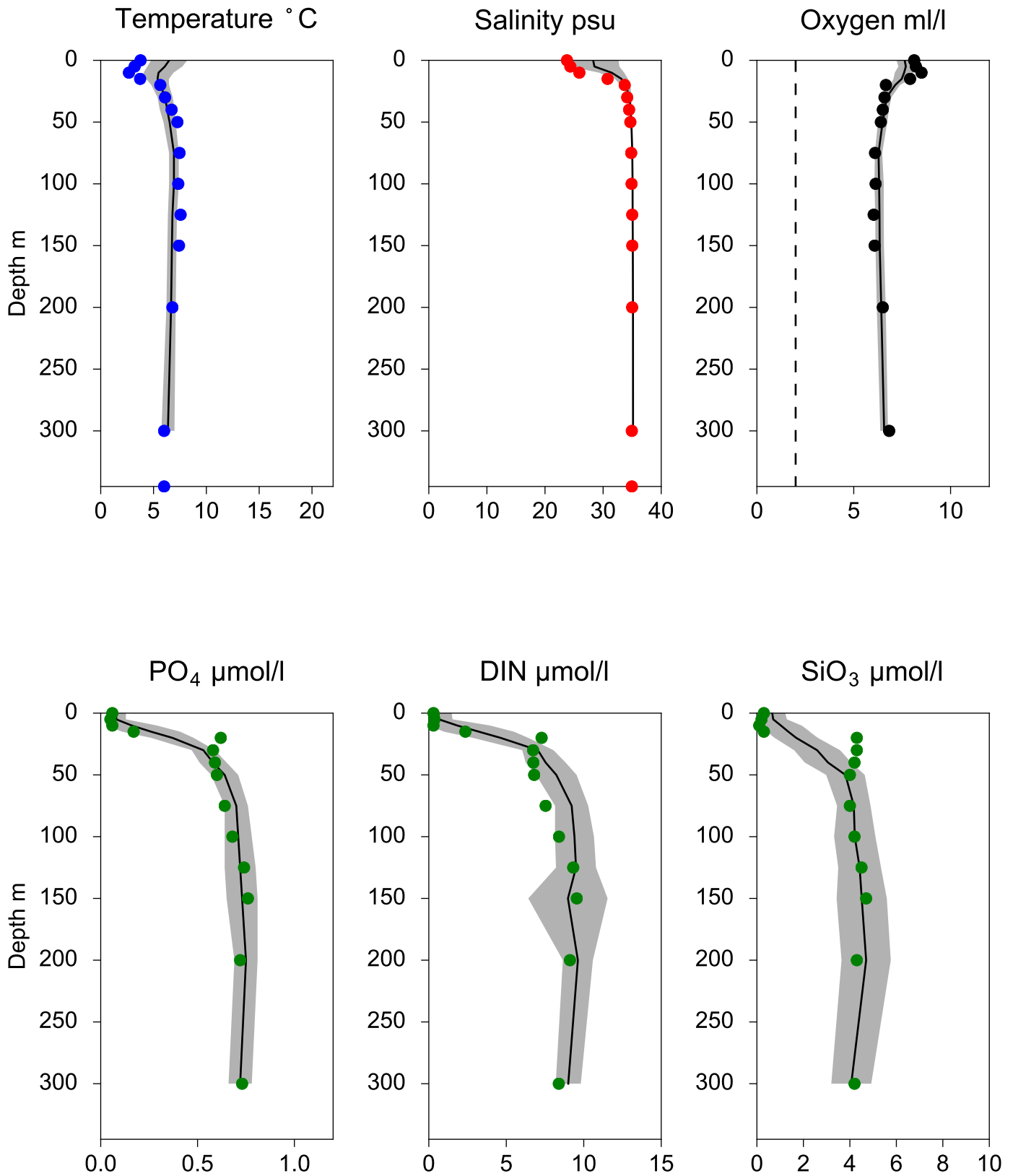


## OXYGEN IN BOTTOM WATER (depth >= 300 m)



# Vertical profiles Å17 April

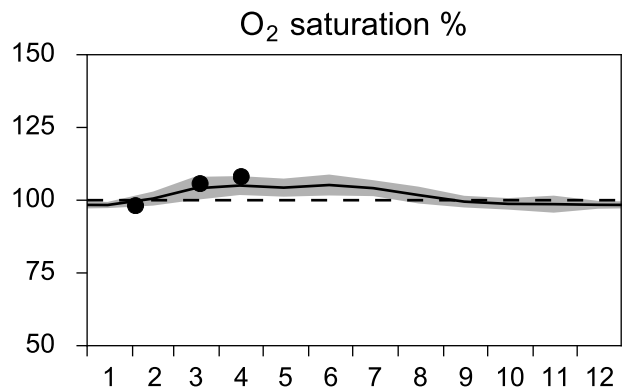
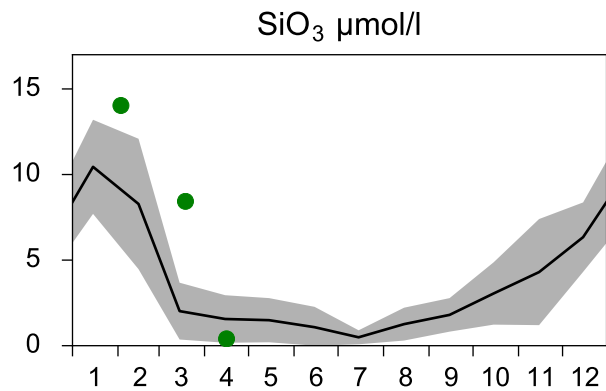
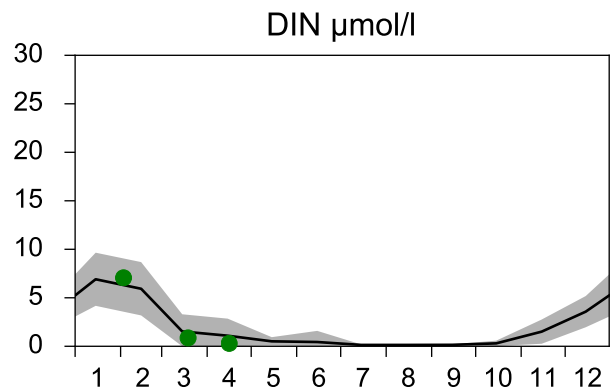
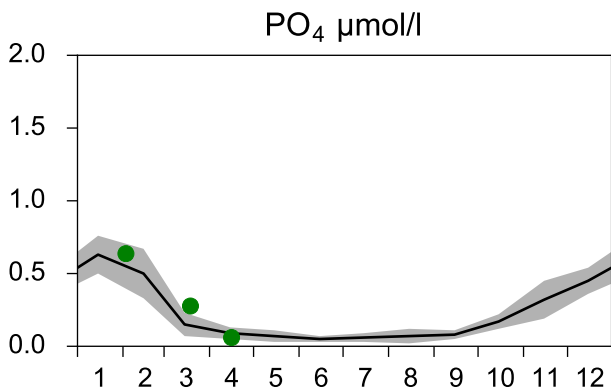
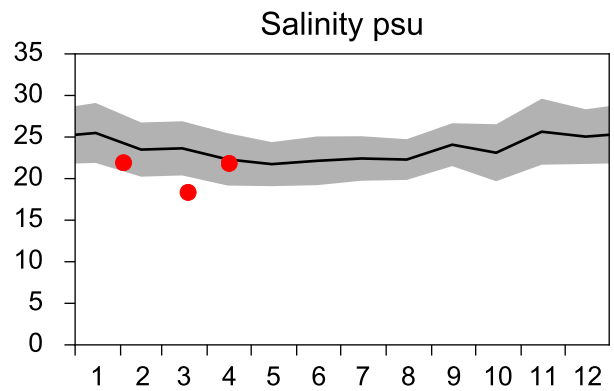
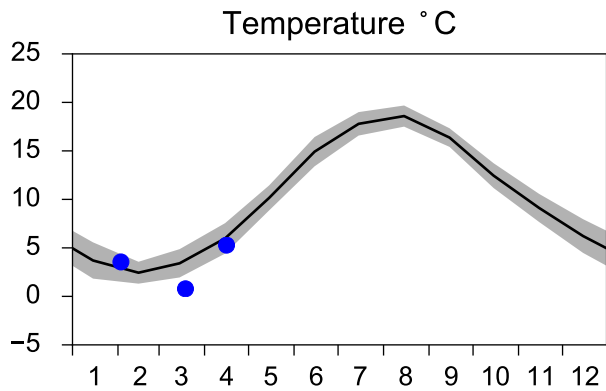
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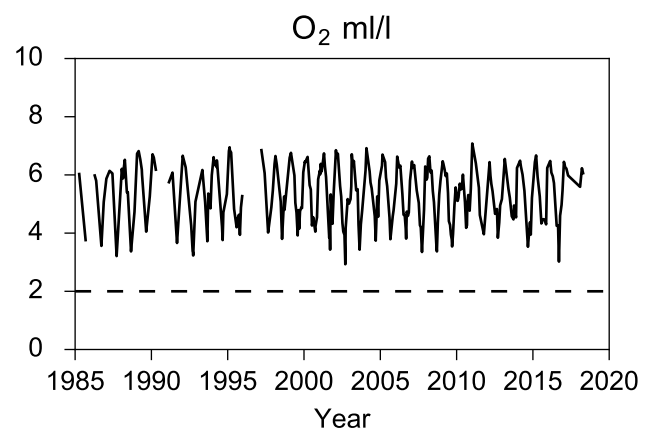
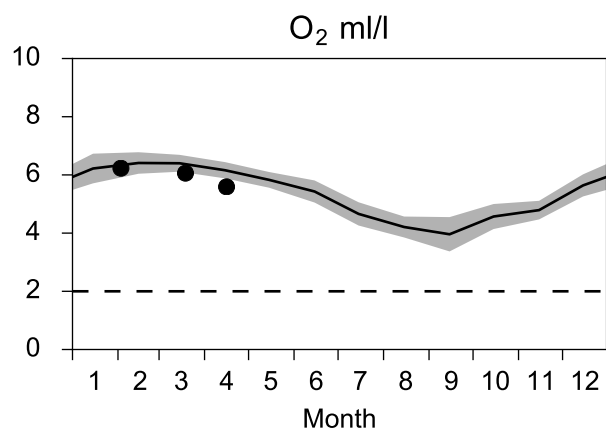
# STATION FLADEN SURFACE WATER (0-10 m)

Annual Cycles

— Mean 2001-2015    ■ St.Dev.    ● 2018

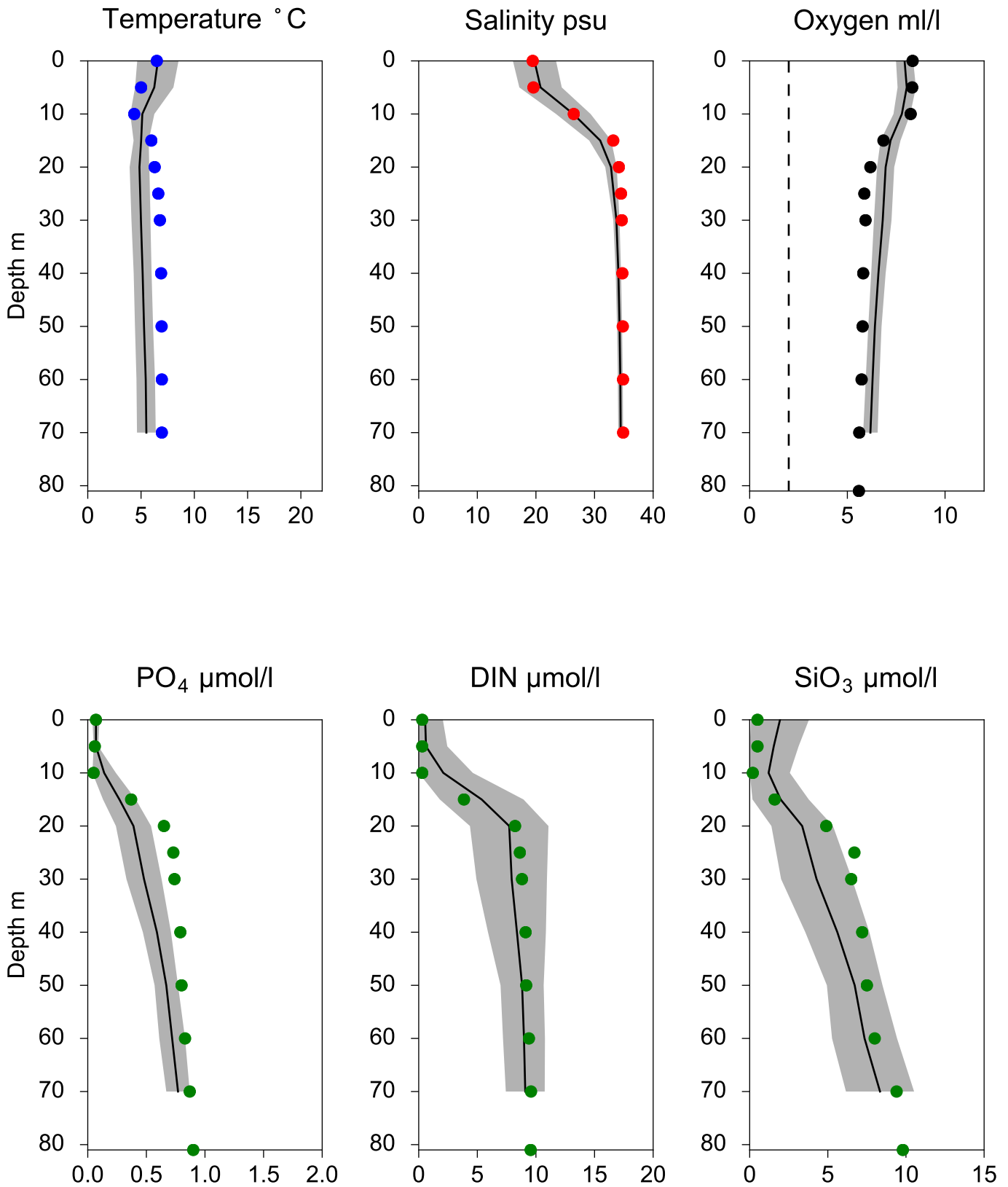


## OXYGEN IN BOTTOM WATER (depth >= 74 m)



# Vertical profiles FLADEN April

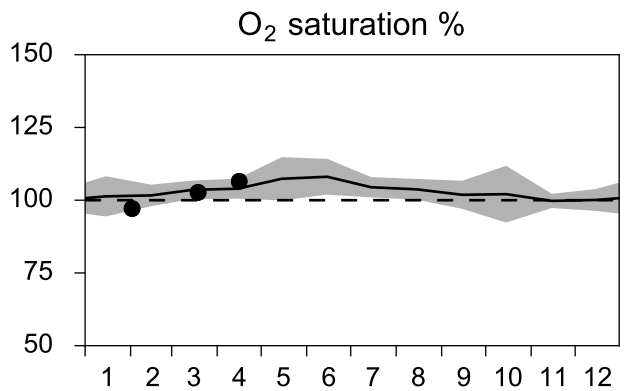
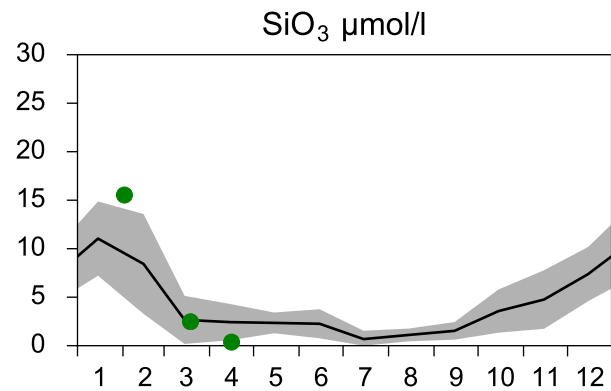
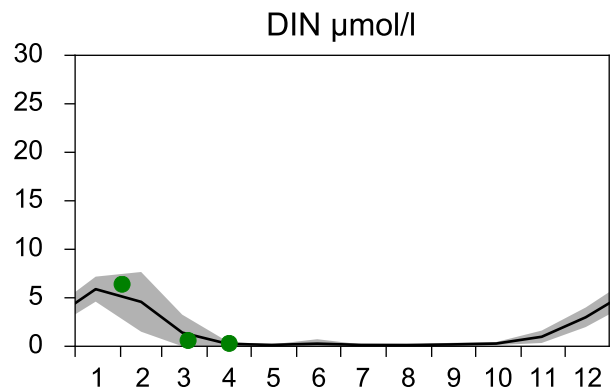
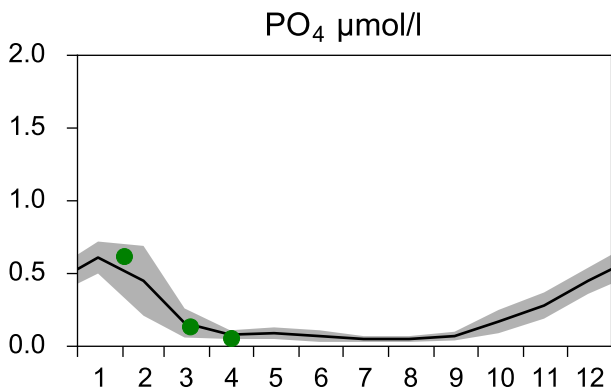
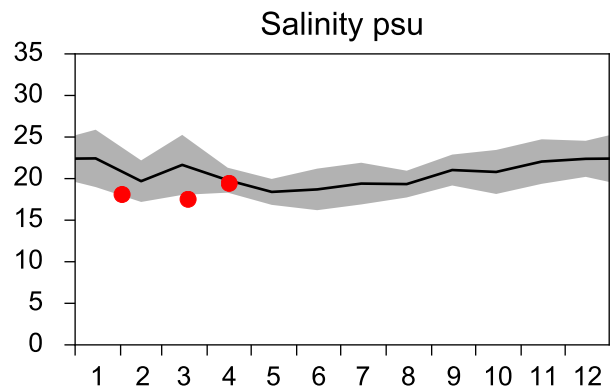
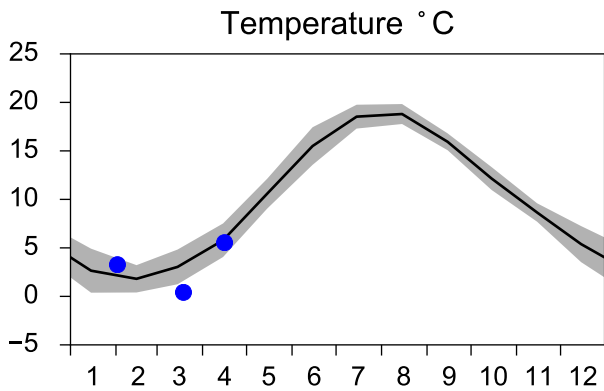
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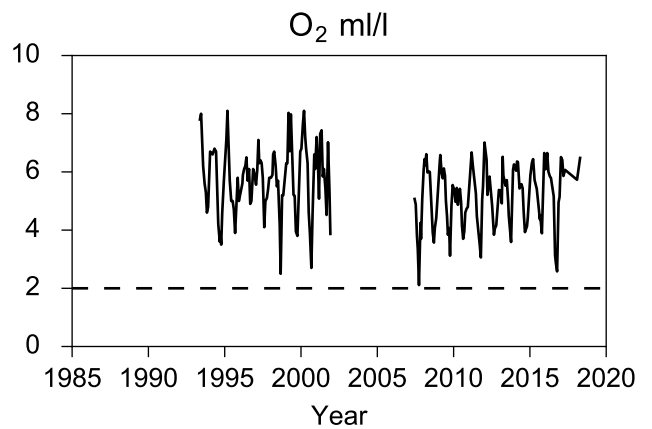
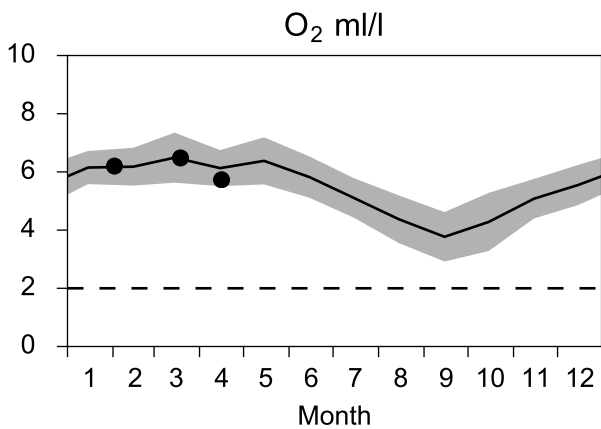
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Annual Cycles

