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#### Swedish Meteorological and Hydrological Institute Oceanographic Laboratory

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



**Survey period:** 2014-12-06 - 2014-12-14

Survey area: Skagerrak, Kattegat, the Sound and the Baltic Proper

**Principal:** SMHI and the Swedish Agency for Marine and Water Management

#### **SUMMARY**

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

The temperature of the surface water remained above normal, but not as pronounced as during the November expedition. Surface nutrients showed, for the season almost normal values, except silicate in the Baltic Proper. In the Bornholm Basin and Hanö Bight acute hypoxia (<2 ml / l) occurred from depths exceeding 70 meters. In the Eastern Gotland Basin completely oxygen-free conditions were registered from depths exceeding 125 meters (at BY20 already from 90 m) and acute hypoxia from 70 -80 meters. In western Gotland Basin, the oxygen situation is still serious as acute hypoxia already occurred from depths exceeding 70 meters and hydrogen sulphide from 80-90 meters depth.

The next regular expedition will start on the 7<sup>th</sup> of January 2015.



#### PRELIMINARY RESULTS

The cruise, performed on board the Finnish research vessel Aranda, began in Turku on  $\boldsymbol{6}^{\text{th}}$  of December and ended in Helsinki on the 13<sup>th</sup>. The winds during the expedition were essentially fresh to hard, between 15 and 20 m/s mainly from the southwest. Air temperatures ranged between 5-6  $^{\circ}$ 

During the expedition an inflow to the Baltic Sea took place. Through the Sound about 40 km<sup>3</sup> flowed into the Baltic Sea.

#### The Skagerrak

Surface water temperatures had since the previous cruise in November, decreased to values normal for the season, about 7°C. However, there was still a clear excess in temperatures at depths between 20 and 50 meters. At 30 meters a temperature of just above 12°C were registered, which is approximately 3 degrees above normal. Surface salinity was below normal, about 25 psu. At the station P2 in the southeast, however, both salinity and temperature were above normal and the water homogenous from surface down to 70 meters. Salinity here was 32.5 psu and the temperature 8.9°C. Phosphate and inorganic nitrogen (nitrite + nitrate) showed concentrations normal for the season, while the levels of silicate were elevated. Phosphate showed values of 0.45 µmol/l, nitrite + nitrate 3.3  $\mu$ mol/l. while the concentrations of silicate were in the range 6.5 – 7  $\mu$ mol/l.

Fluorescence measurements showed some plankton activity in the surface layer.

The lowest oxygen level in the bottom waters, 3.2 ml/l were measured at the station Släggö, in the mouth of the Gullmar fjord, an increase with 1 ml/l since the previous visit in November.

#### The Kattegat and the Sound

In this area, the surface temperature was still above normal, with values of ca. 7°C compared to normal 5°C. Thermocline and halocline coincided and were found at depths between 15 and 20 meters. The salinity of the surface water in Kattegat was normal about 23 psu, while it in the Sound was high above normal 22 psu.

The concentrations of phosphate and inorganic nitrogen showed values typical for the season, while silicate levels were higher than normal. Phosphate concentrations were ca. 0.5 µmol/l, nitrite + nitrate ca. 3.5 µmol/l, while silicate varied between 7 and 10.6 µmol/l.

Fluorescence measurements showed some plankton activity in the surface layer.

The lowest oxygen levels in the bottom waters were measured at W Landskrona, in the Sound, 4.36 m1/1.

#### The Baltic Proper

The water temperature in the surface layer remained above normal throughout the area, varying between 6.6 and 8.9°C. The salinity of the surface water was normal in most of the area, between 6.5 and 8.6 psu. In the eastern Gotland Basin, at BY15, surface salinity was still lower than normal, about 6.8 psu. The halocline was found at depths about 60 to 80 meters in the Northern, Western and Eastern Gotland Basins, while it was more shallow in the south, at depths between 30 and 60 meters.

The nutrients showed almost normal levels for the season in the surface layer, phosphate concentrations were in the range 0.44 to 0.56 µmol/l, while concentrations of inorganic nitrogen (nitrite + nitrate) ranged from 1.24 to 2.63 µmol/l. Silicate showed slightly elevated concentrations in the northern and central parts, while concentrations in the southern regions were lower than normal. The concentrations ranged between 6.3 and 14.6 µmol/l.

Fluorescence measurements showed that plankton activity was low throughout the area.



During the expedition an inflow to the Baltic Sea took place. Between the 2<sup>nd</sup> and 15<sup>th</sup> of December a total of 40 km³ entered through the Sound. The effects of this inflow were seen only at stations in the Arkona Basin where the oxygen concentration in the bottom water was high, 6-7 ml/l. Acute hypoxia occurred in the Bornholm Basin and Hanö Bight from 70 meters depth. In the central parts of Eastern Gotland Basin acute hypoxia were measured from 70-80 meters depth and hydrogen sulfide at the depths exceeding 125 meters. At the station BY20, in the north, hydrogen sulphide was present already at 90 meters depth. In Western Gotland Basin oxygen situation was serious when acute hypoxia occurred from depths exceeding 70-80 meters and hydrogen sulphide from 80-90 meters depth.

#### **PARTICIPANTS**

Name		Institute
Lars Andersson	Chief Scientist	SMHI
Örjan Bäck (Lysekil-Helsingfors)		SMHI
Daniel Bergman-Sjöstrand		SMHI
Martin Hansson (Åbo-Lysekil)		SMHI
Johan Håkansson		SMHI
Sari Sipilä		SMHI
Ilkka Lastumäki		SYKE

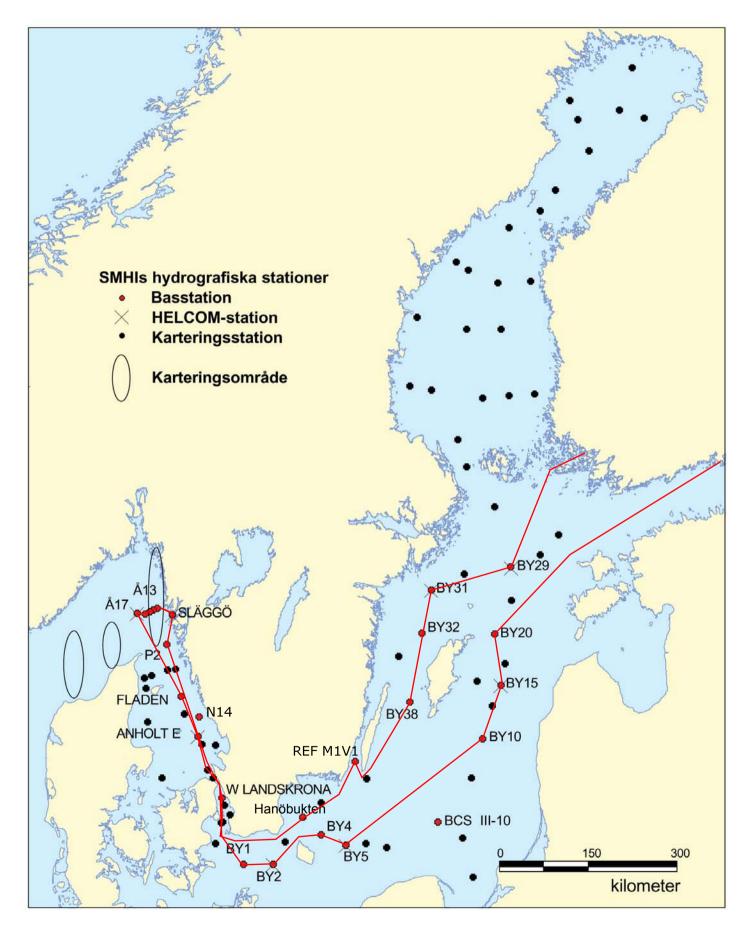
#### **APPENDICES**

- 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: 20141206-201413

Series: 0772-0797



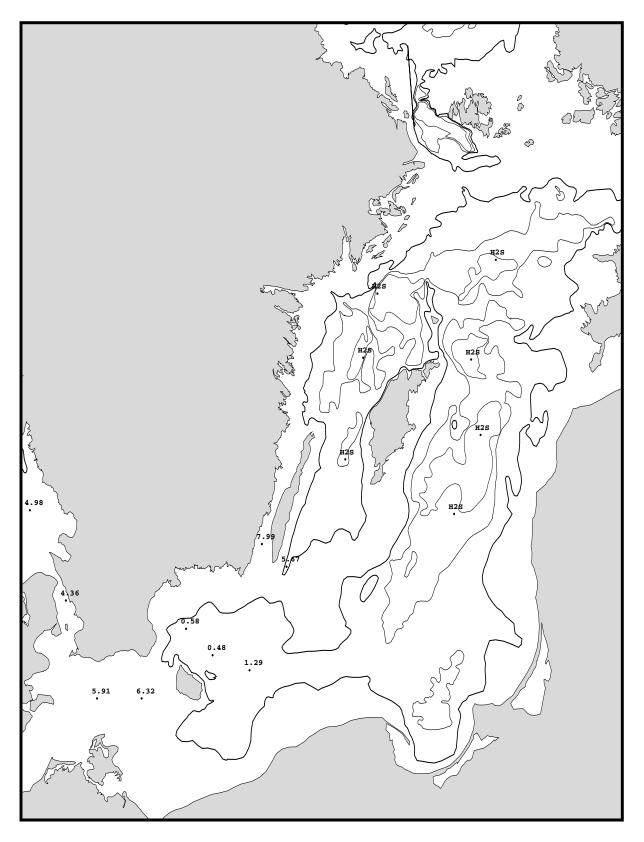
SMHI	****	Hydrographic	Ship: 01-Aranda	* * * * *	Date: 2014-12-13
Ocean enh	****	series	Year: 2014	****	Time: 16:57