— Mean 2001-2015    ■ St.Dev.    ● 2018

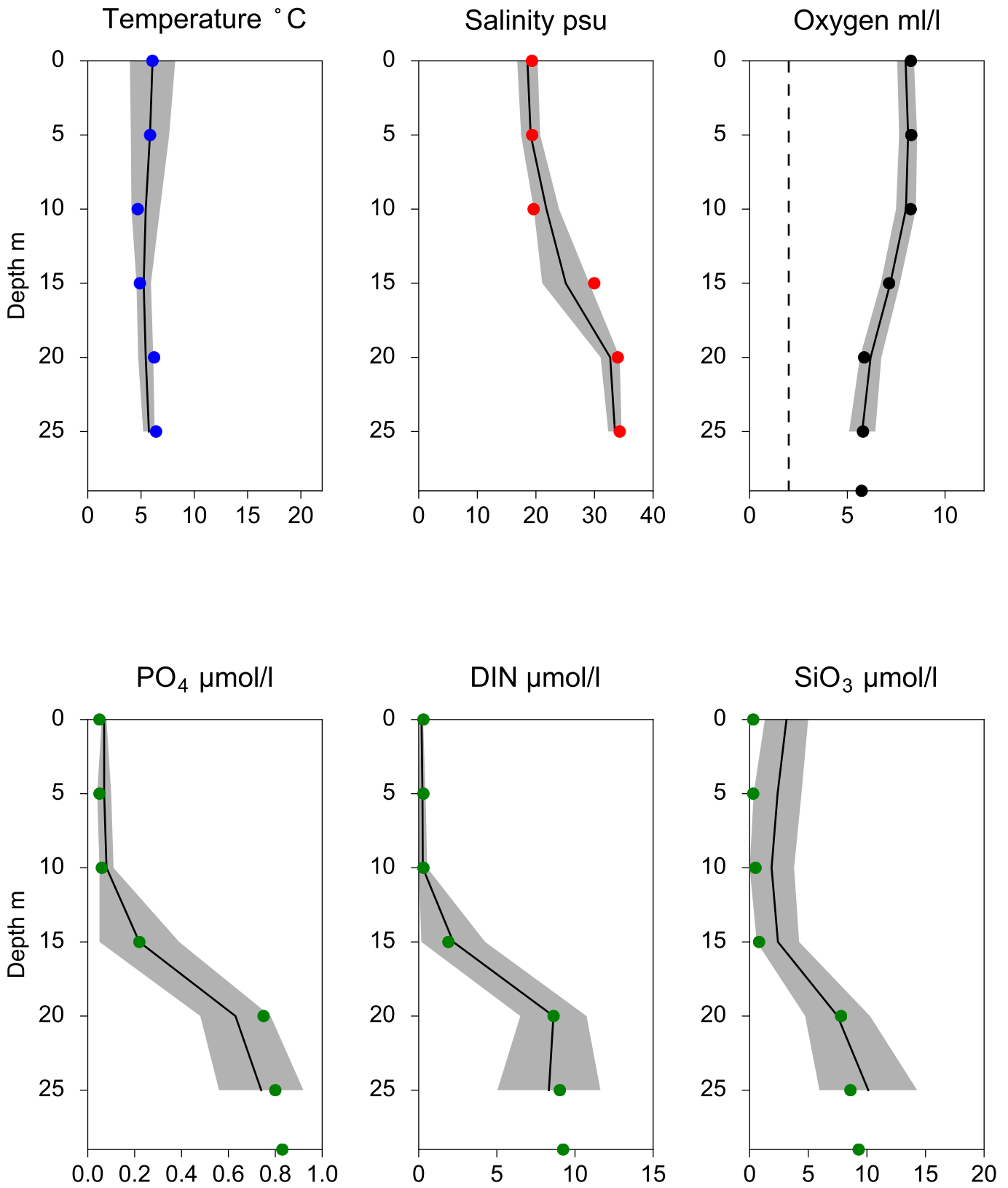


## OXYGEN IN BOTTOM WATER (depth >= 25 m)



# Vertical profiles N14 FALKENBERG April

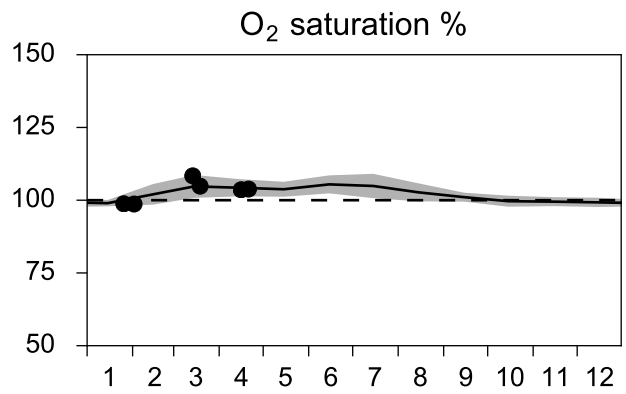
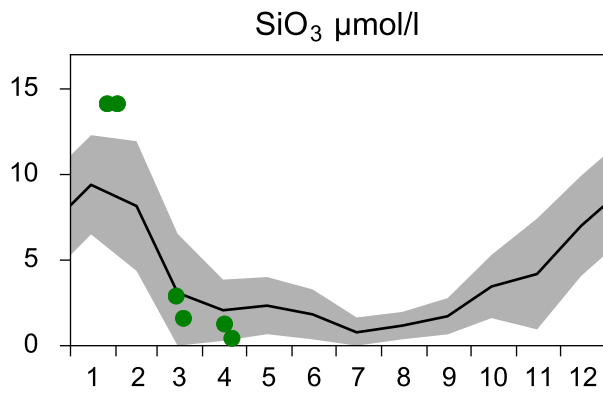
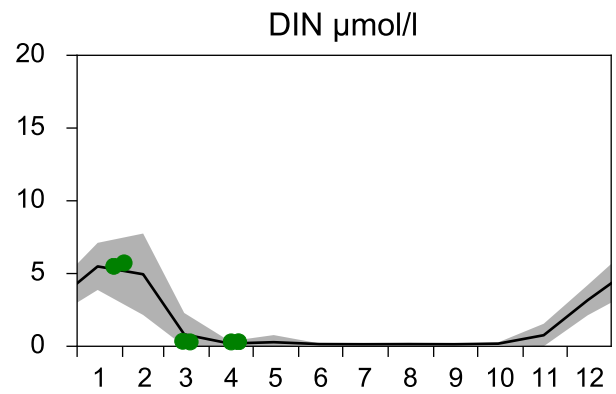
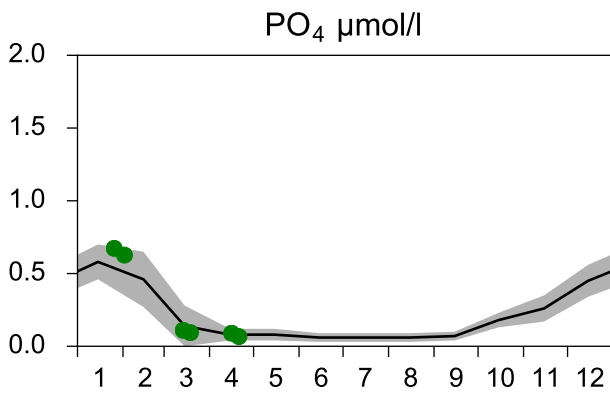
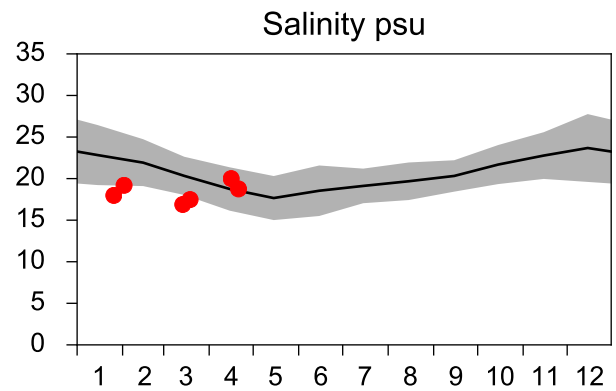
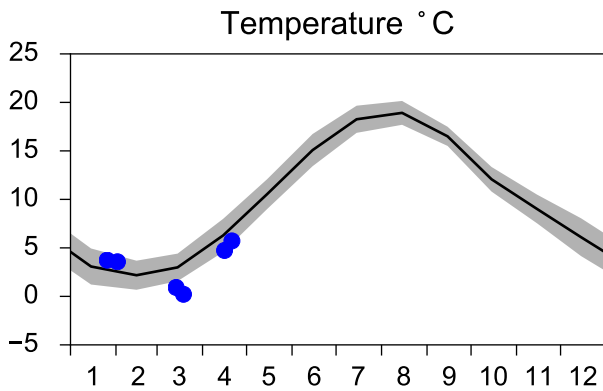
— Mean 2001-2015    ■ St.Dev.    ● 2018-04-16



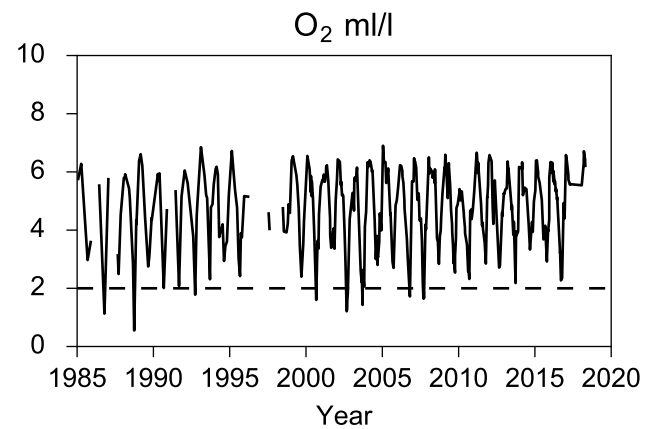
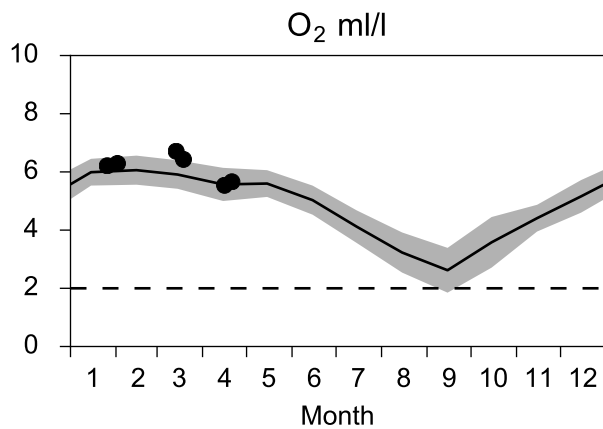
# STATION ANHOLT E SURFACE WATER (0-10 m)

Annual Cycles

— Mean 2001-2015    ■ St.Dev.    ● 2018



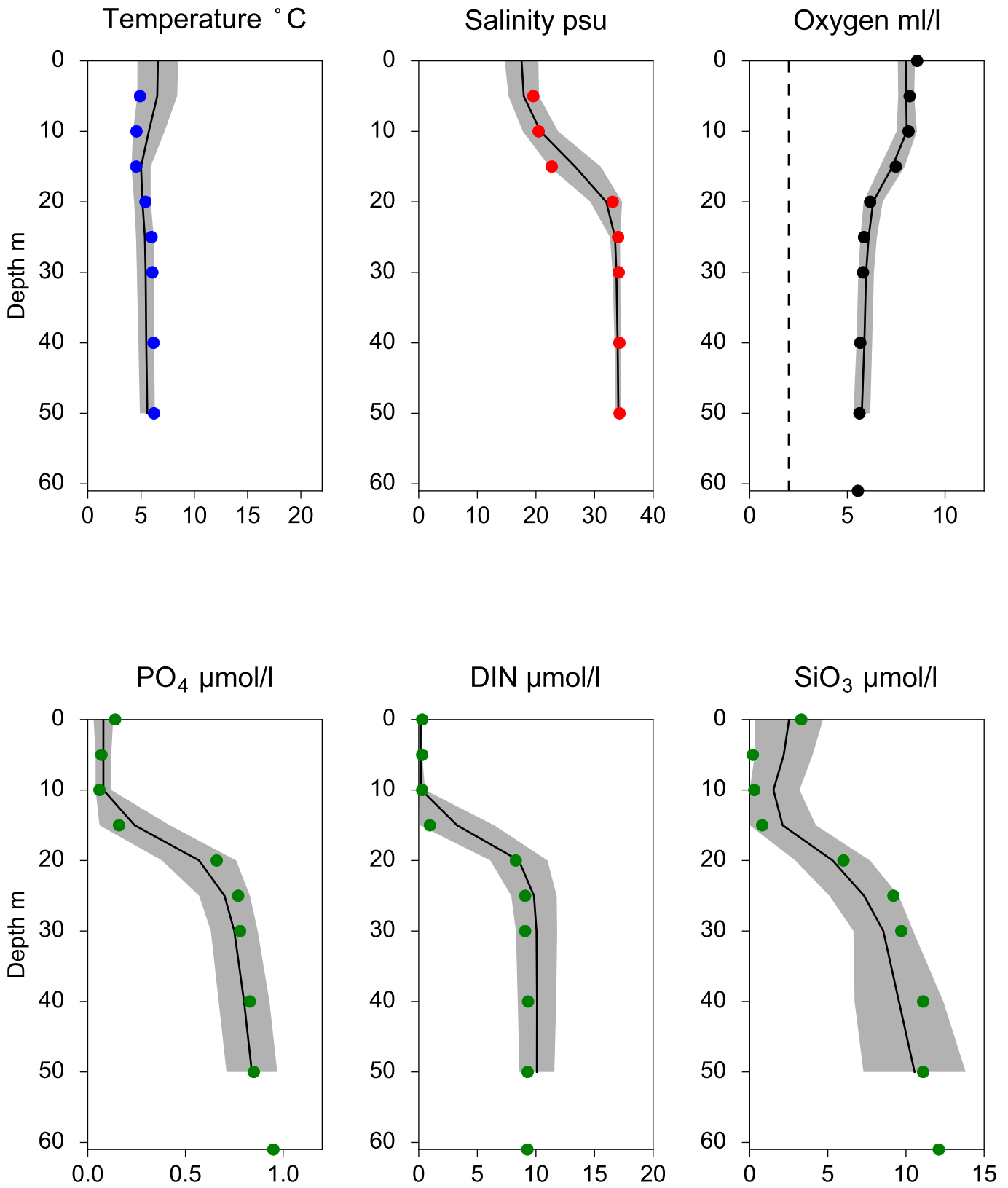
## OXYGEN IN BOTTOM WATER (depth >= 52 m)





# Vertical profiles ANHOLT E April

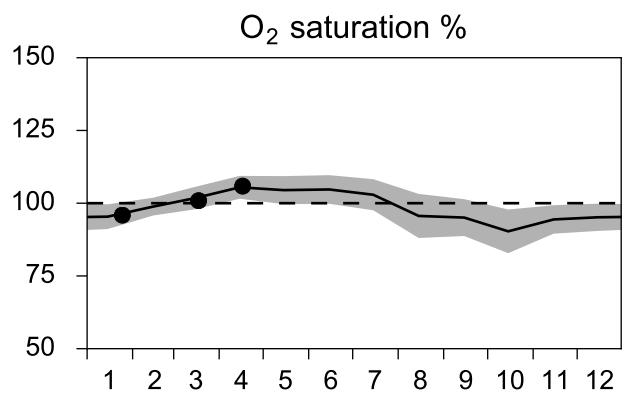
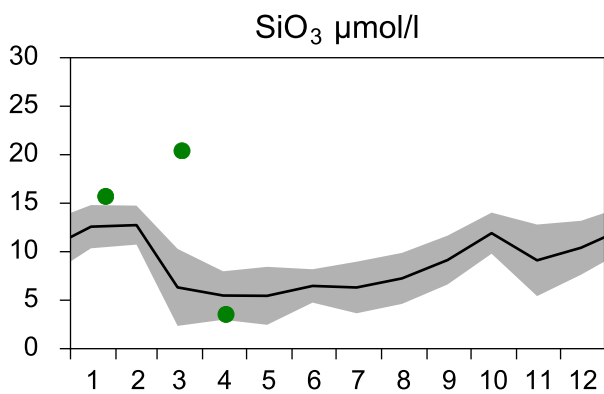
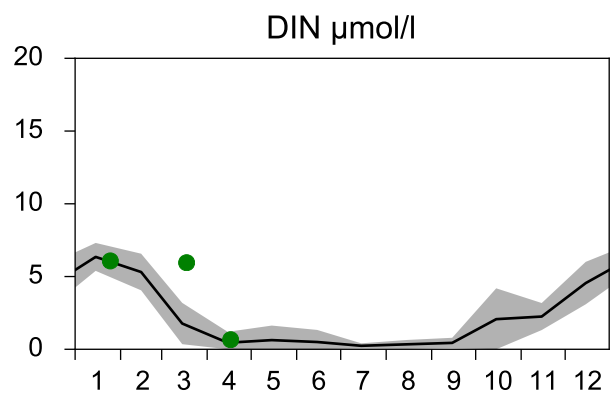
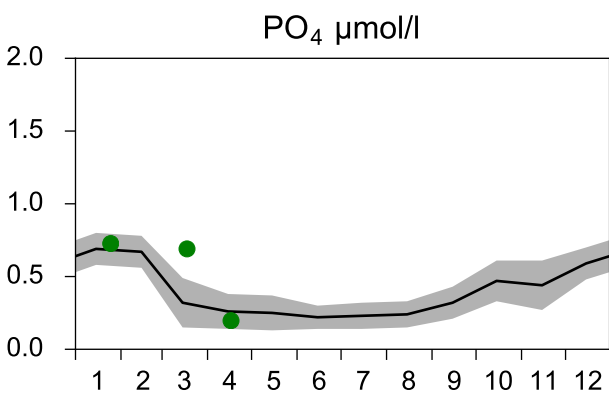
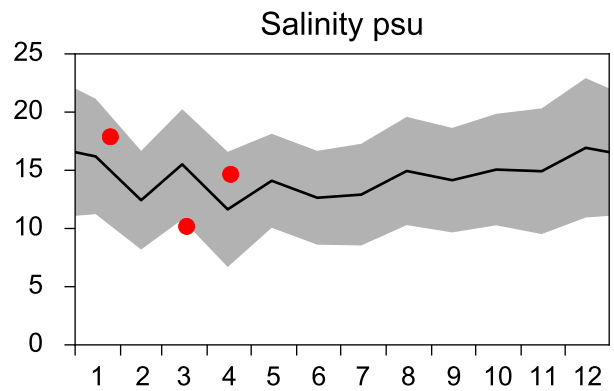
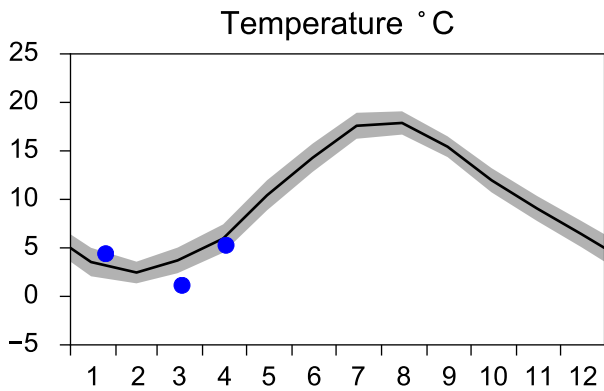
— Mean 2001-2015    ■ St.Dev.    ● 2018-04-16



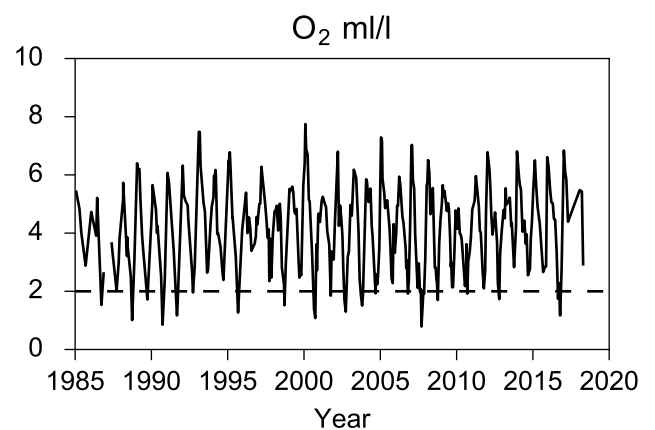
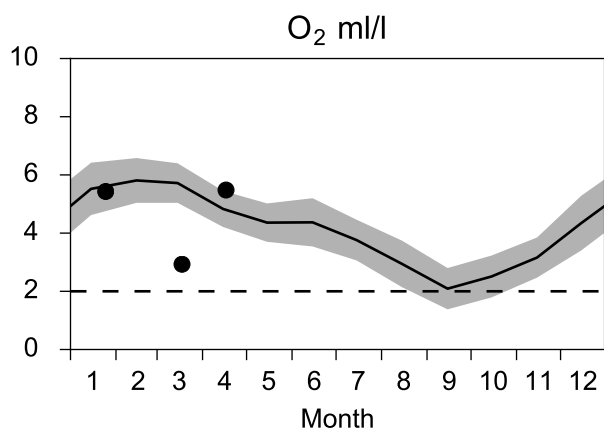
# STATION W LANDSKRONA SURFACE WATER (0-10 m)