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J							hd PrP l n l si
0772 BPNX35BAS BY29	N5853 E2019	20141206 1700	175		30 7	5.0 1012	9990 xx 16 x x - x x x x x x x x x - x x
0773 BPNX37BAS BY31 LANDSORTSDJ	N5835 E1814	20141206 2340	445		25 8	4.4 1013	9990 xxx 23 - x x x x x x x x x x x x x x
0774 BPWX38BAS BY32 NORRKÖPINGSDJ	N5801 E1759	20141207 0725	201		23 8	4.5 1012	9990 x -xx 17 x x - x x x x x x x x x x x
0775 BPWX45BAS BY38 KARLSÖDJ	N5707 E1740	20141207 1500	110		22 15	6.6 1010	2740 xx 14 x x - x x x x x x x x - x x x
0776 BPWX00EXT 4.5 NO ÖLANDS SÖDRA	N5610.06 E1638.	54 20141207 2140	59		21 17	6.1 1008	9990 1 x x - x
0777 BPWK01BAS REF M1V1	N5622.25 E1612.	20141207 2320	20		21 10	5.2 1005	9990 x -xxx 5 x x x x - x x x x x x x x
0778 BPSH05BAS HANÖBUKTEN	N5537 E1452	20141208 0700	79	8	26 10	6.2 1007	2830 xx 11 x x - x - x x x x x x - x -
0779 SOCX39BAS W LANDSKRONA	N5552.0 E1245.	20141208 1725	51		23 8	5.0 1010	9990 xx 9 - x - x - x x x x x x - x -
0780 KAEX29BAS ANHOLT E	N5640.0 E1207.	20141208 2355	62		25 7	5.3 1013	9990 x -xxx 10 x x x x - x x x x x x x x x x
0781 KANX25BAS FLADEN	N5711.5 E1140	20141209 0410	85		24 9	5.7 1014	9990 xx 12 x x - x - x x x x x x - x
0782 SKEX00EXT SKAGERRAK E	N5801.65 E1050.	25 20141209 0850	206	12	25 5	6.3 1016	1130 x 14 x
0783 SKEX18BAS Å17	N5816.5 E1030.	3 20141209 1200	349		24 8	6.0 1016	1240 xx 14 x x x x - x x x x x x x x x
0784 SKEX17BAS Å16	N5816 E1043.	20141209 1350	202		25 10	6.4 1015	1440 x 13
0785 SKEX16BAS Å15	N5817.7 E1051	20141209 1445	135		24 11	6.5 1016	1330 xx 12 x x - x - x x x x x x - x x
0786 SKEX15BAS Å14	N5819 E1056.	20141209 1546	111		21 14	6.7 1014	9990 x 11
0787 SKEX14BAS Å13	N5820.2 E1102	20141209 1635	93		21 14	6.0 1013	9990 xx 10 x x - x - x x x x x x - x x
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0789 SKEX23BAS P2	N5752 E1118	20141210 1500	94		23 13	6.8 995	1350 xx 10 x x - x - x x x x x x - x
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0791 BPSA03BAS BY2 ARKONA	N5500 E1405	20141211 1035	47		21 17	5.4 999	2850 xx 8 x x - x - x x x x x x - x x x
0792 BPSB06BAS BY4 CHRISTIANSÖ	N5523 E1520	20141211 1540	92		20 14	5.8 997	9990 xx 12 x x - x - x x x x x x - x
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0794 BPEX13BAS BY10	N5638 E1935	20141212 0720	144	10	26 8	5.4 996	5740 xx 15 x x - x x x x x x x x - x
0795 BPEX21BAS BY15 GOTLANDSDJ	N5720 E2003	20141212 1200	239	11	21 11	5.0 995	1540 x -xxx 19 - x x x x x x x x x x x x x x
0796 BPEX21EXT BY15 GOTLANDSDJ	N5720 E2003	20141212 1310			21 11	5.0 995	1540 x 5 - x - x x x x x x x x - x
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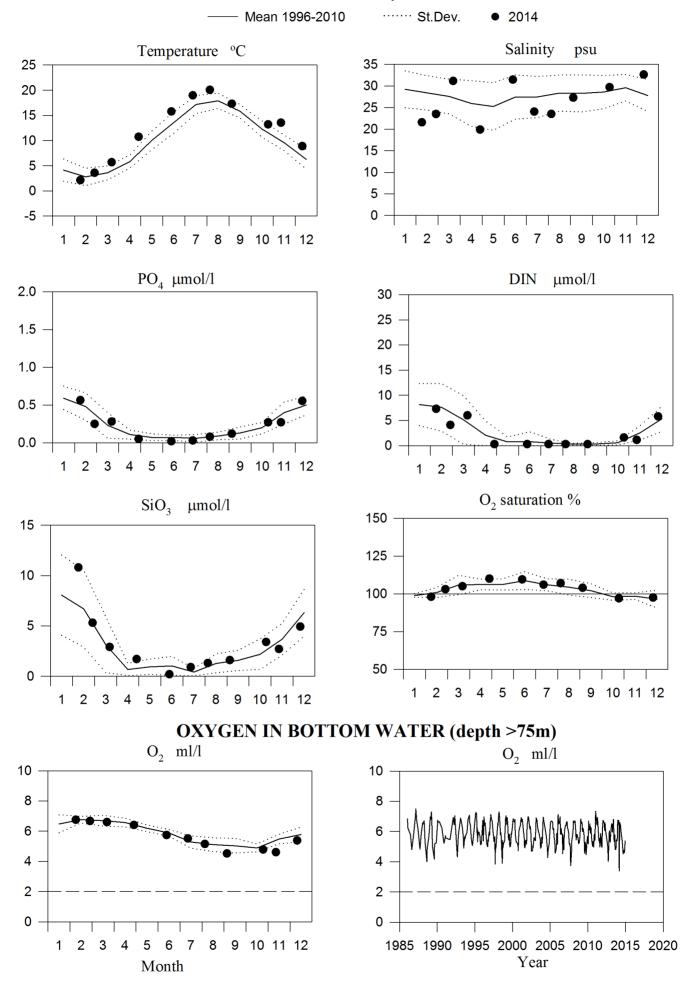
### Bottom water oxygen concentration (ml/1)

Country: Finland

Ship : Aranda
Date : 20141206-20141212
Series : 0772-0797

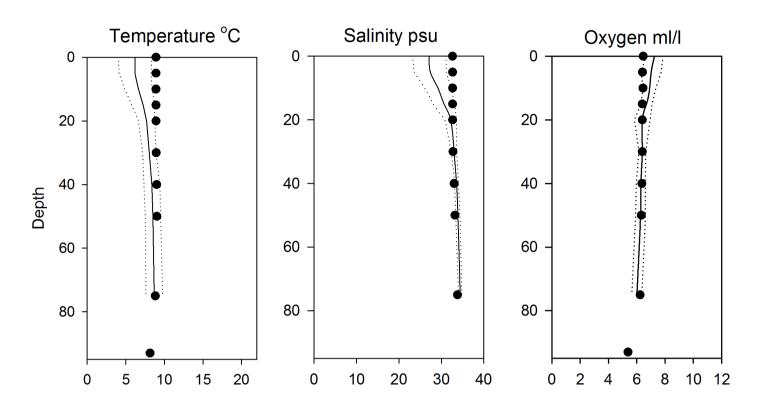


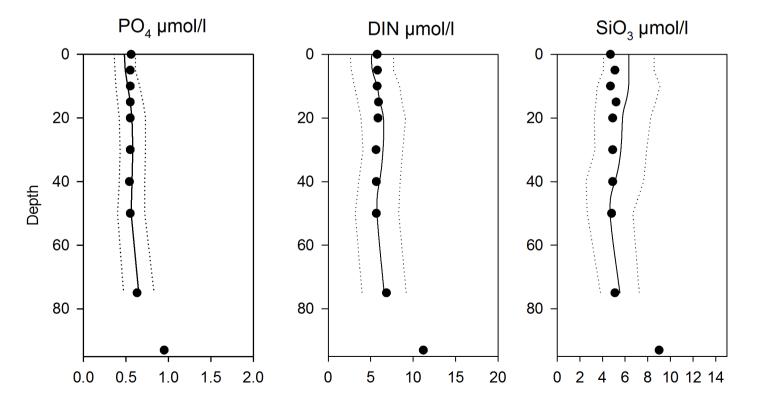
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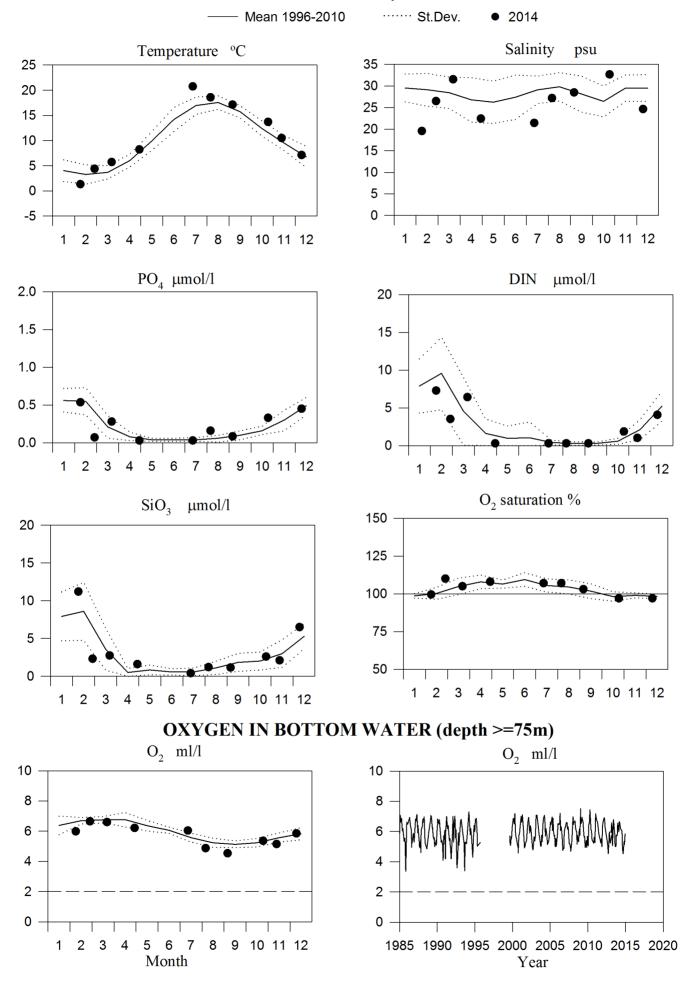
### Vertical profiles P2 December