Annual Cycles

— Mean 2001-2015    ■ St.Dev.    ● 2018

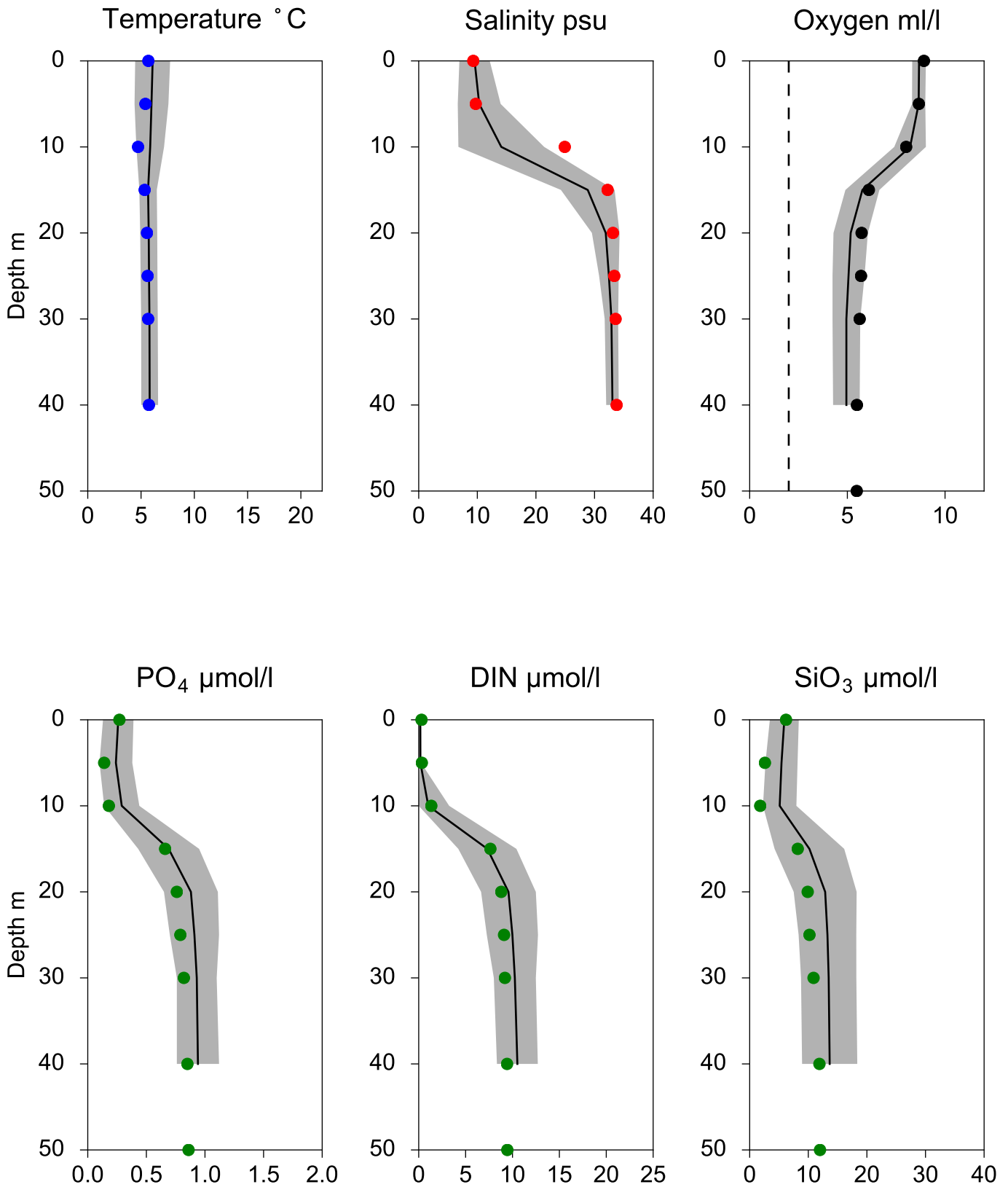


## OXYGEN IN BOTTOM WATER (depth >= 40 m)



# Vertical profiles W LANDSKRONA April

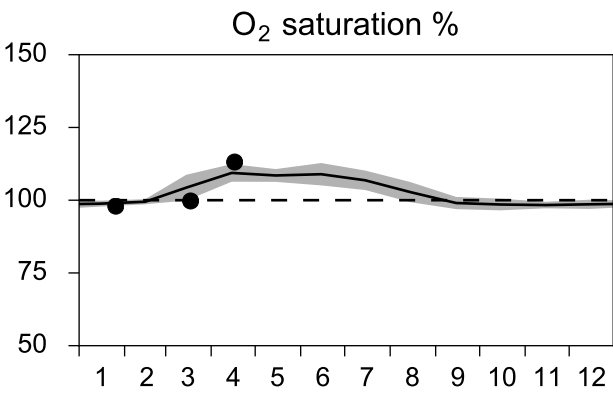
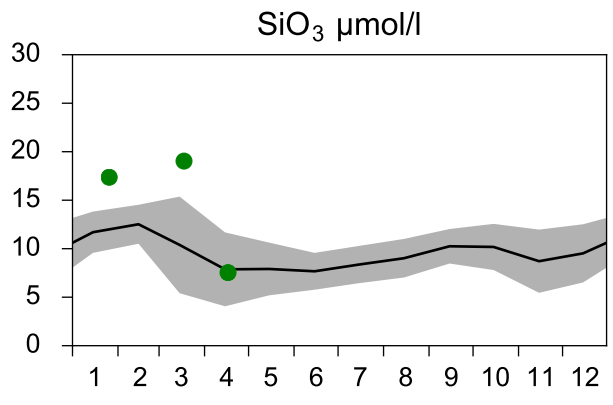
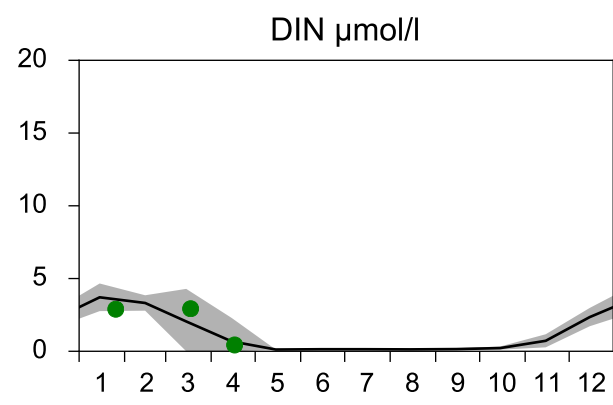
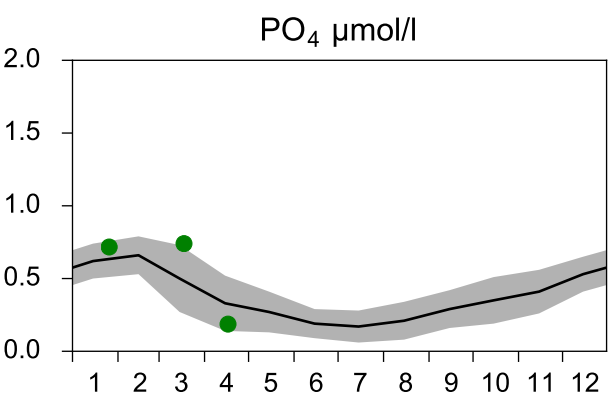
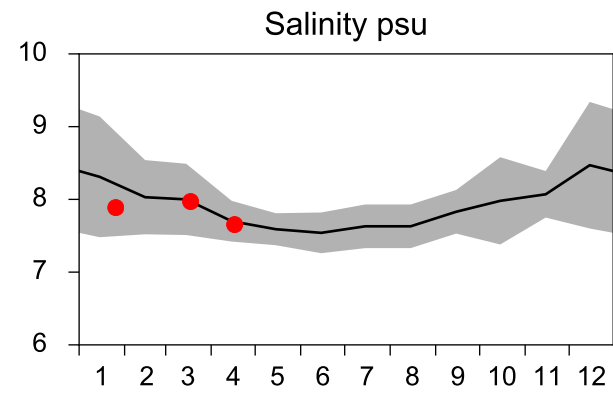
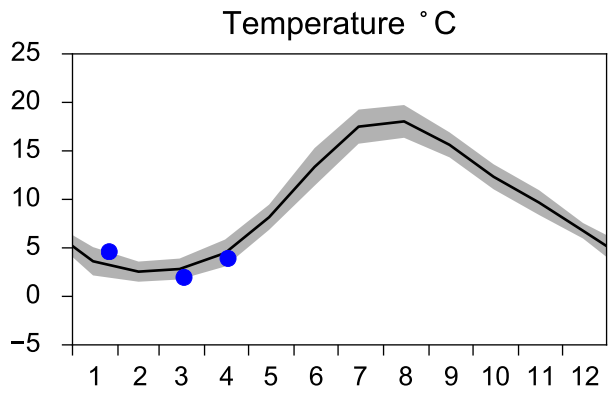
— Mean 2001-2015    ■ St.Dev.    ● 2018-04-17



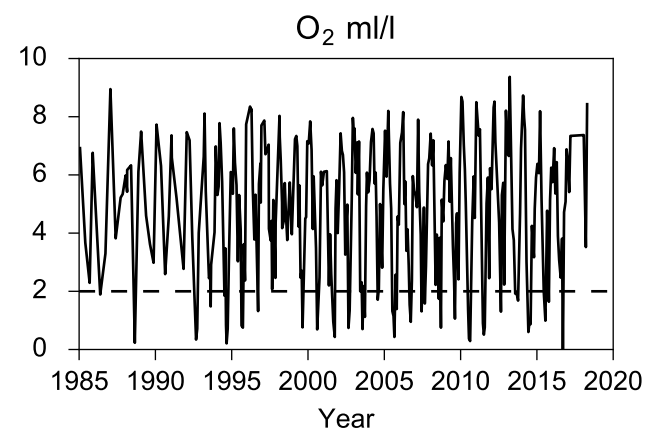
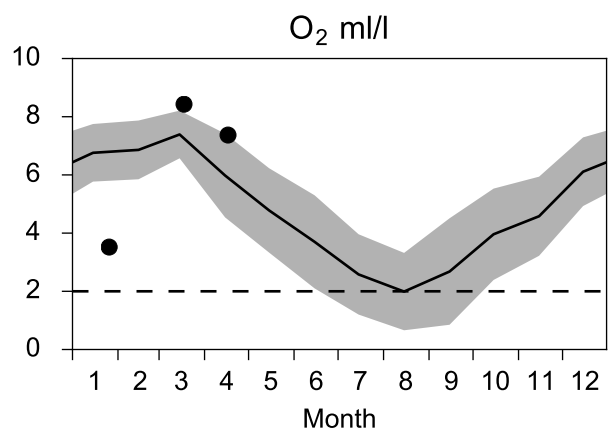
# STATION BY1 SURFACE WATER (0-10 m)

Annual Cycles

— Mean 2001-2015    ■ St.Dev.    ● 2018

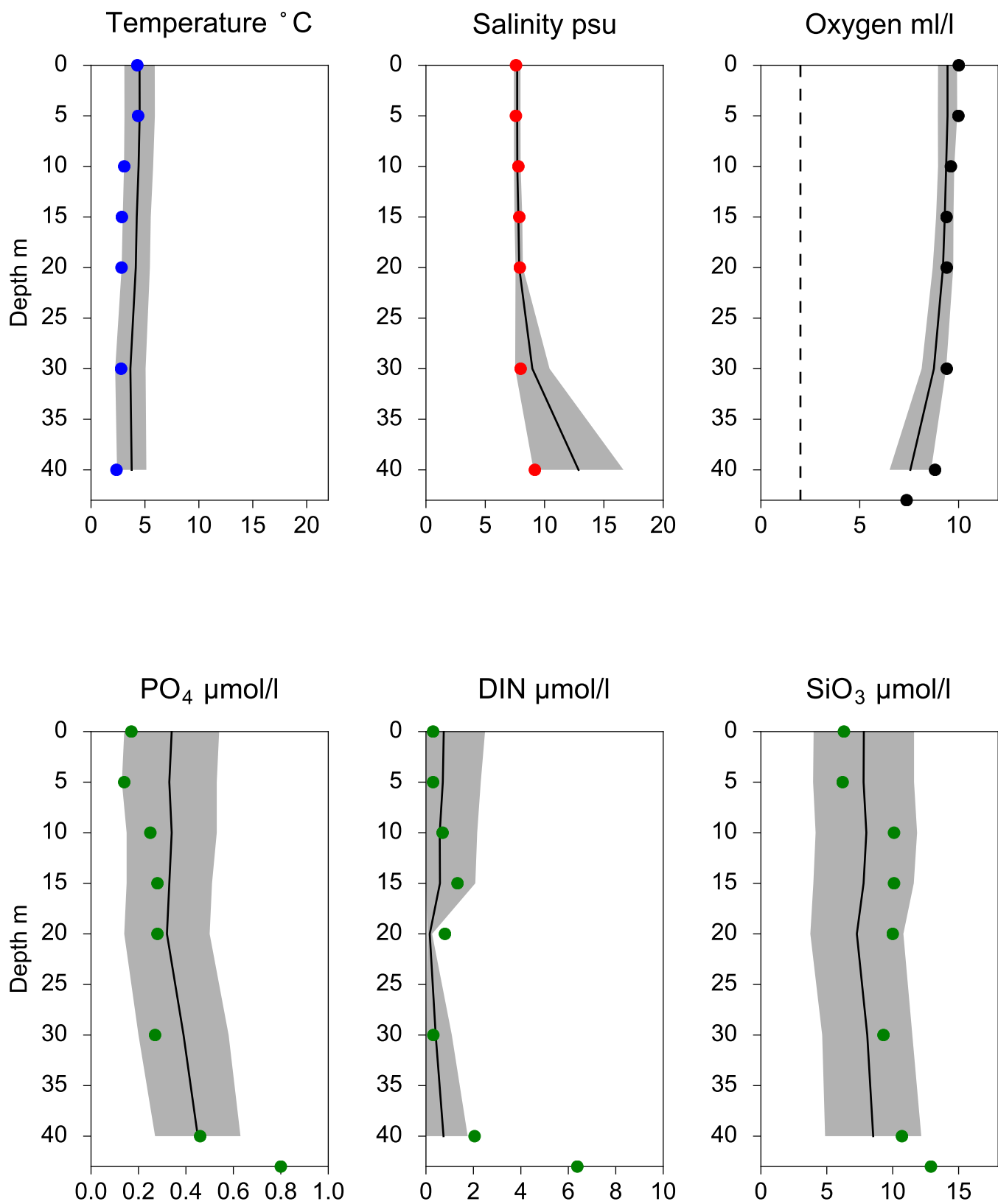


# OXYGEN IN BOTTOM WATER (depth >= 40 m)



# Vertical profiles BY1 April

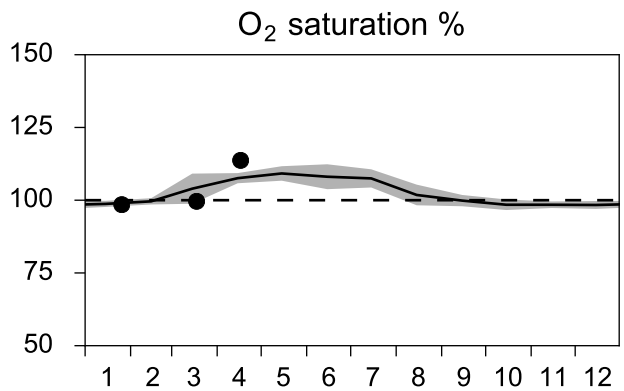
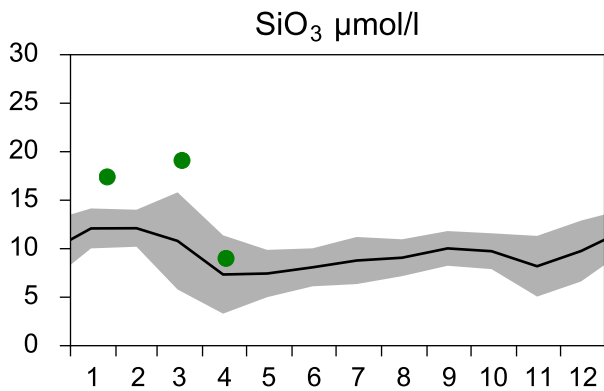
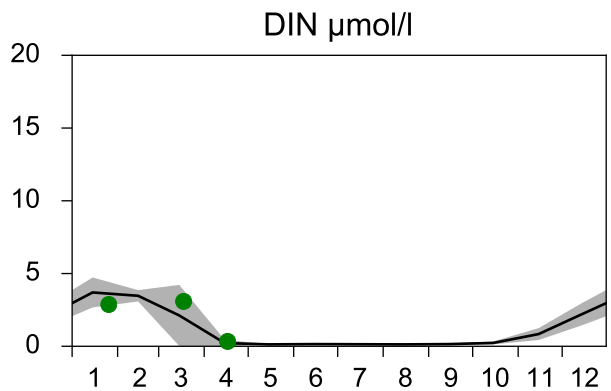
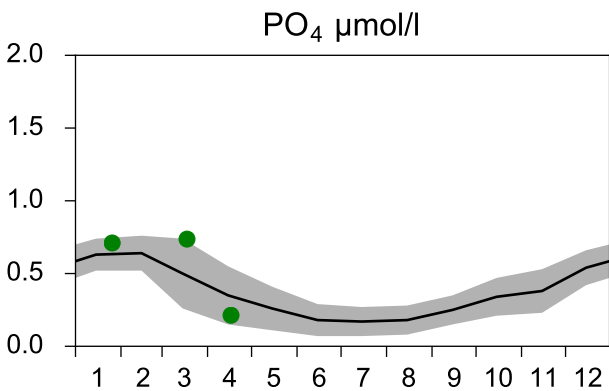
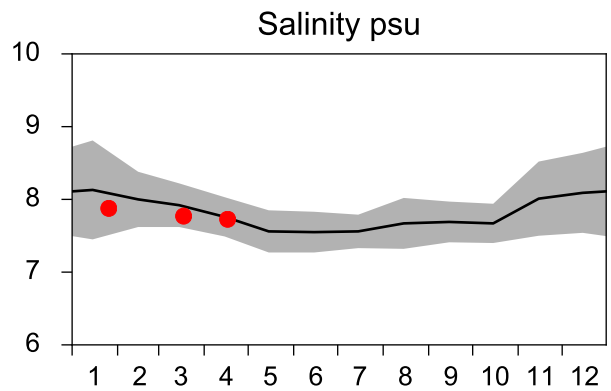
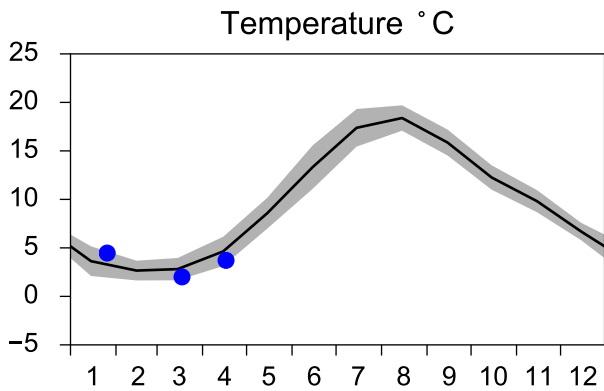
— Mean 2001-2015    ■ St.Dev.    ● 2018-04-17



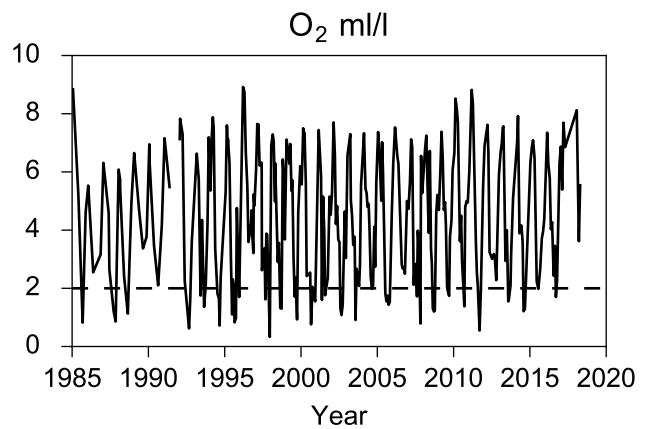
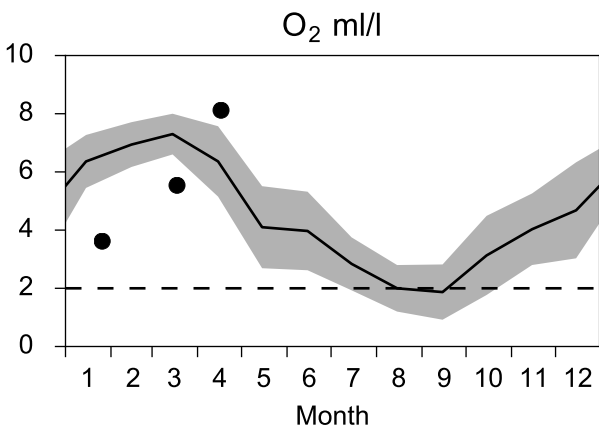
# STATION BY2 ARKONA SURFACE WATER (0-10 m)

Annual Cycles

— Mean 2001-2015    St.Dev.    ● 2018

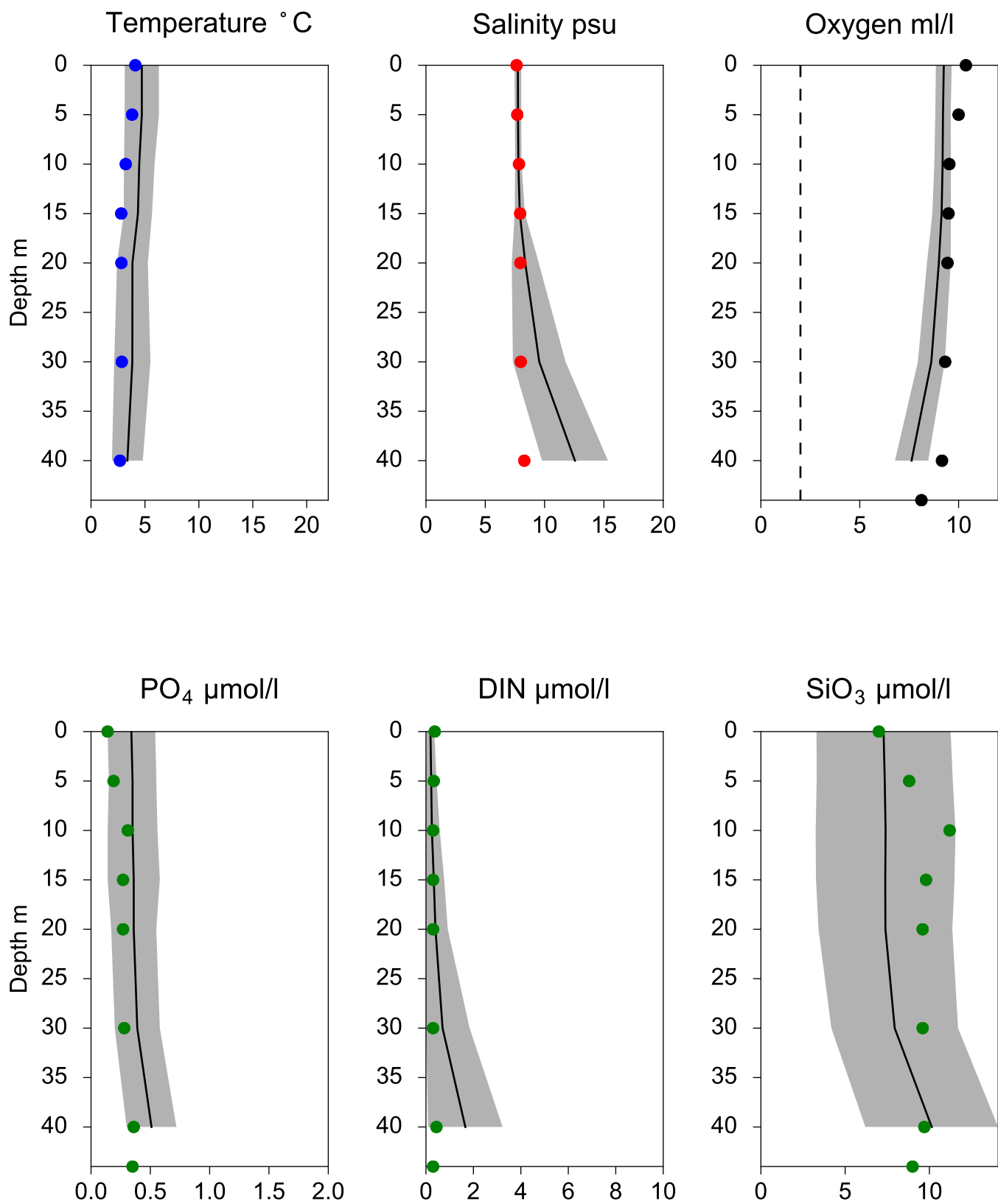


## OXYGEN IN BOTTOM WATER (depth >= 40 m)



# Vertical profiles BY2 ARKONA April

— Mean 2001-2015    ■ St.Dev.    ● 2018-04-17



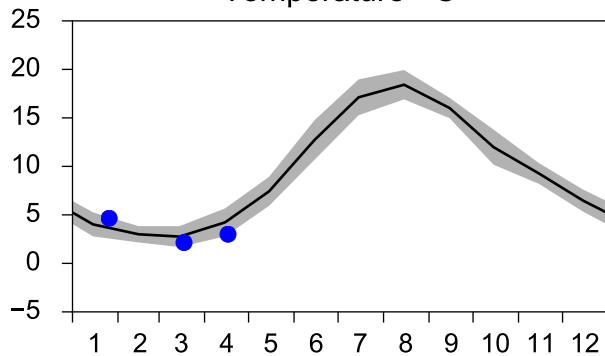


# STATION BY4 CHRISTIANSÖ SURFACE WATER (0-10 m)

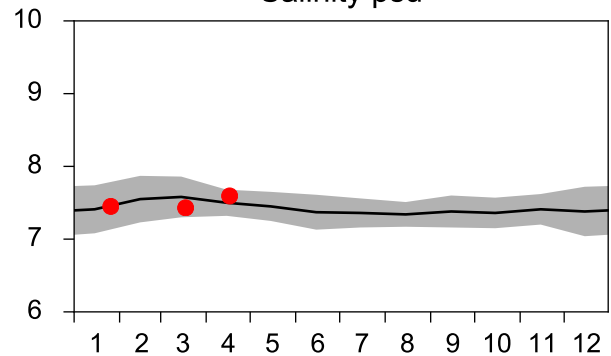
Annual Cycles

— Mean 2001-2015    ■ St.Dev.    ● 2018

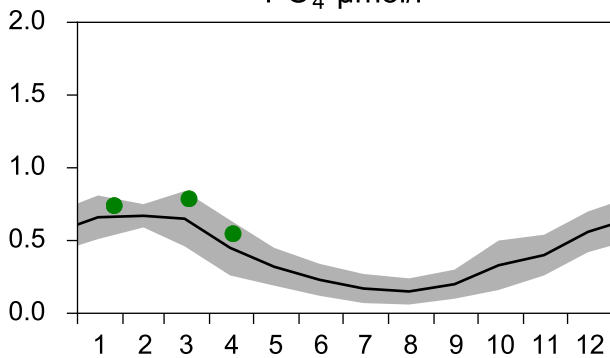
Temperature °C



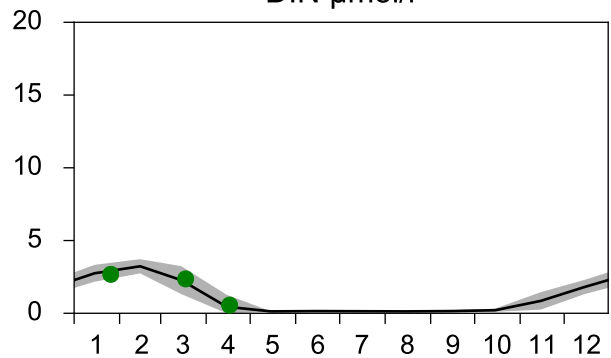
Salinity psu



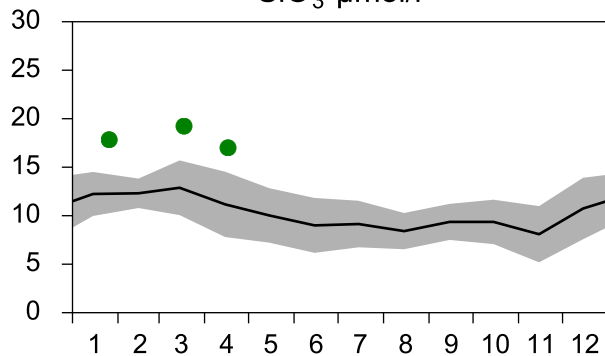
PO<sub>4</sub> μmol/l



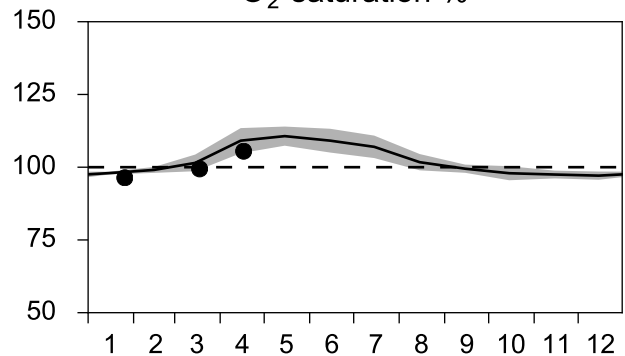
DIN μmol/l



SiO<sub>3</sub> μmol/l

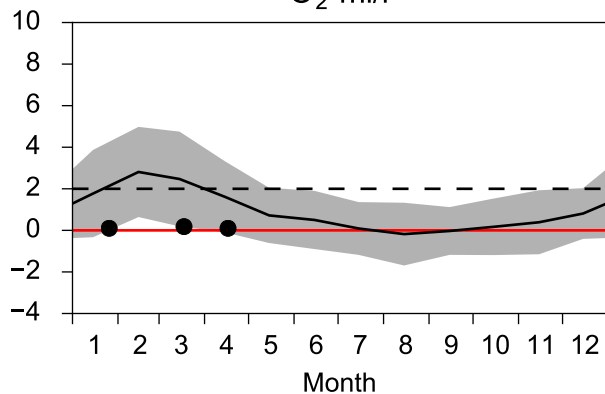


O<sub>2</sub> saturation %

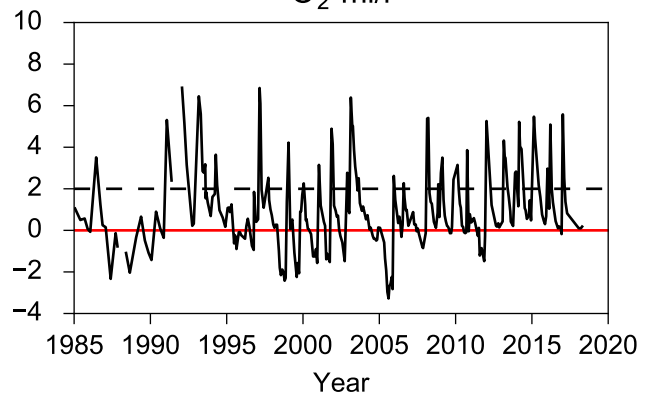


## OXYGEN IN BOTTOM WATER (depth >= 80 m)

O<sub>2</sub> ml/l

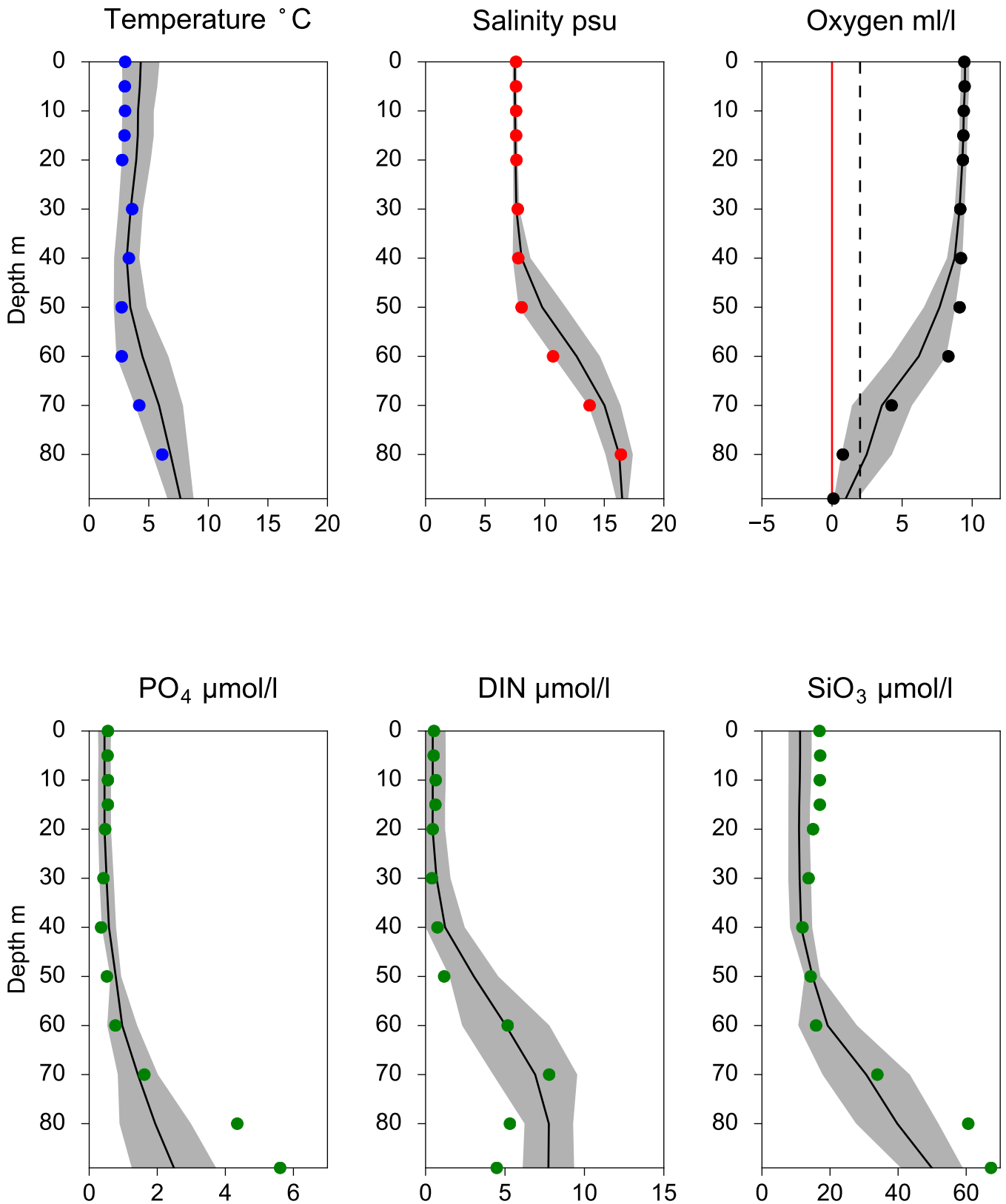


O<sub>2</sub> ml/l



# Vertical profiles BY4 CHRISTIANSÖ April

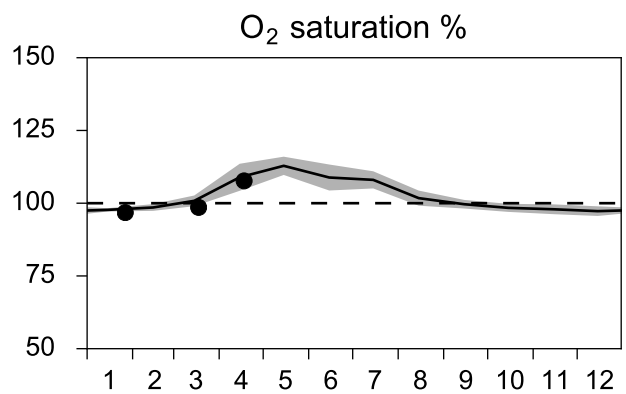
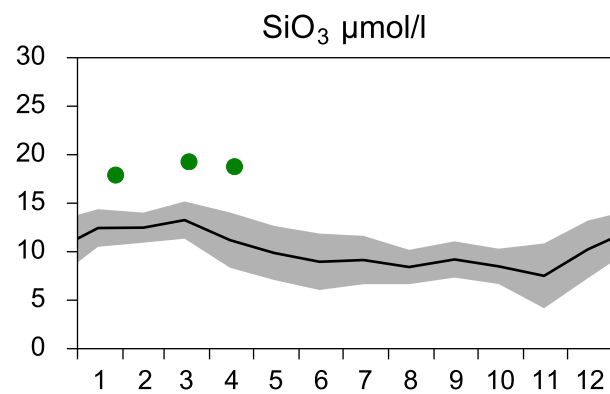
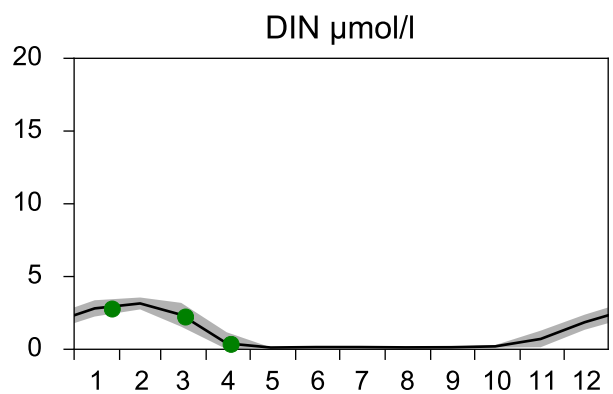
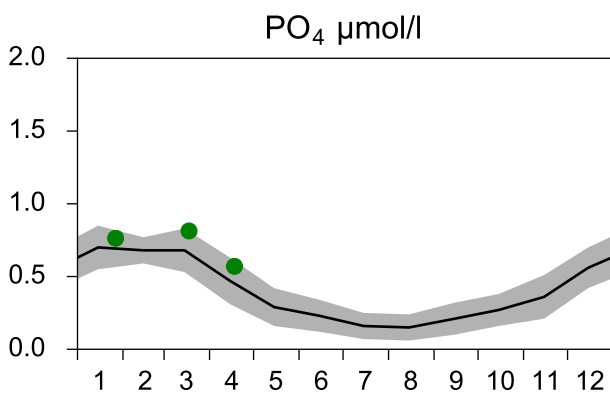
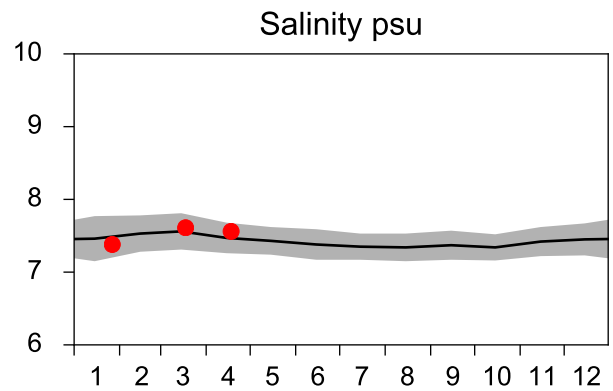
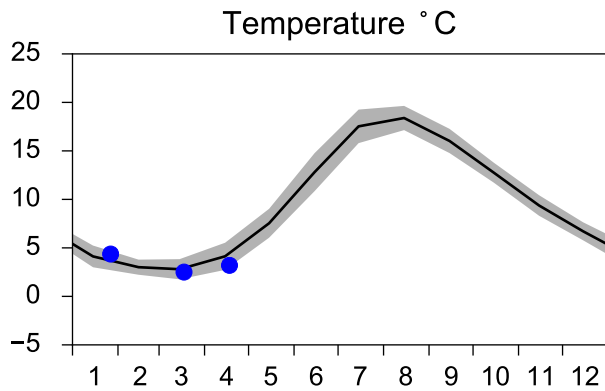
— Mean 2001-2015    ■ St.Dev.    ● 2018-04-17



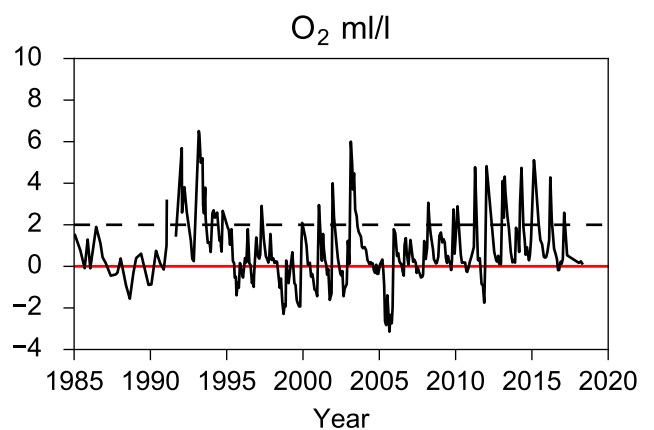
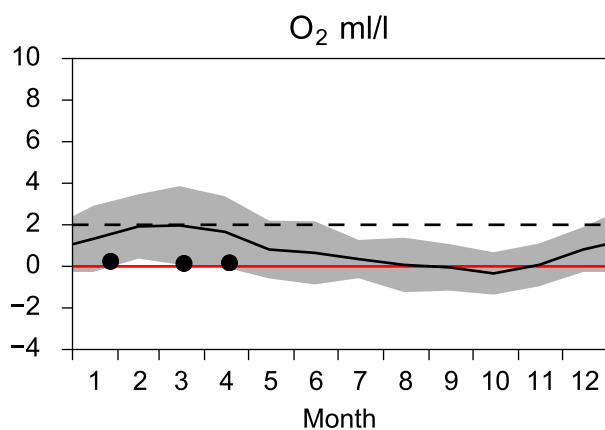
# STATION BY5 BORNHOLMSDJ SURFACE WATER (0-10 m)