—— Mean 1996-2010 St.Dev. ● 2014



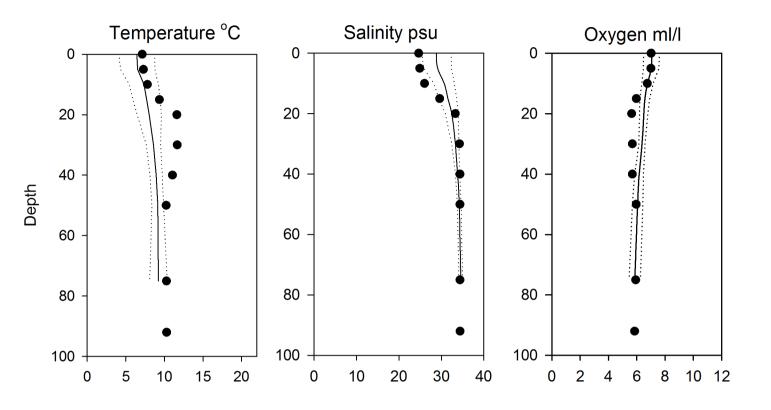


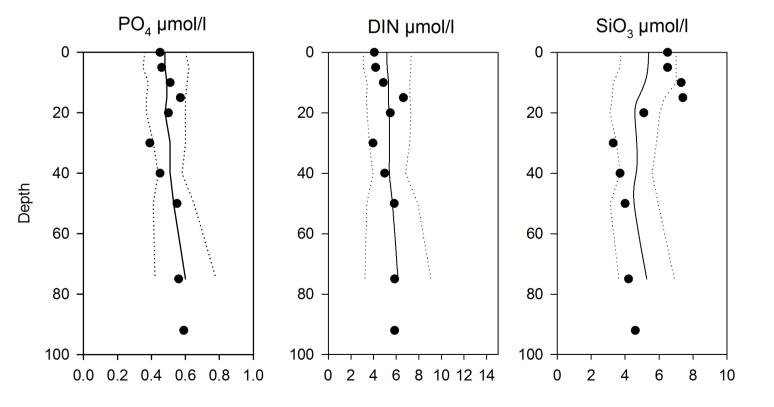
### STATION Å13 SURFACE WATER



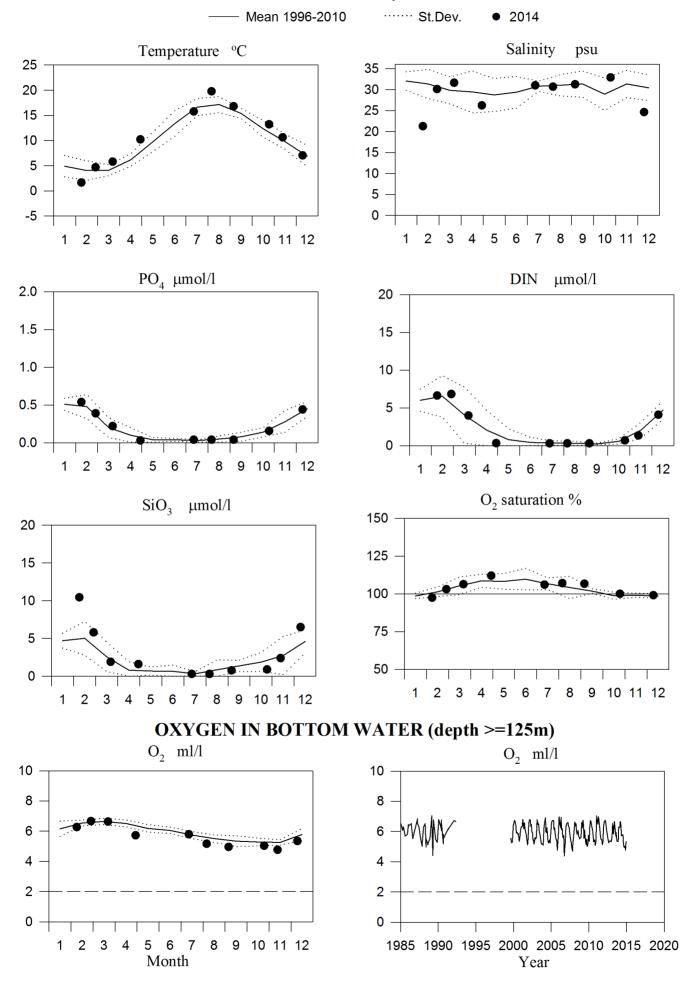
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— Mean 1996-2010 St.Dev. ● 2014