Annual Cycles

— Mean 2001-2015    ■ St.Dev.    ● 2018

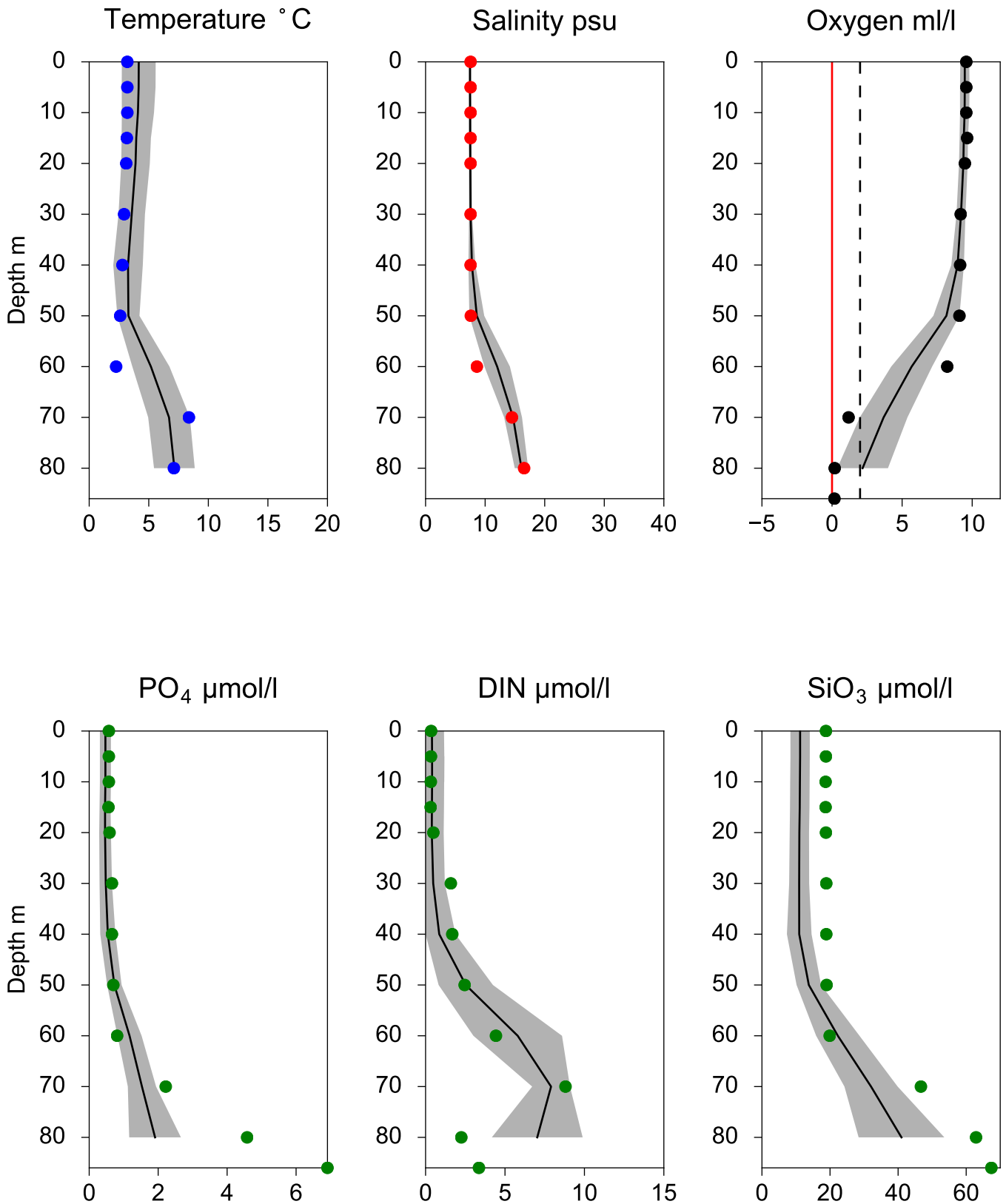


## OXYGEN IN BOTTOM WATER (depth >= 80 m)



# Vertical profiles BY5 BORNHOLMSDJ April

— Mean 2001-2015    ■ St.Dev.    ● 2018-04-18



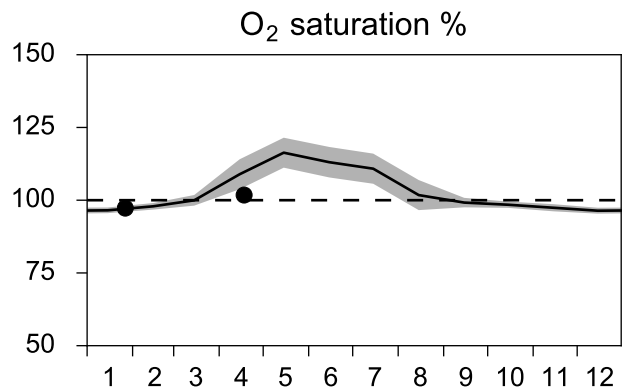
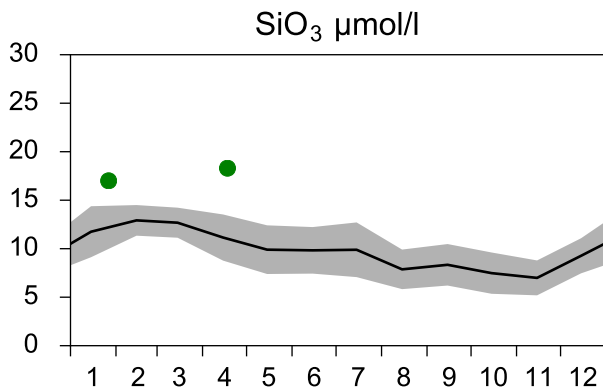
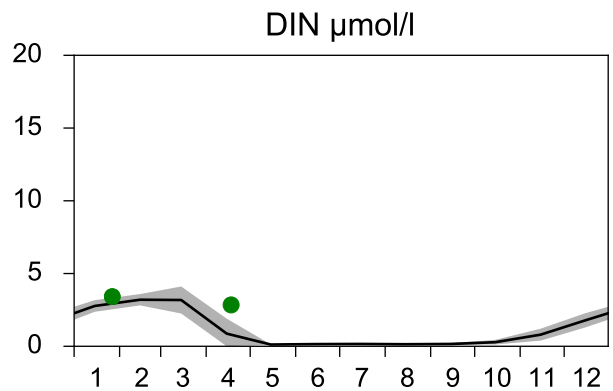
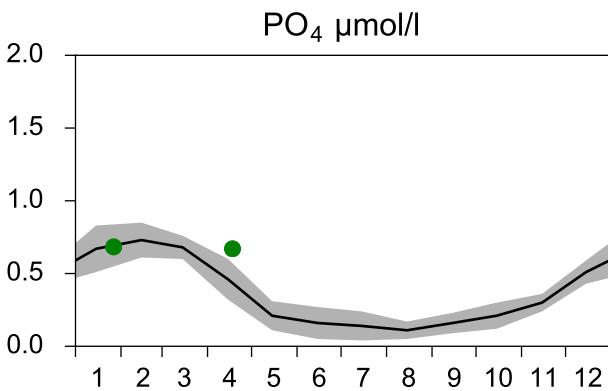
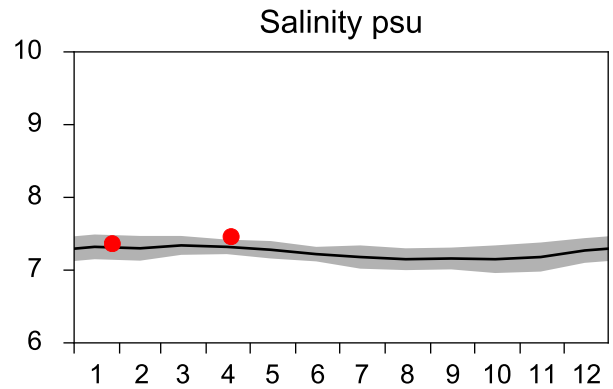
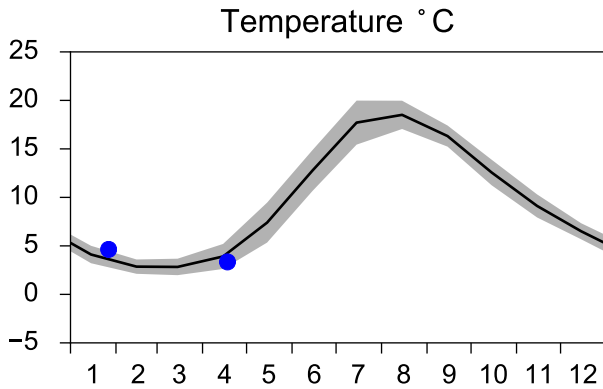
# STATION BCS III-10 SURFACE WATER (0-10 m)

Annual Cycles

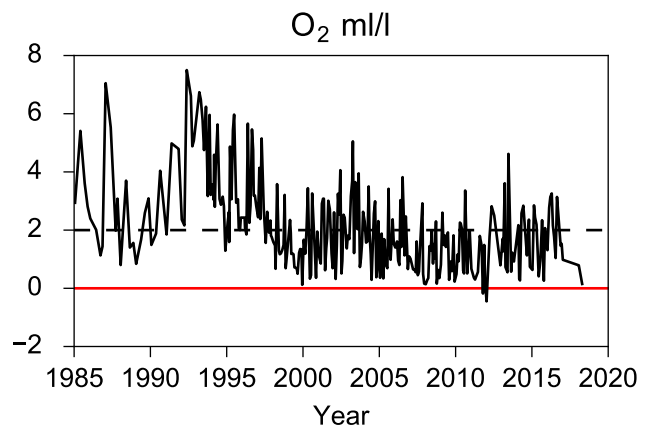
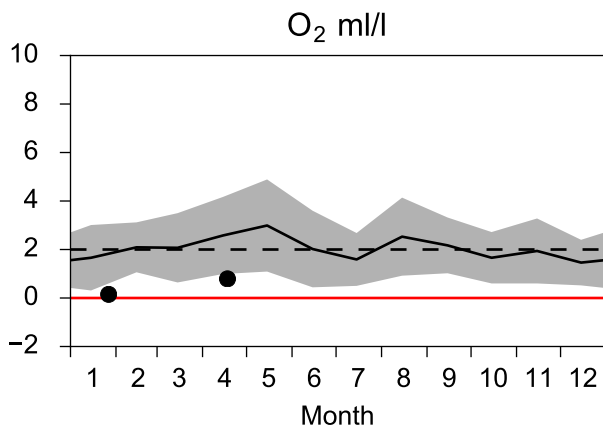
— Mean 2001-2015

■ St.Dev.

● 2018

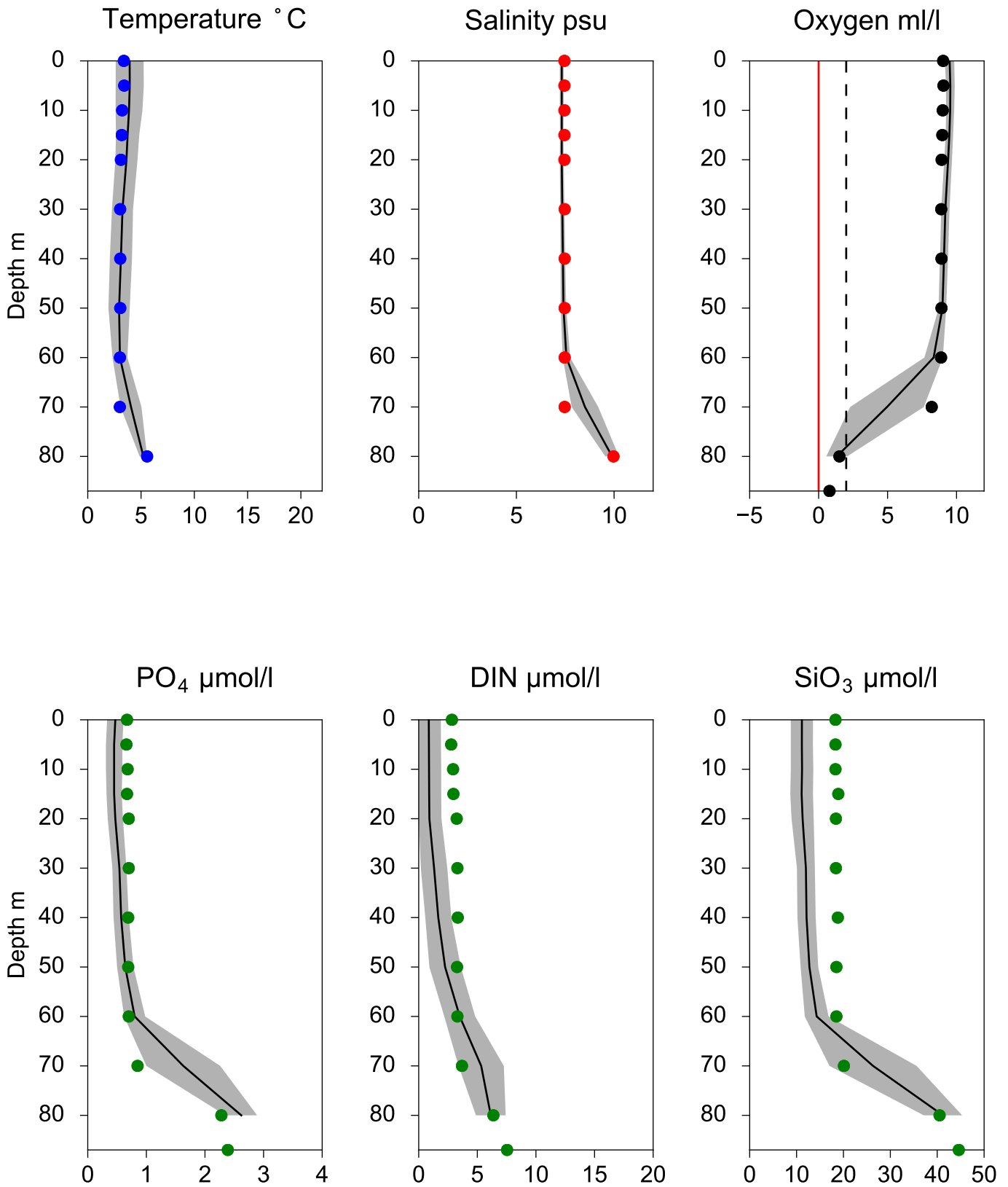


## OXYGEN IN BOTTOM WATER (depth >= 80 m)



# Vertical profiles BCS III-10 April

— Mean 2001-2015    ■ St.Dev.    ● 2018-04-18

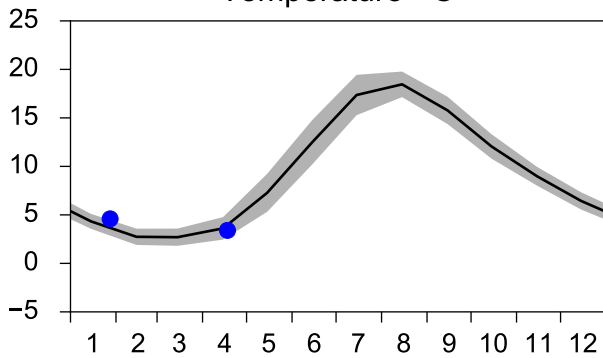


# STATION BY10 SURFACE WATER (0-10 m)

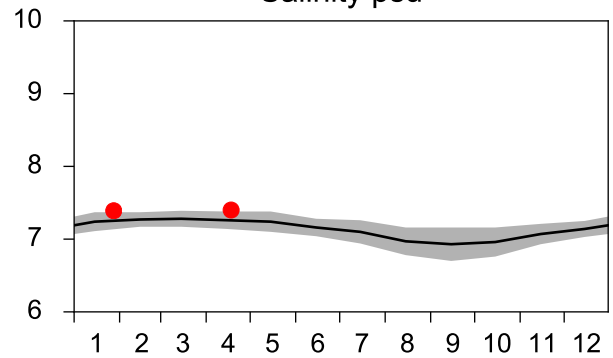
Annual Cycles

— Mean 2001-2015    ■ St.Dev.    ● 2018

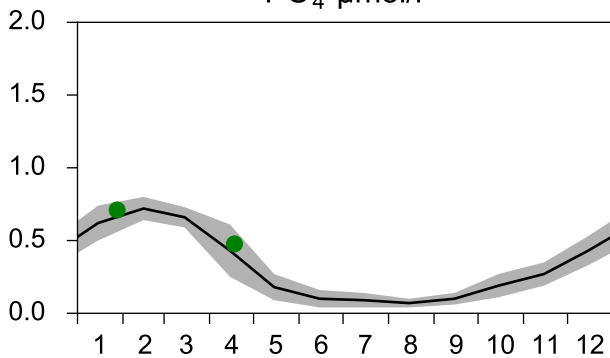
Temperature °C



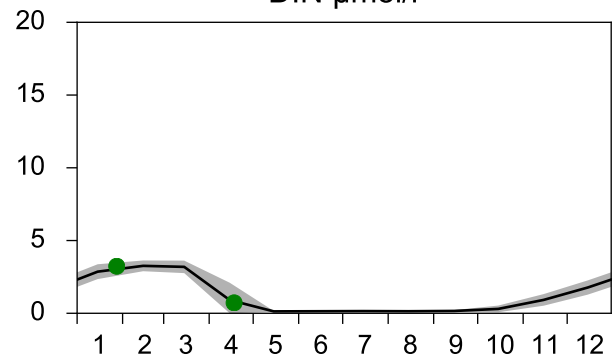
Salinity psu



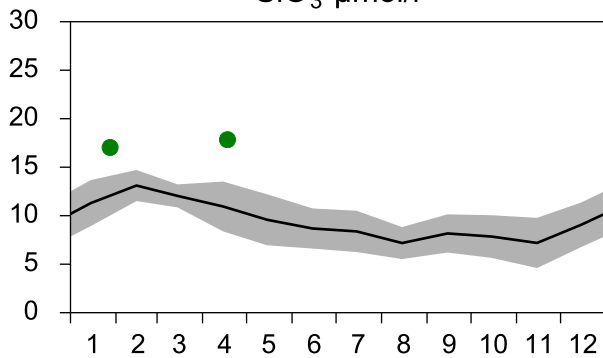
PO<sub>4</sub> µmol/l



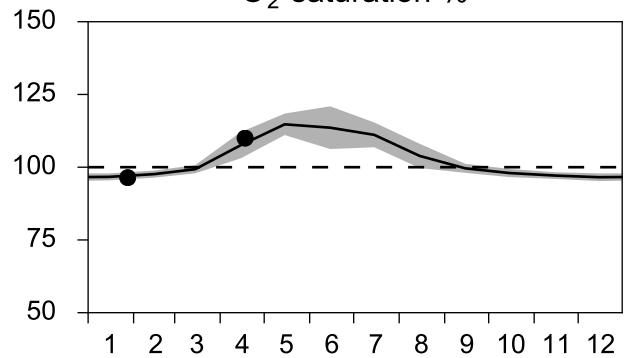
DIN µmol/l



SiO<sub>3</sub> µmol/l

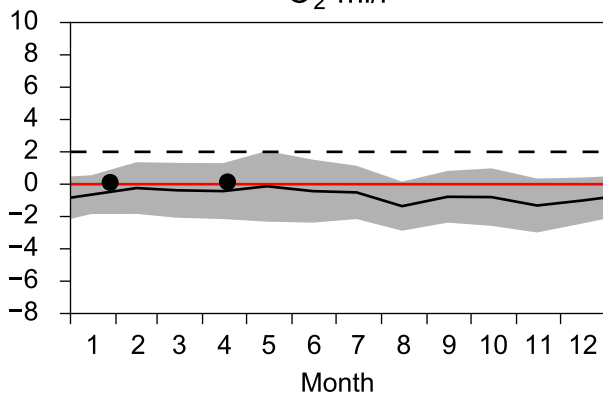


O<sub>2</sub> saturation %

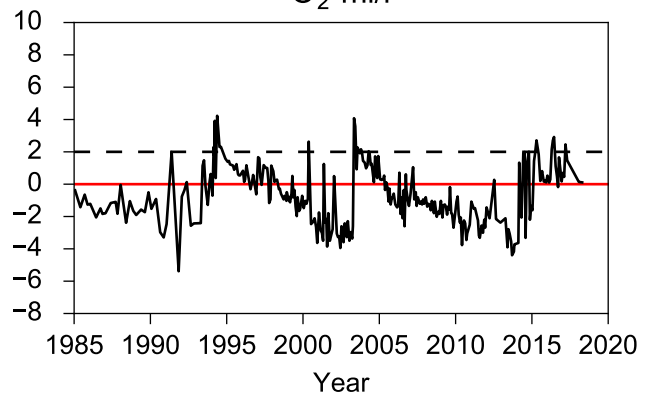


# OXYGEN IN BOTTOM WATER (depth >= 125 m)

O<sub>2</sub> ml/l



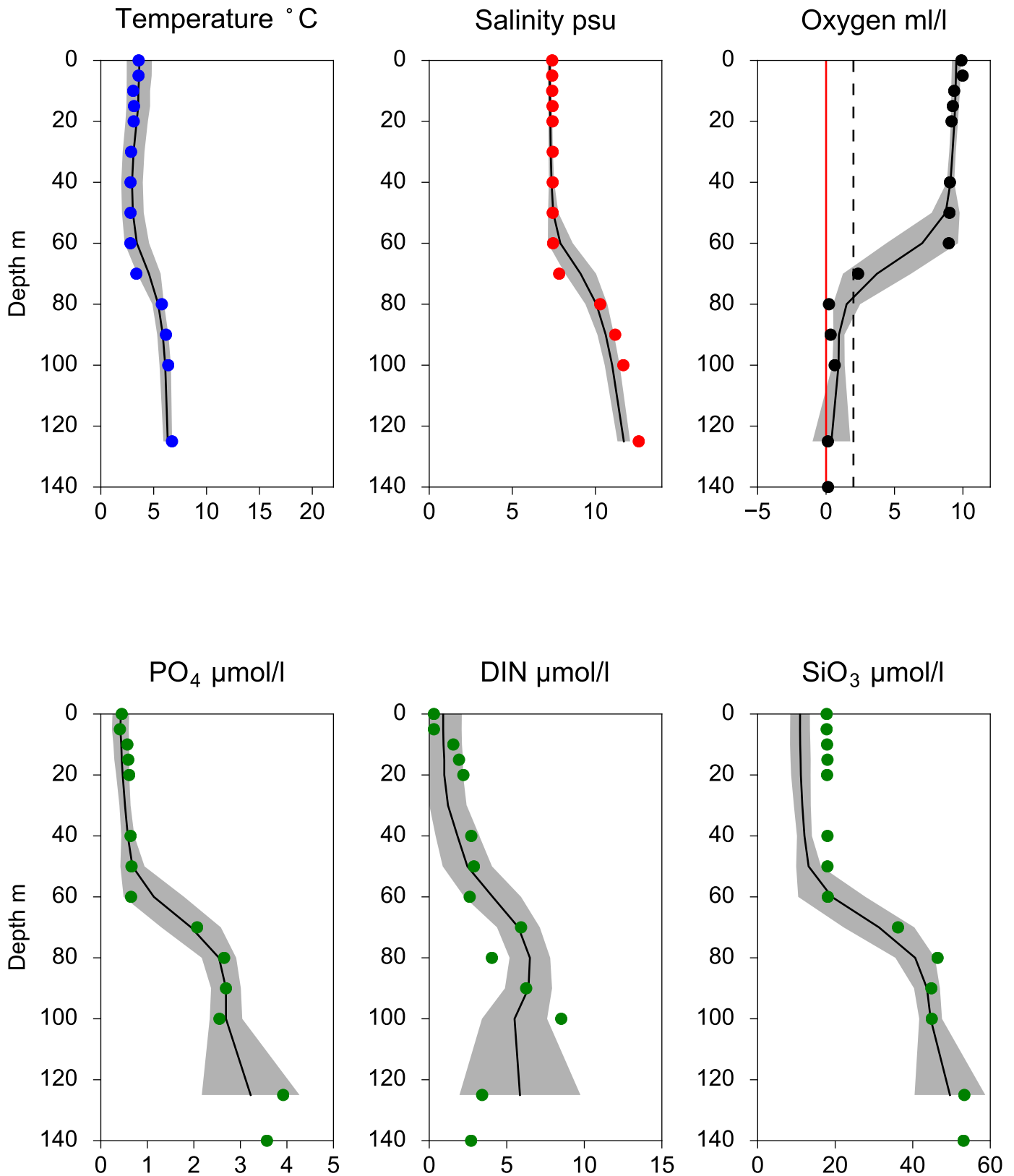
O<sub>2</sub> ml/l





# Vertical profiles BY10 April

— Mean 2001-2015    ■ St.Dev.    ● 2018-04-18

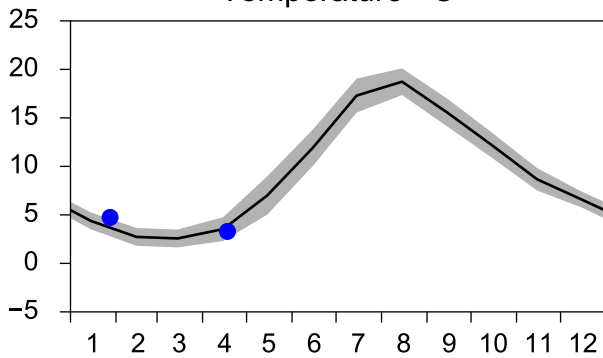


# STATION BY15 GOTLANDSDJ SURFACE WATER (0-10 m)

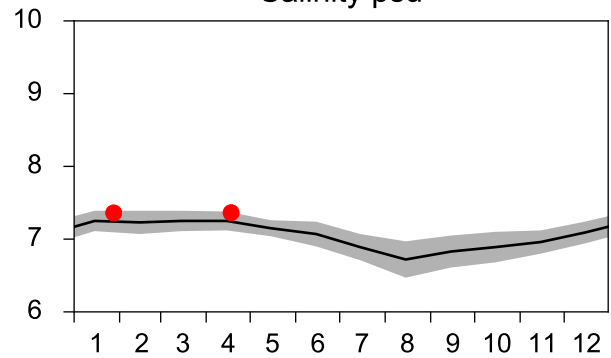
Annual Cycles

— Mean 2001-2015    ■ St.Dev.    ● 2018

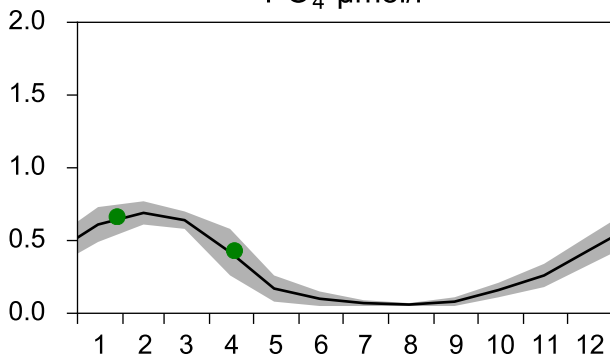
Temperature °C



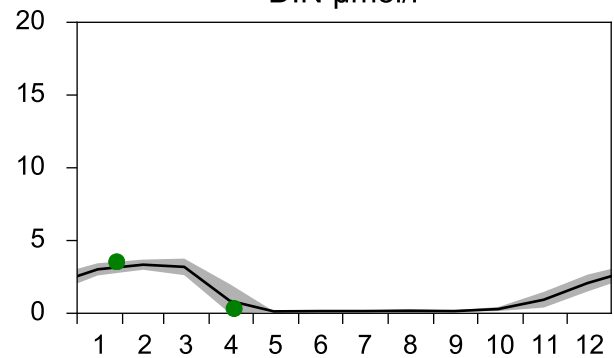
Salinity psu



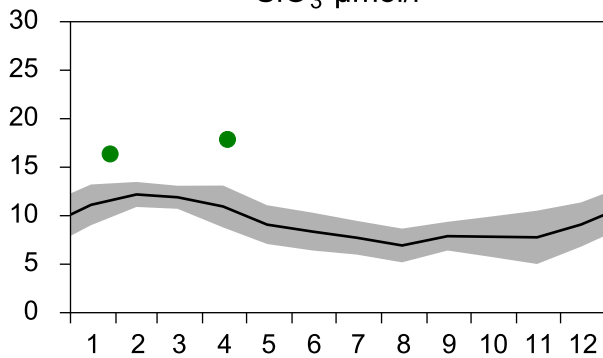
PO<sub>4</sub> µmol/l



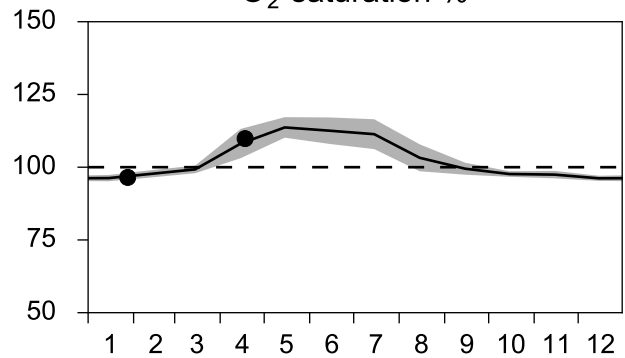
DIN µmol/l



SiO<sub>3</sub> µmol/l

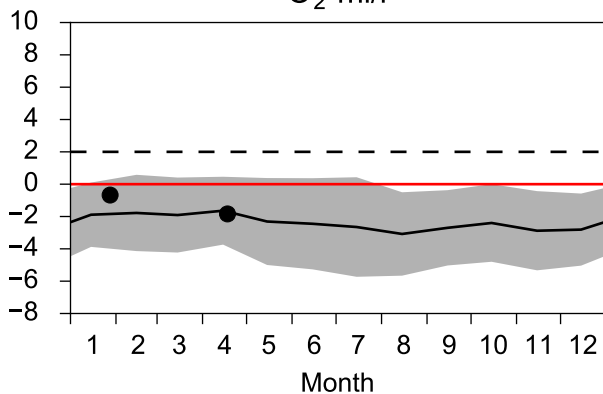


O<sub>2</sub> saturation %

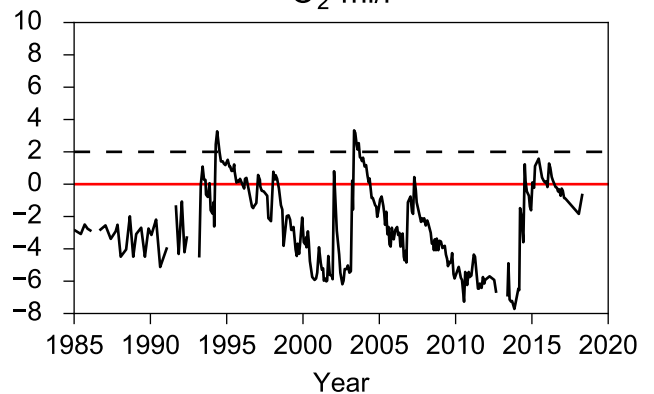


## OXYGEN IN BOTTOM WATER (depth >= 225 m)

O<sub>2</sub> ml/l

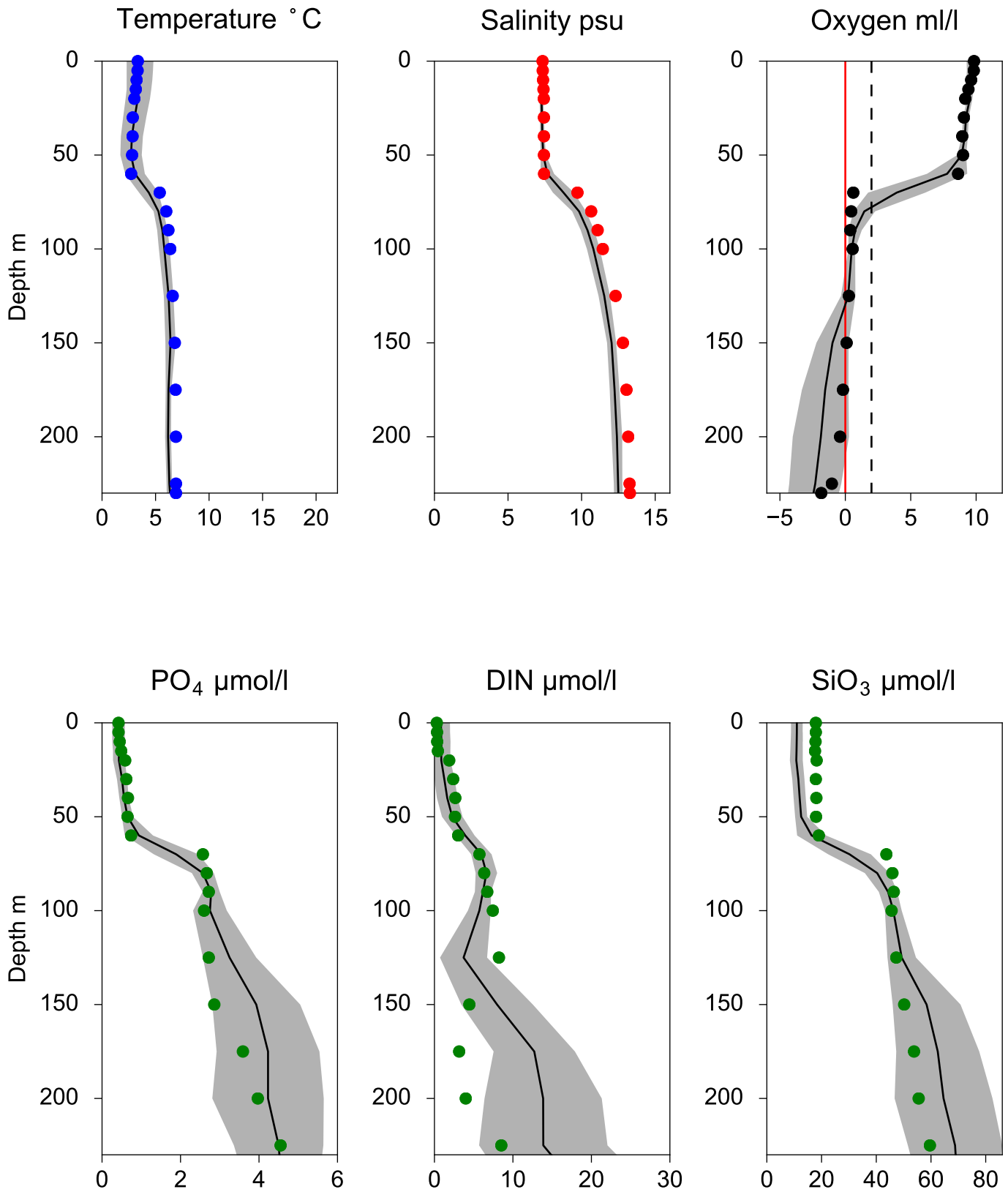


O<sub>2</sub> ml/l



# Vertical profiles BY15 GOTLANDSDJ April

— Mean 2001-2015    ■ St.Dev.    ● 2018-04-18

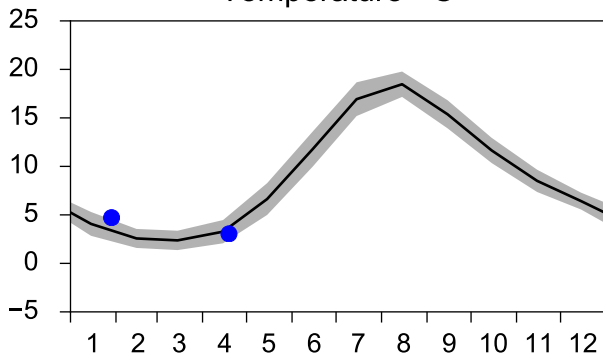


# STATION BY20 FÅRÖDJ SURFACE WATER (0-10 m)

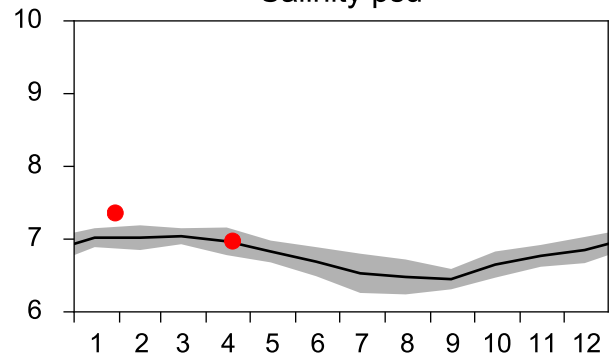
Annual Cycles

— Mean 2001-2015    ■ St.Dev.    ● 2018

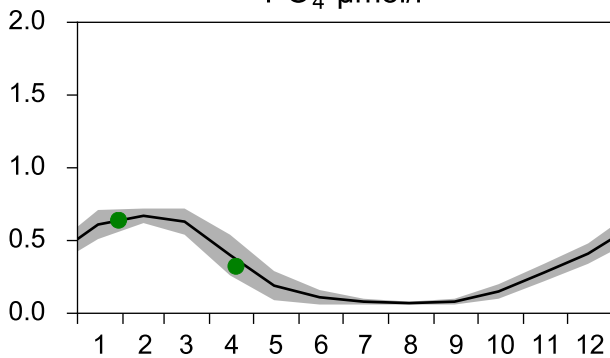
Temperature °C



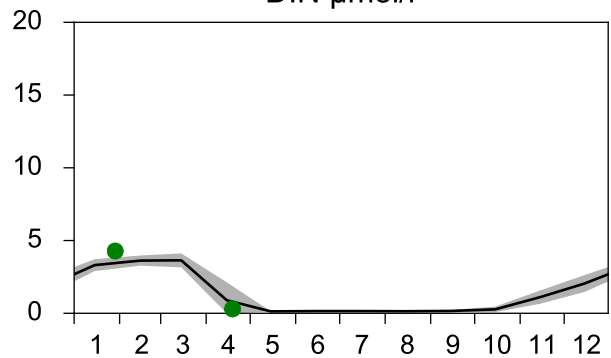
Salinity psu



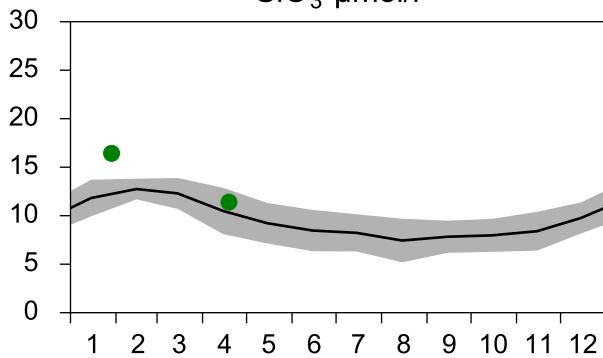
PO<sub>4</sub> µmol/l



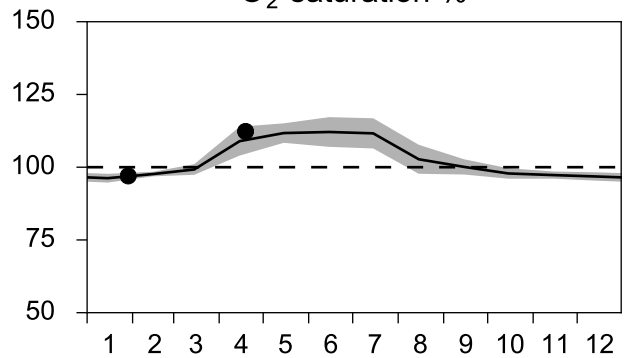
DIN µmol/l



SiO<sub>3</sub> µmol/l

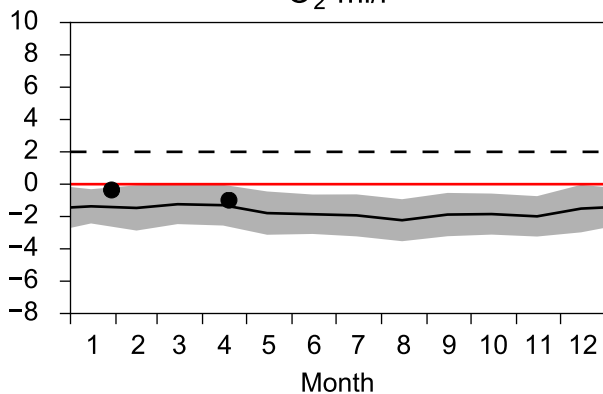


O<sub>2</sub> saturation %

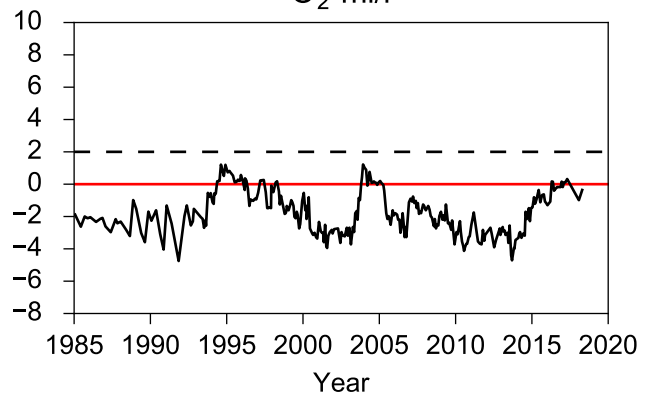


## OXYGEN IN BOTTOM WATER (depth >= 175 m)

O<sub>2</sub> ml/l

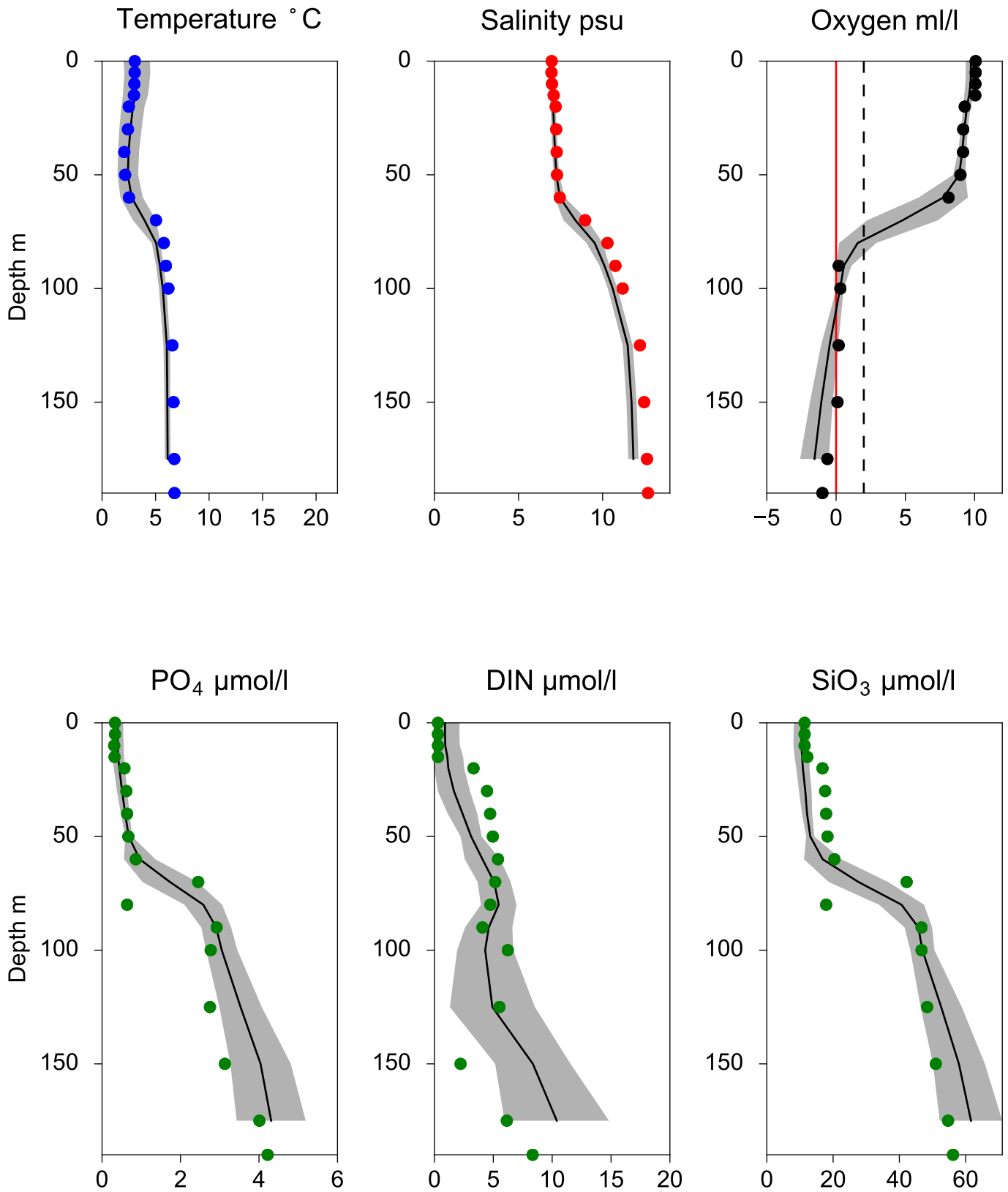


O<sub>2</sub> ml/l



# Vertical profiles BY20 FÅRÖDJ April

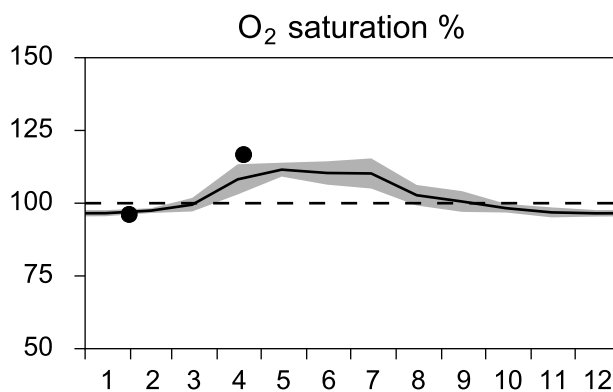
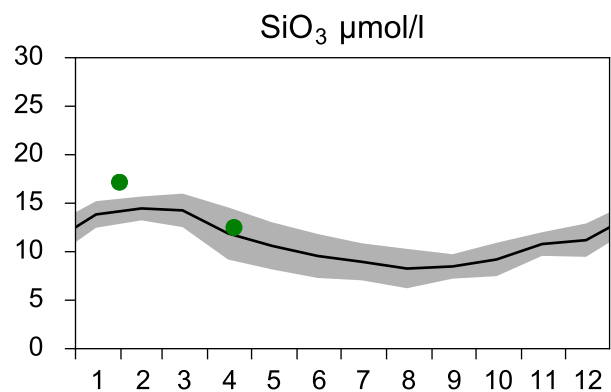
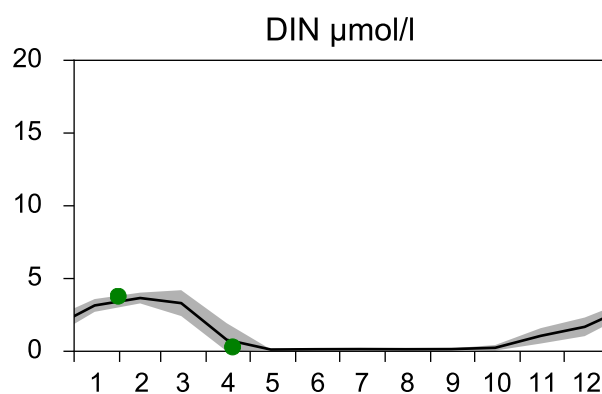
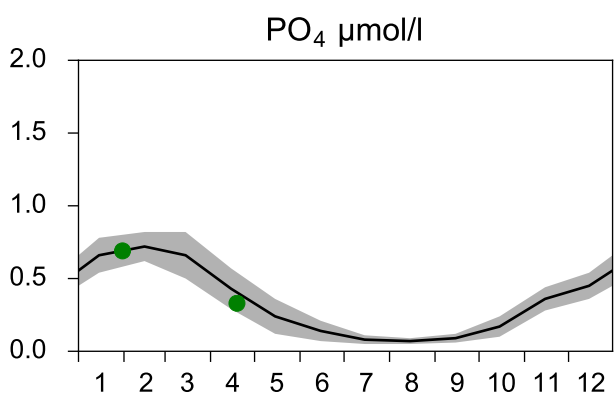
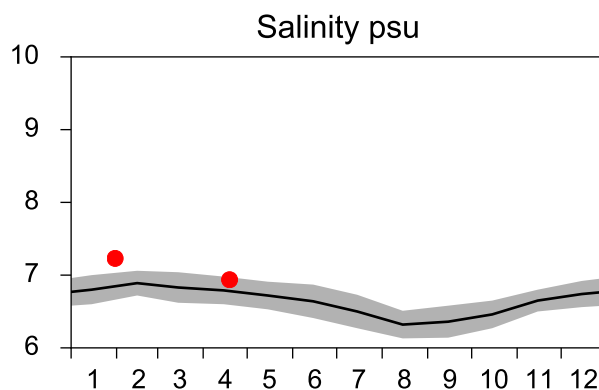
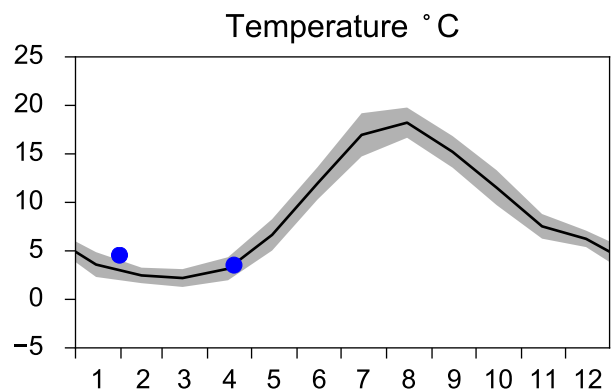
— Mean 2001-2015    ■ St.Dev.    ● 2018-04-19