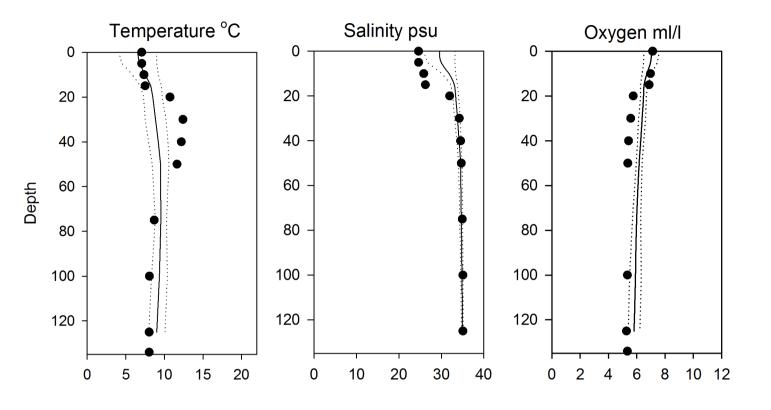


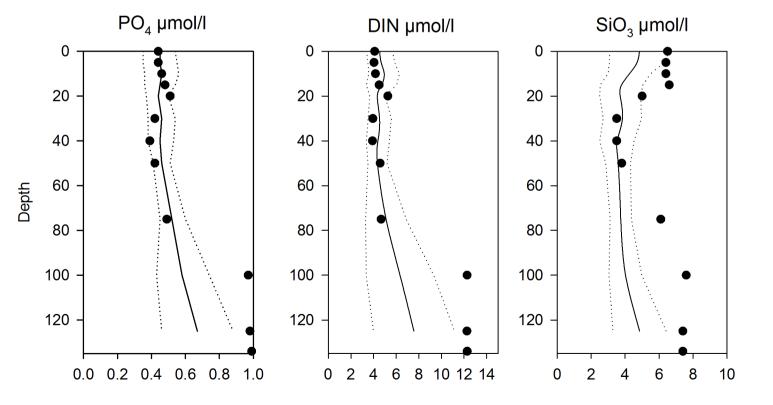
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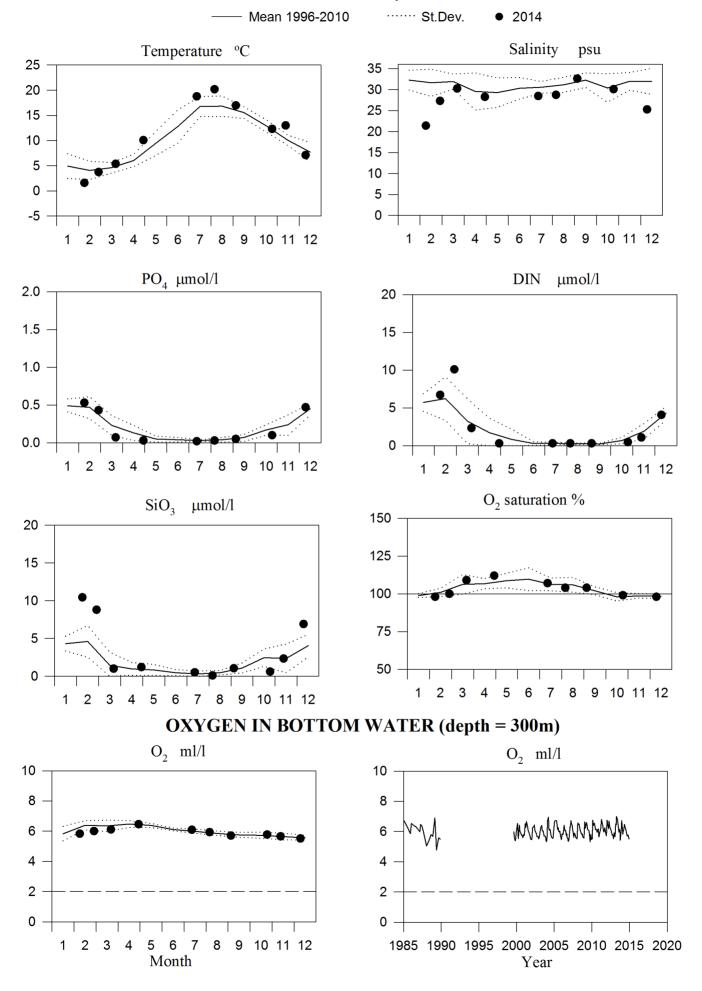
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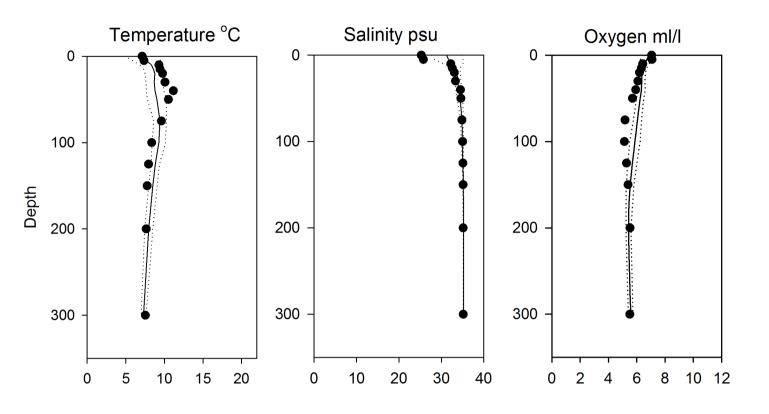


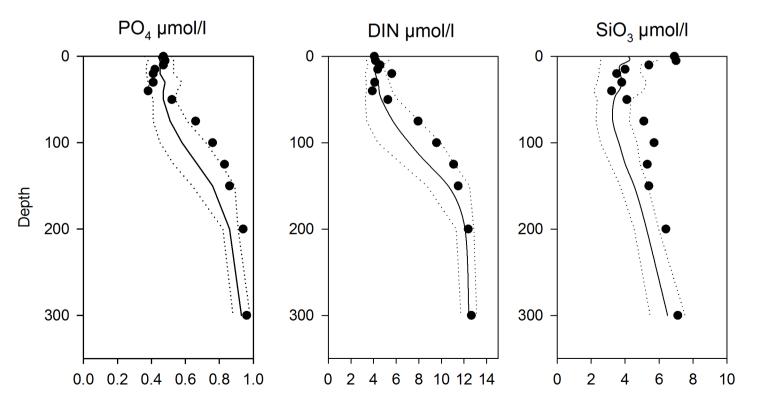
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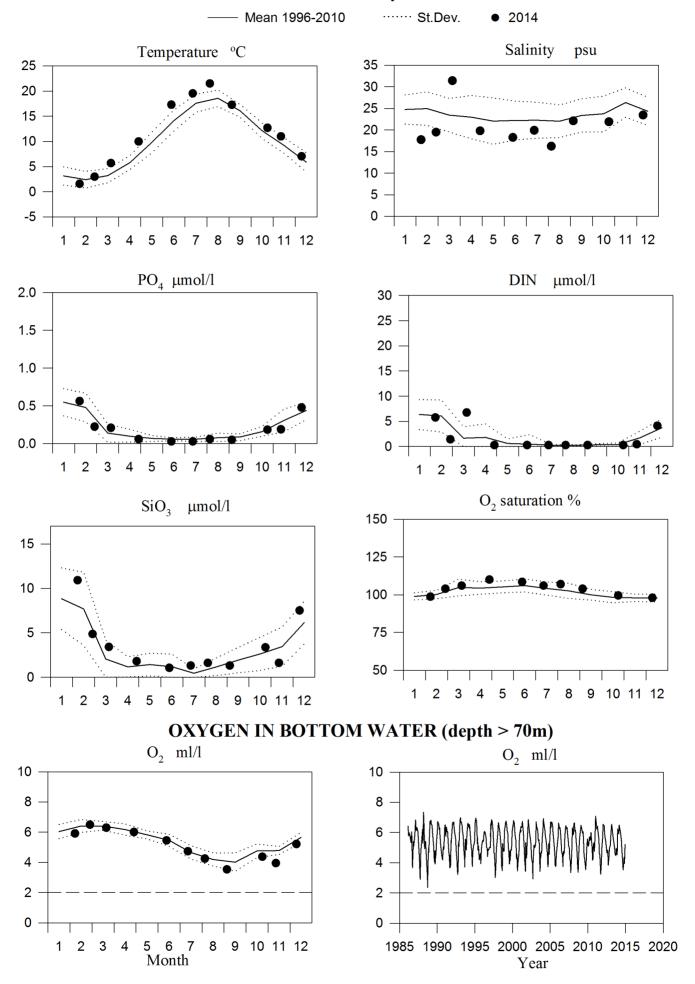
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— Mean 1996-2010 St.Dev. ● 2014