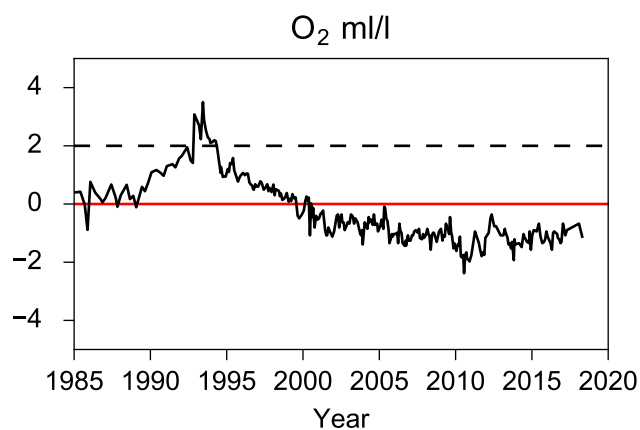
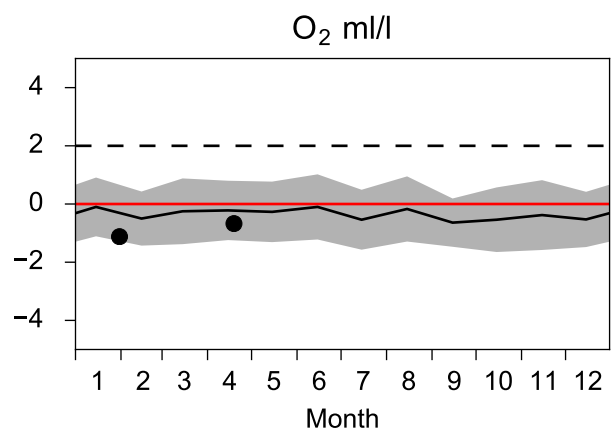
# STATION BY32 NORRKÖPINGSDJ SURFACE WATER (0-10 m)

Annual Cycles

— Mean 2001-2015    ■ St.Dev.    ● 2018

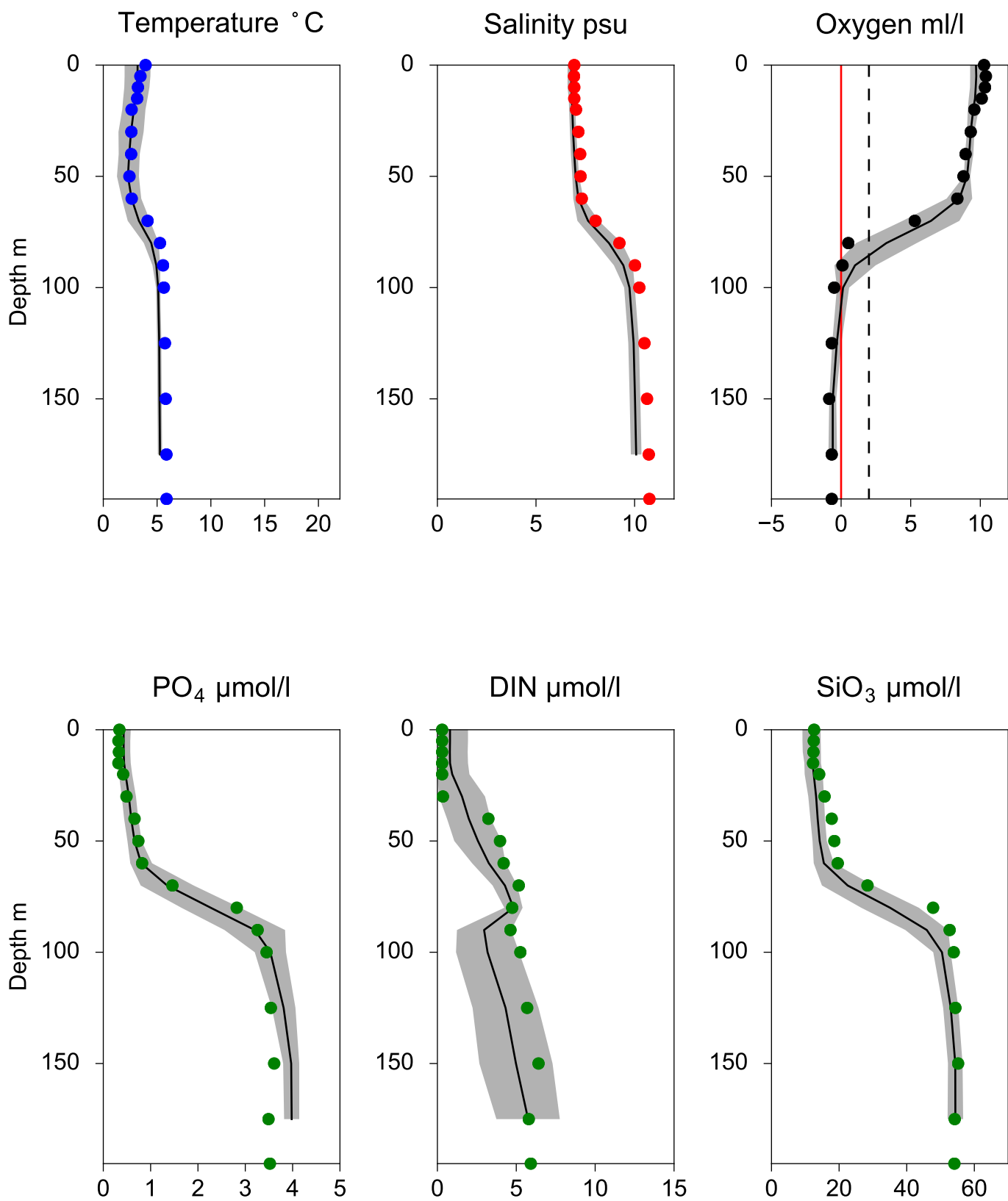


## OXYGEN IN BOTTOM WATER (depth >= 175 m)



# Vertical profiles BY32 NORRKÖPINGSDJ April

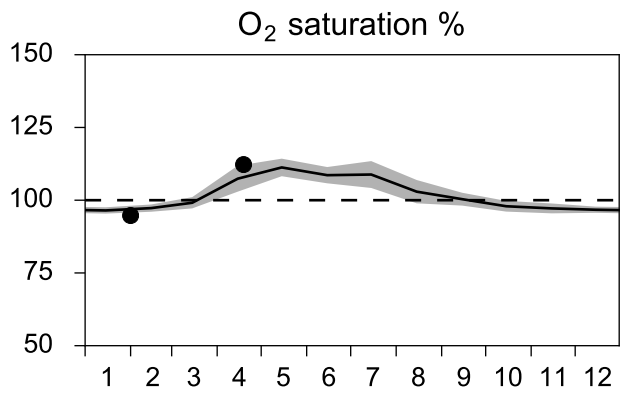
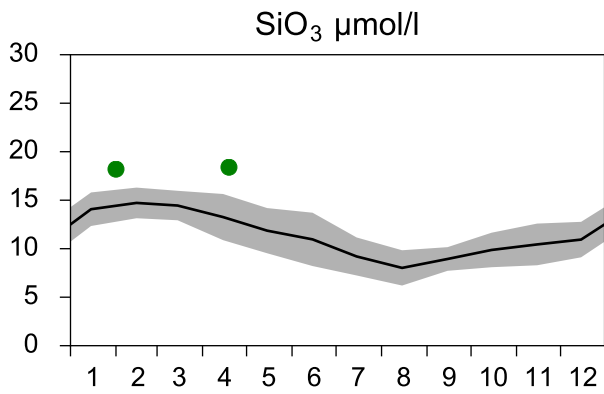
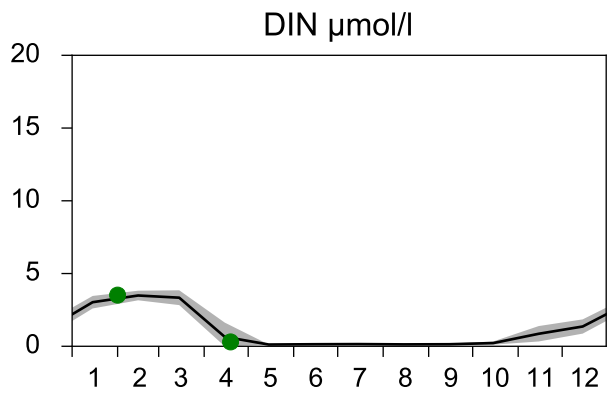
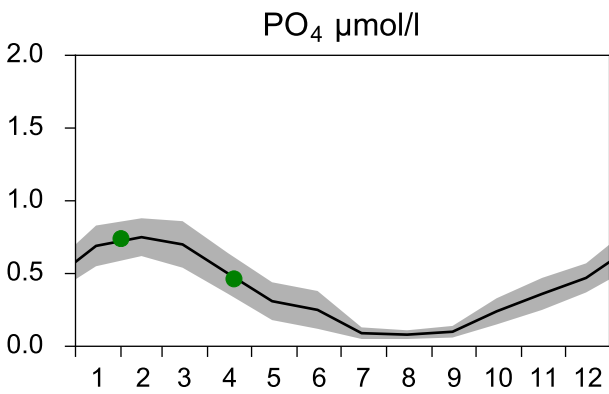
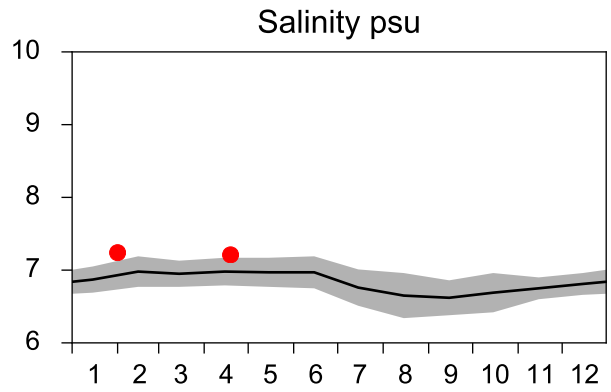
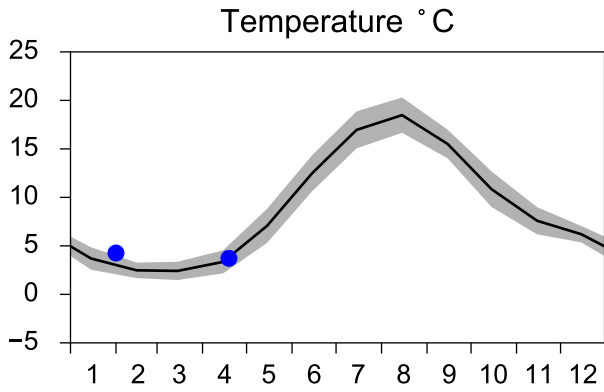
— Mean 2001-2015    ■ St.Dev.    ● 2018-04-19



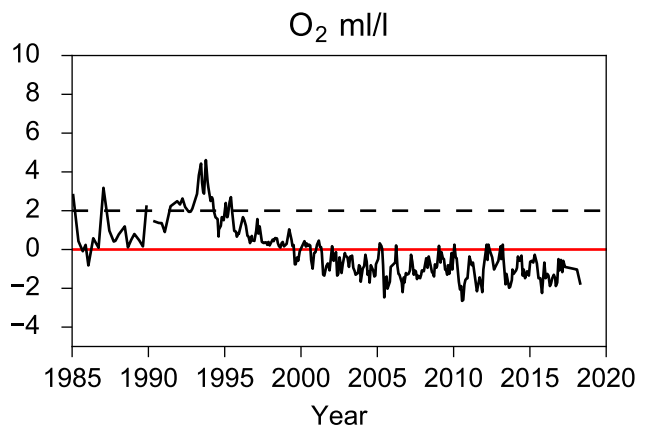
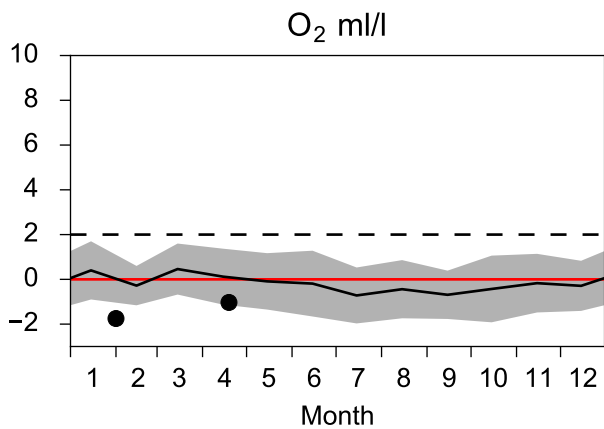
# STATION BY38 KARLSÖDJ SURFACE WATER (0-10 m)

Annual Cycles

— Mean 2001-2015    ■ St.Dev.    ● 2018



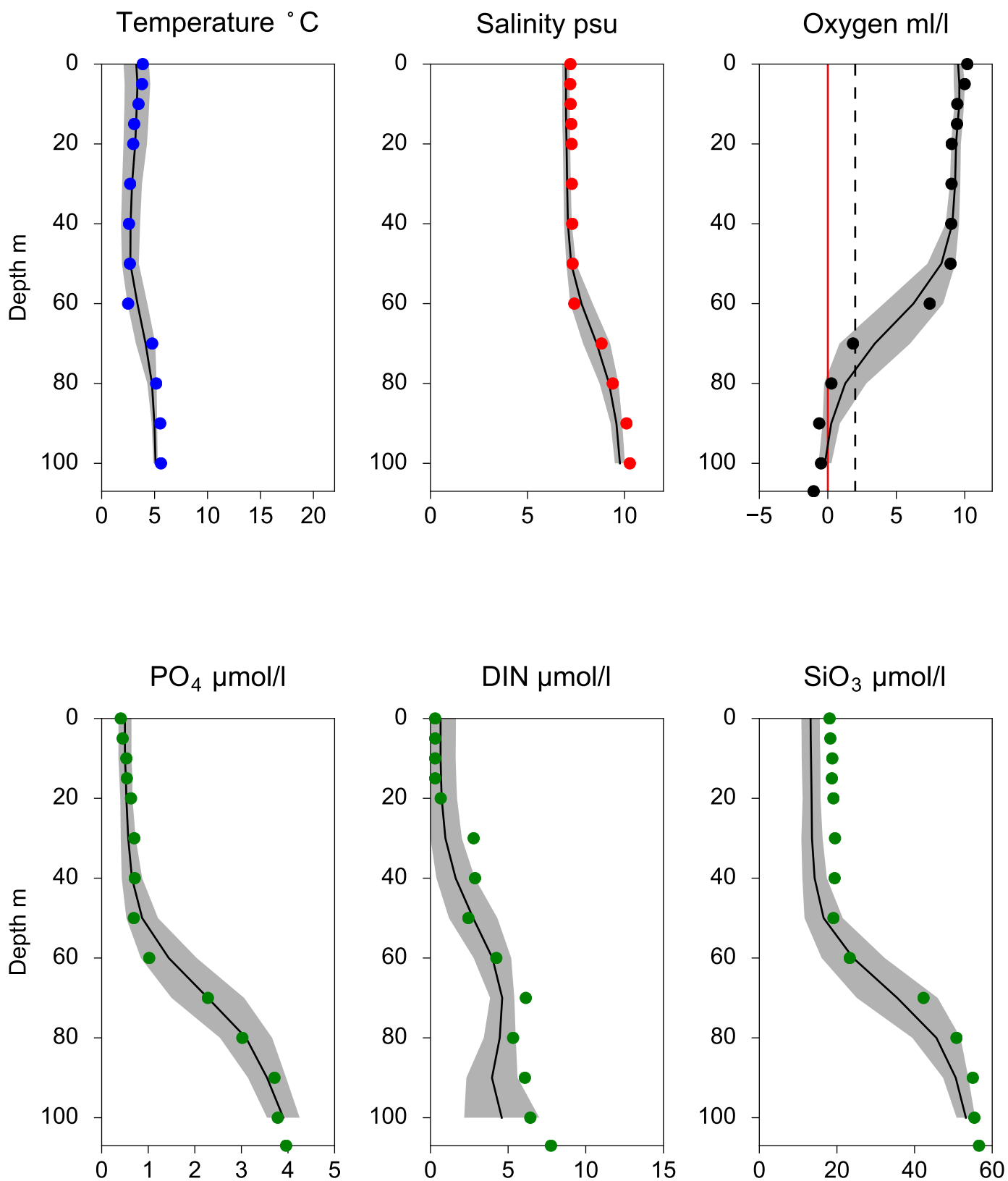
## OXYGEN IN BOTTOM WATER (depth >= 100 m)





# Vertical profiles BY38 KARLSÖDJ April

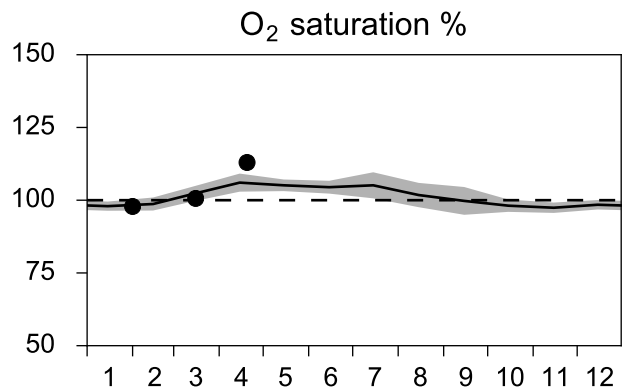
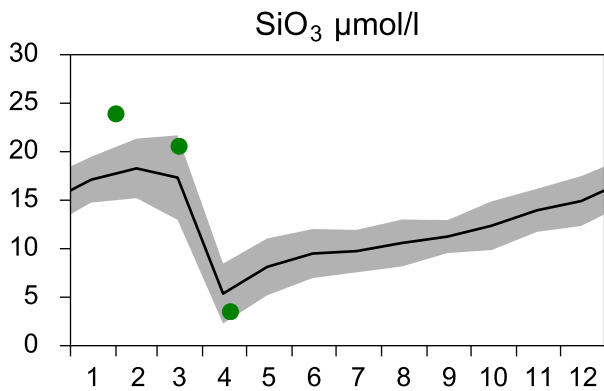
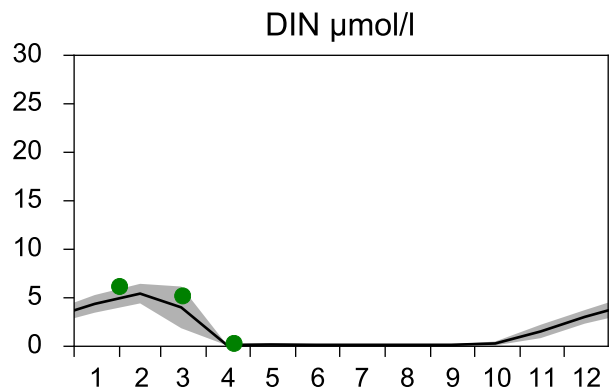
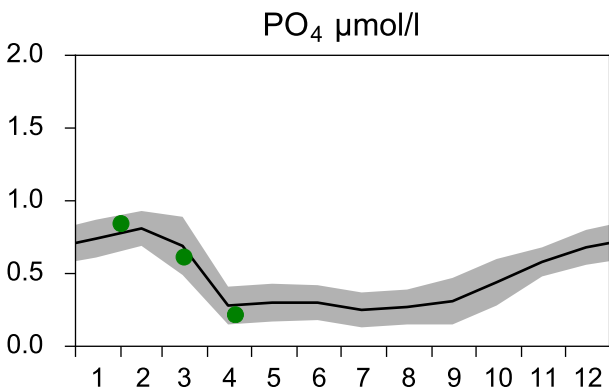
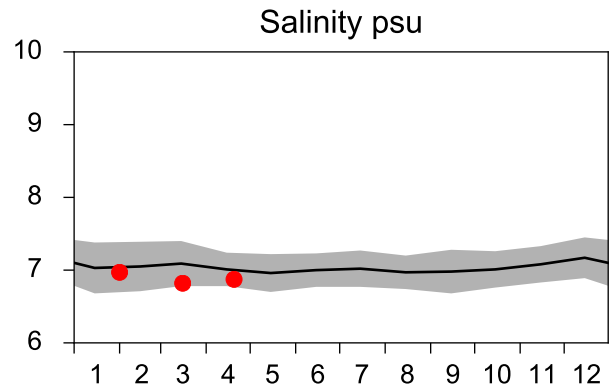
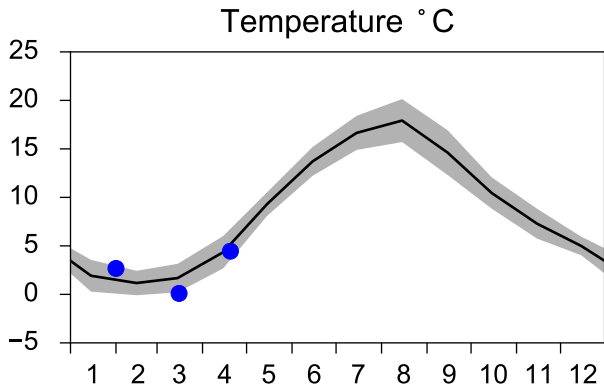
— Mean 2001-2015    ■ St.Dev.    ● 2018-04-19



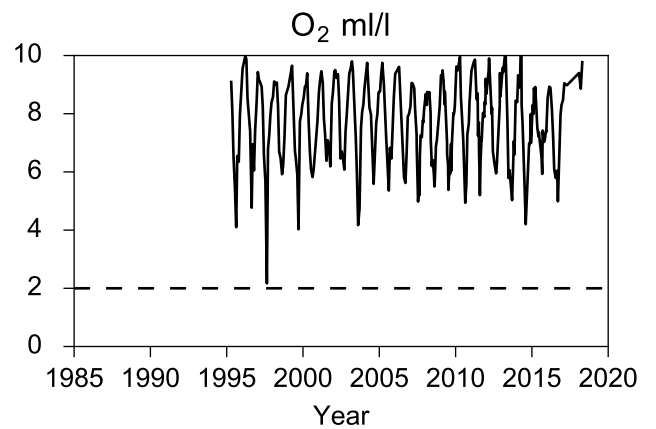
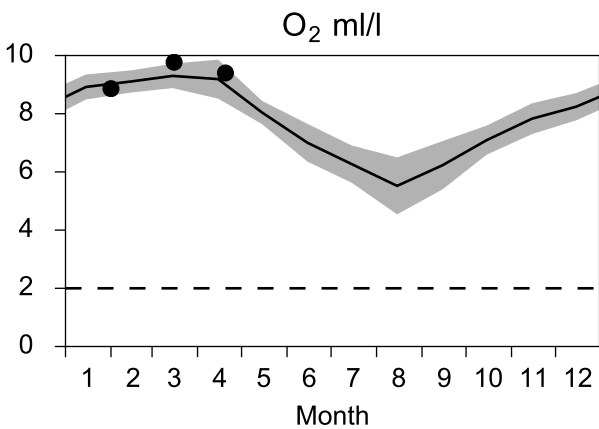
# STATION REF M1V1 SURFACE WATER (0-10 m)

Annual Cycles

— Mean 2001-2015    St.Dev.    ● 2018

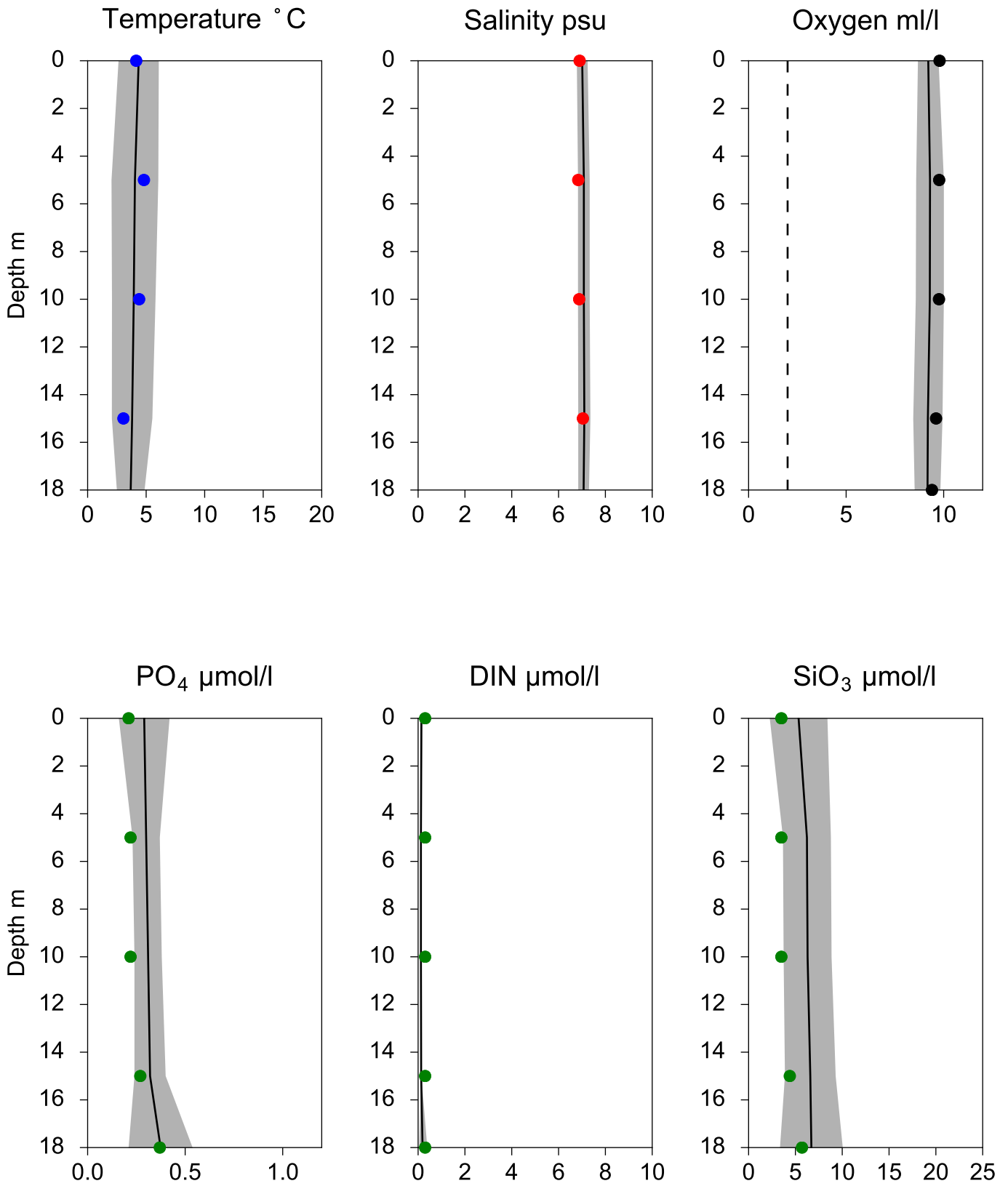


## OXYGEN IN BOTTOM WATER (depth >= 17 m)



# Vertical profiles REF M1V1 April

— Mean 2001-2015    ■ St.Dev.    ● 2018-04-20

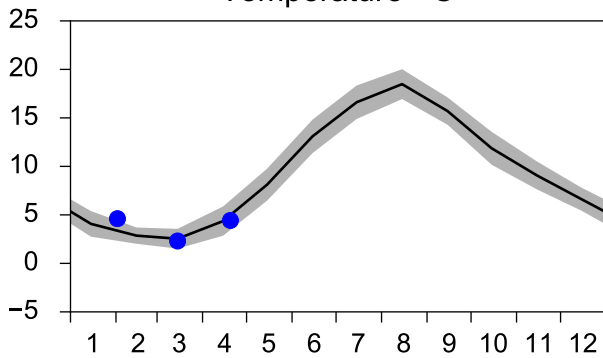


# STATION HANÖBUKTEN SURFACE WATER (0-10 m)

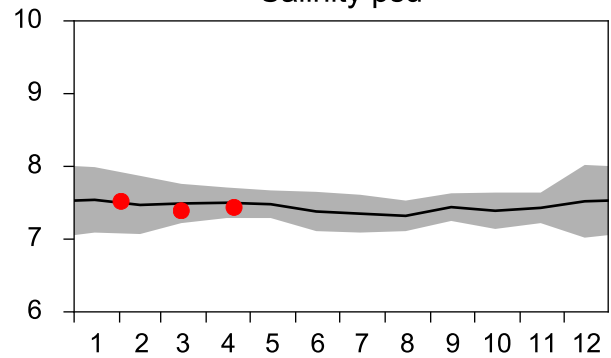
Annual Cycles

— Mean 2001-2015    ■ St.Dev.    ● 2018

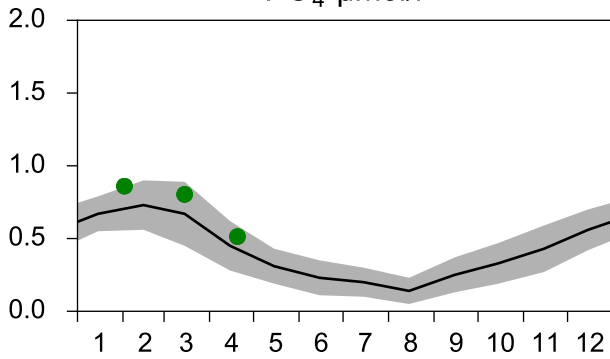
Temperature °C



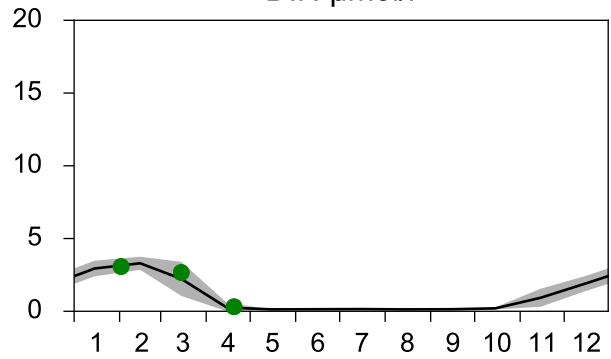
Salinity psu



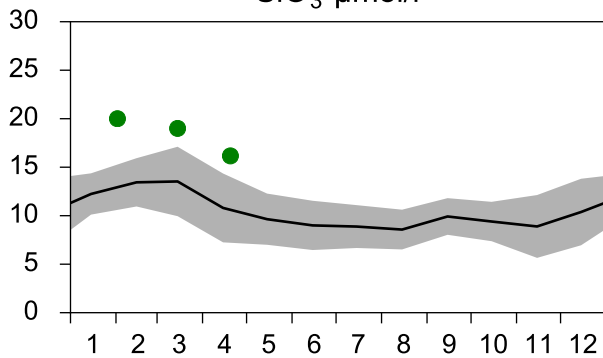
PO<sub>4</sub> µmol/l



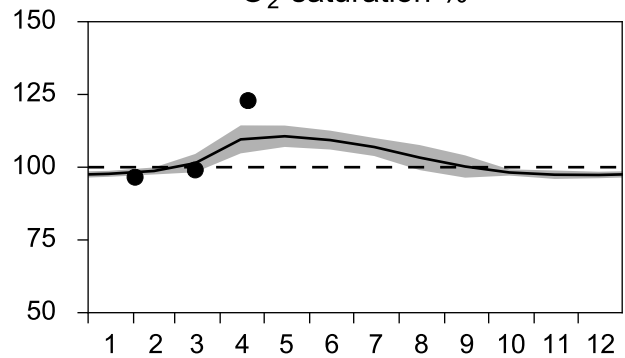
DIN µmol/l



SiO<sub>3</sub> µmol/l

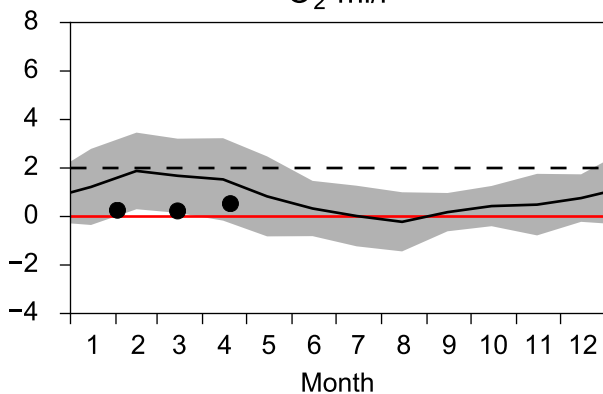


O<sub>2</sub> saturation %

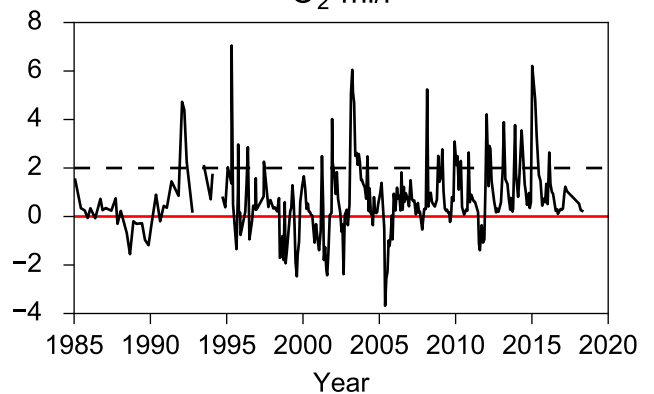


## OXYGEN IN BOTTOM WATER (depth >= 70 m)

O<sub>2</sub> ml/l

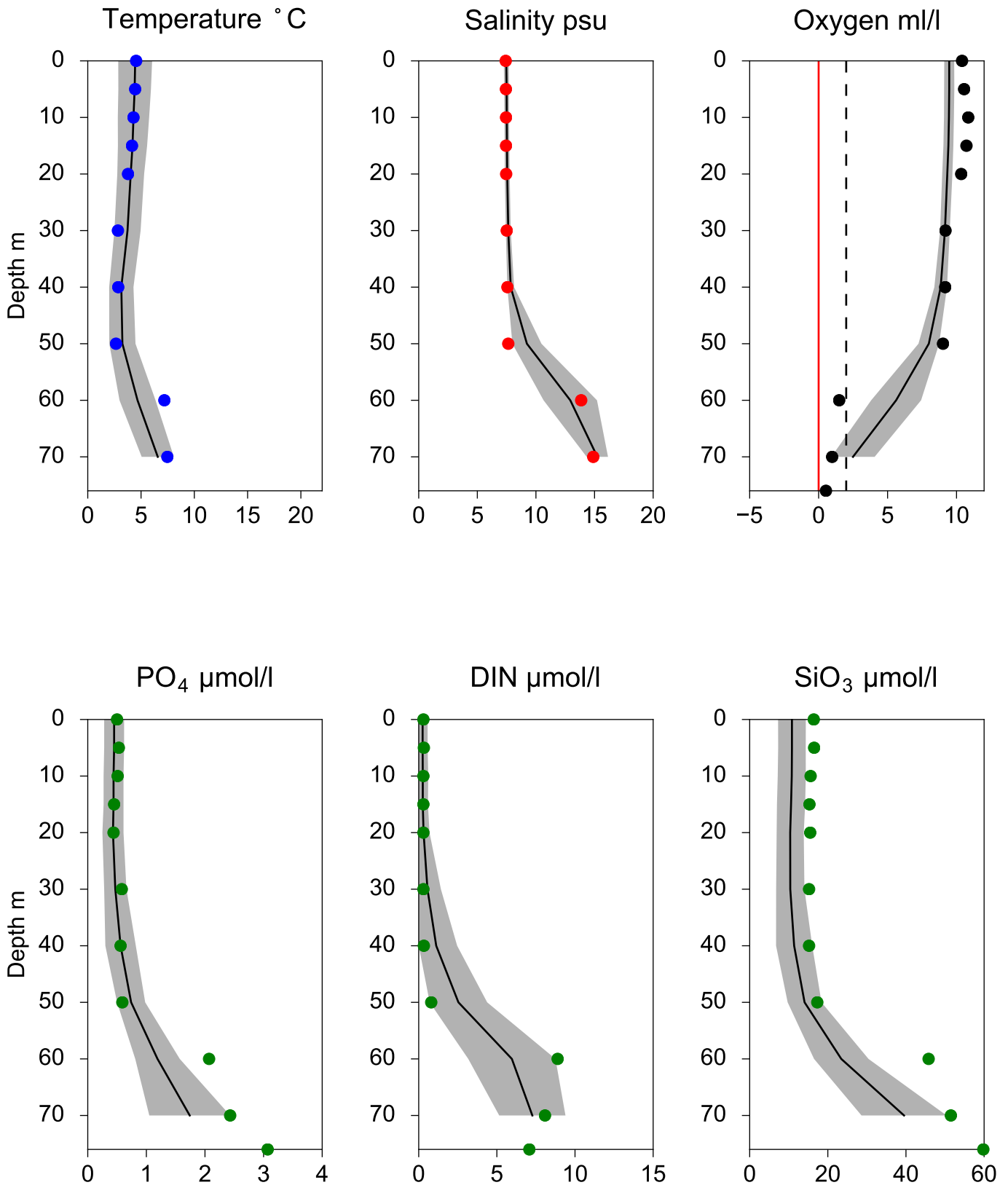


O<sub>2</sub> ml/l



# Vertical profiles HANÖBUKTEN April

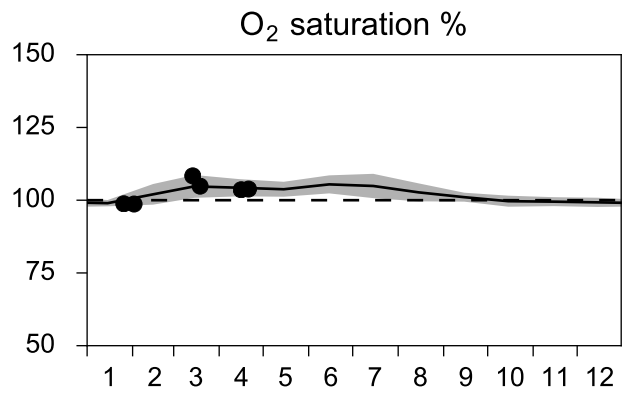
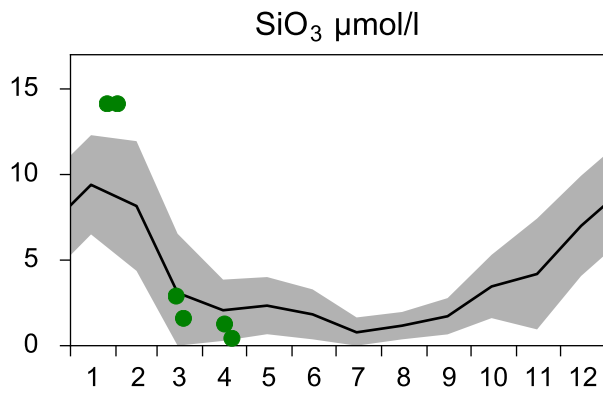
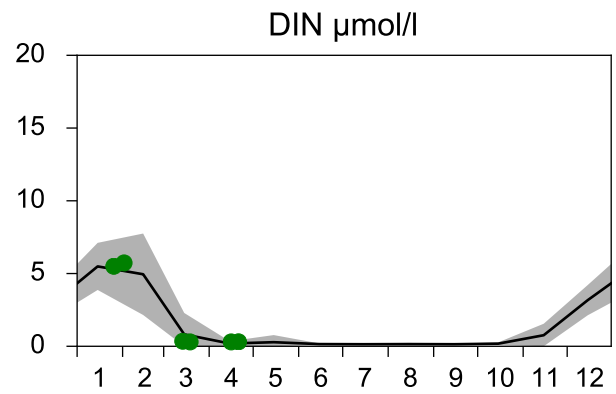
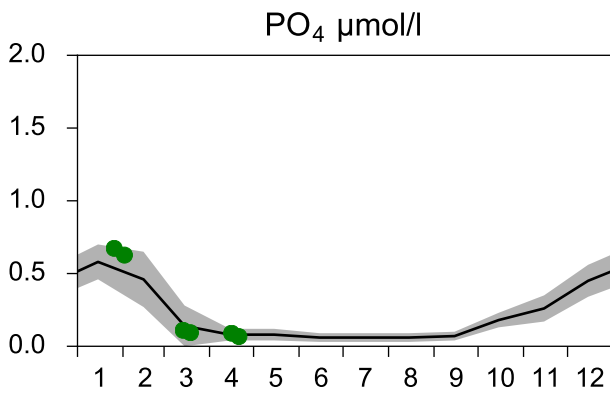
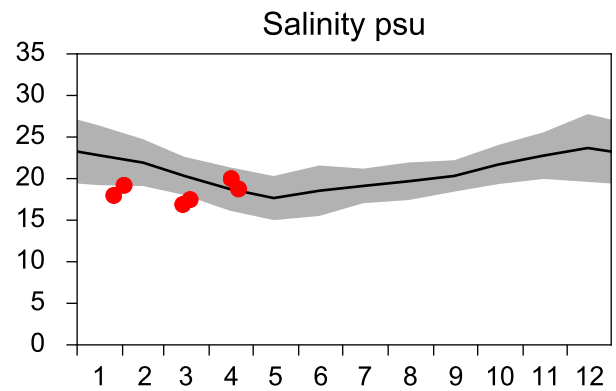
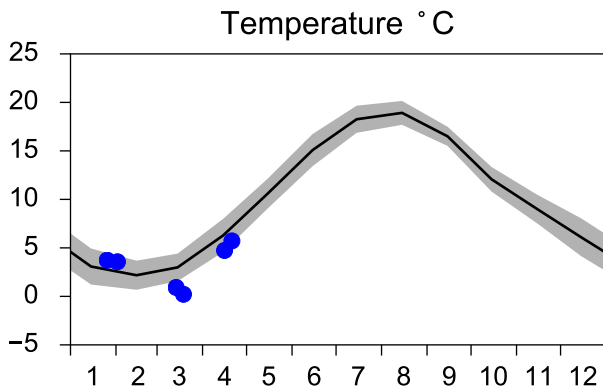
— Mean 2001-2015    ■ St.Dev.    ● 2018-04-20



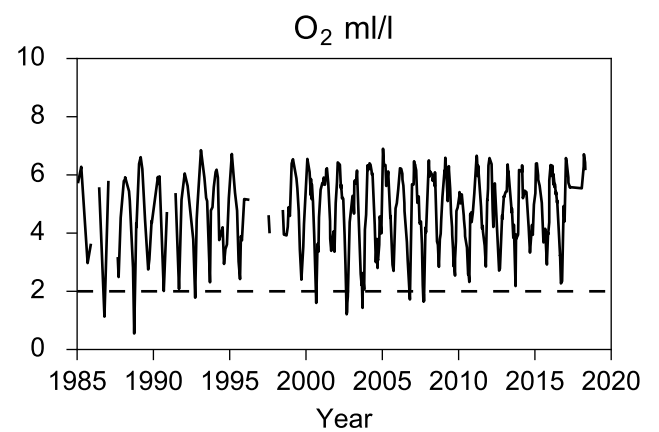
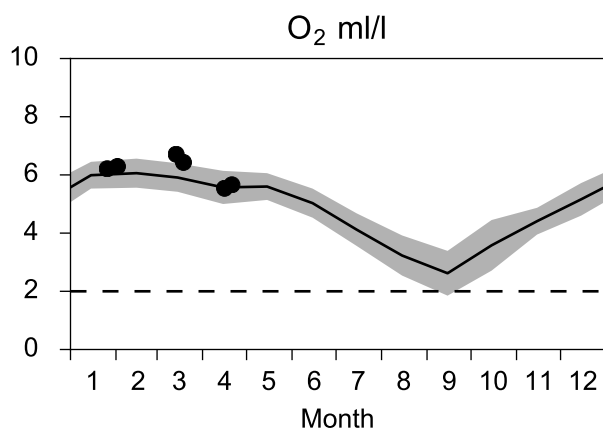
# STATION ANHOLT E SURFACE WATER (0-10 m)

Annual Cycles

— Mean 2001-2015    ■ St.Dev.    ● 2018



## OXYGEN IN BOTTOM WATER (depth >= 52 m)



# Vertical profiles ANHOLT E April

— Mean 2001-2015    ■ St.Dev.    ● 2018-04-21