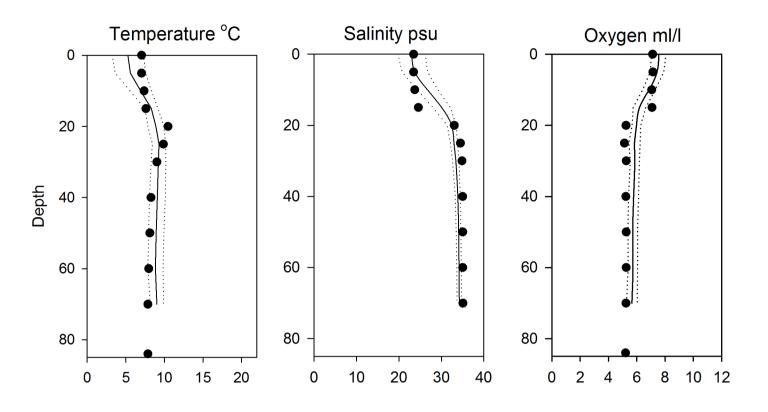


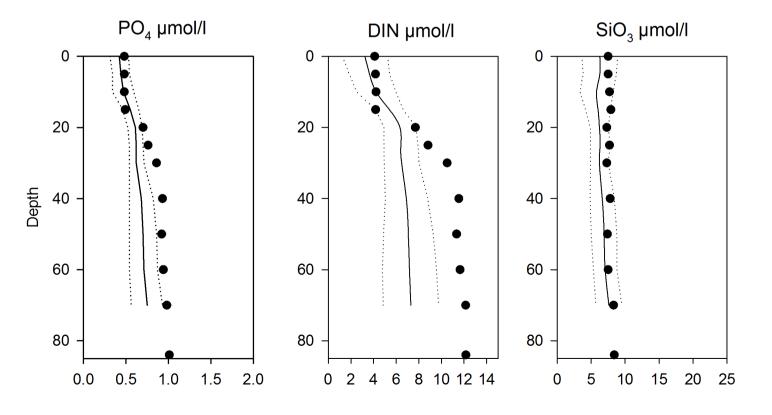
### STATION FLADEN SURFACE WATER



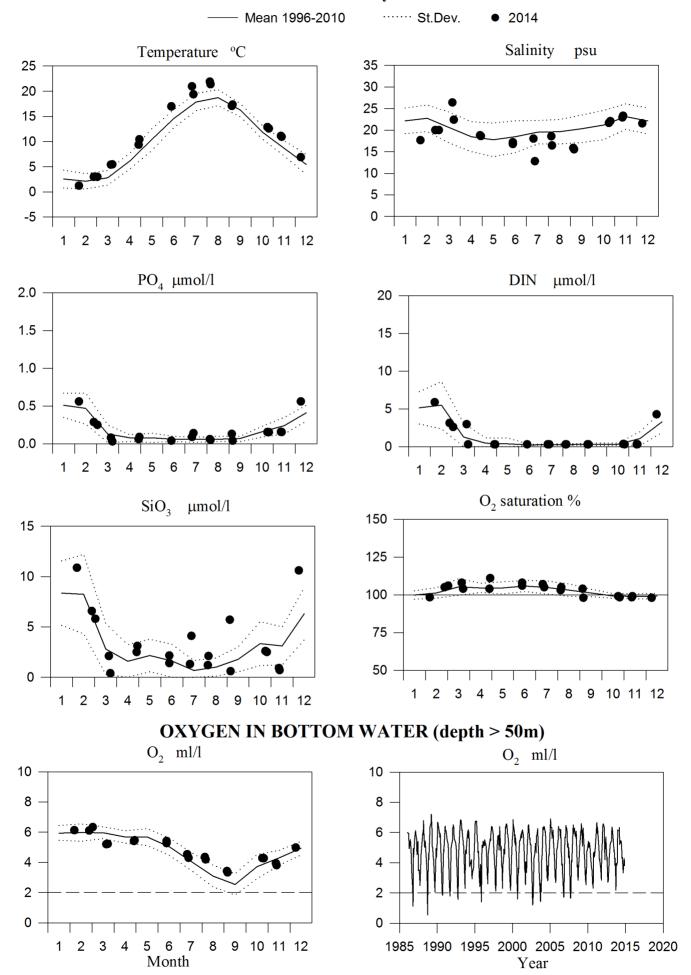
# Vertical profiles Fladen December

—— Mean 1996-2010 St.Dev. ● 2014



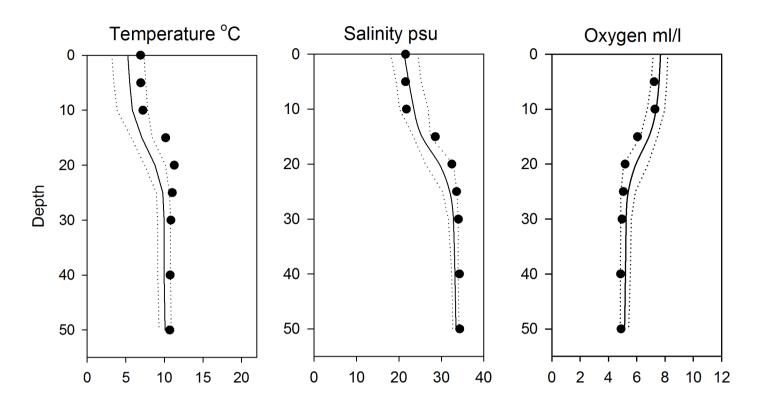


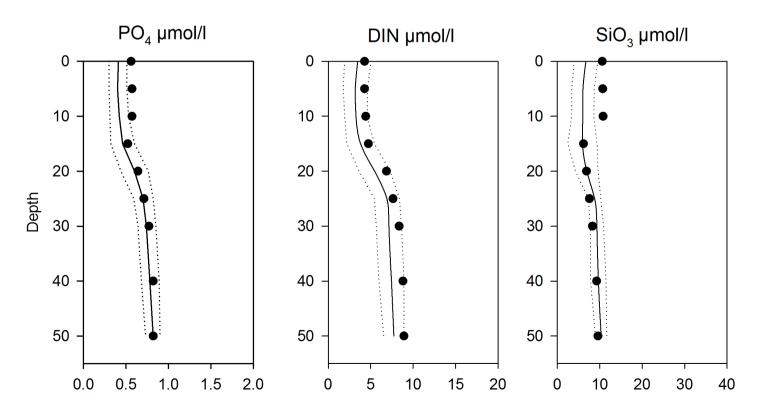
### STATION ANHOLT E SURFACE WATER



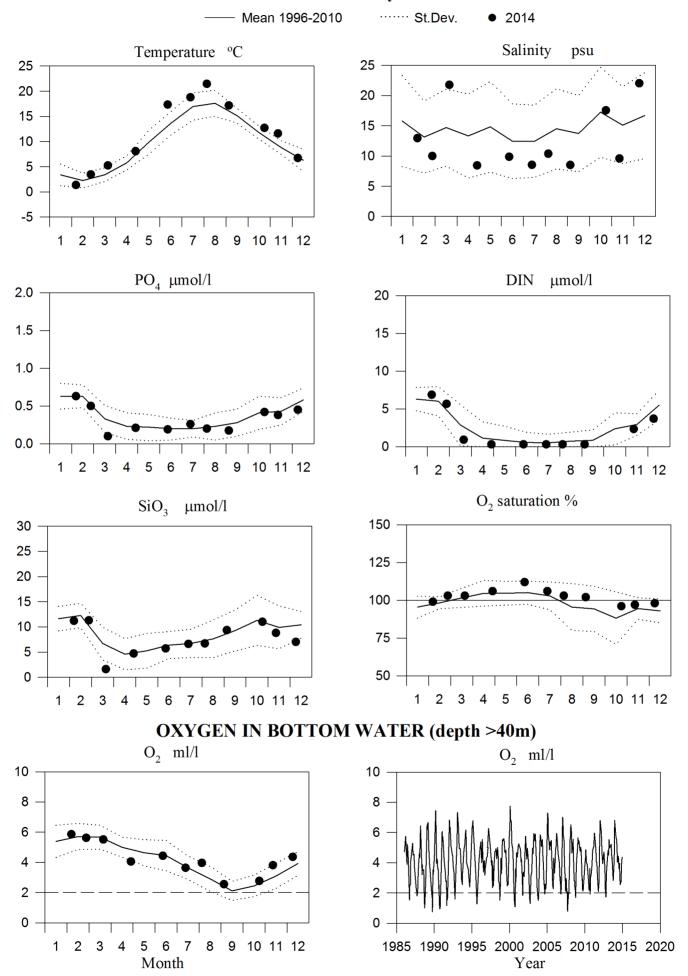
### Vertical profiles Anholt E December

— Mean 1996-2010 St.Dev. ● 2014



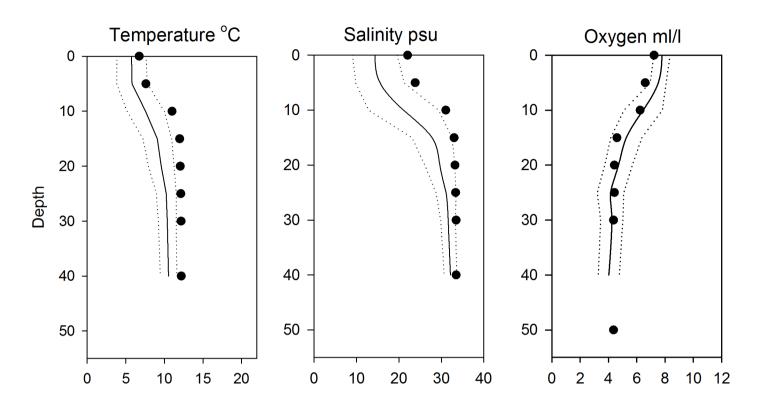


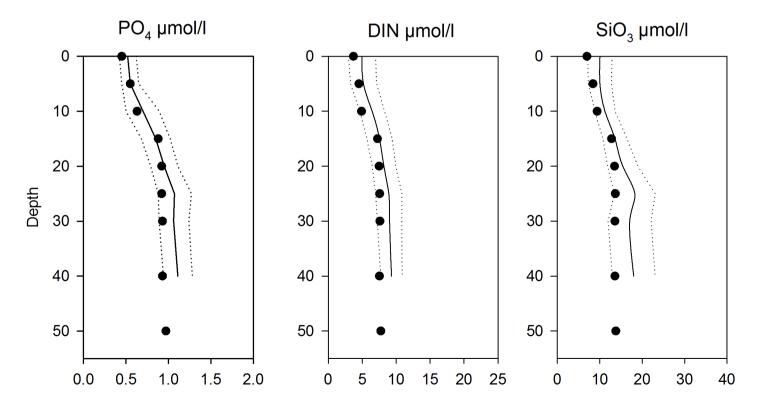
### STATION W LANDSKRONA SURFACE WATER



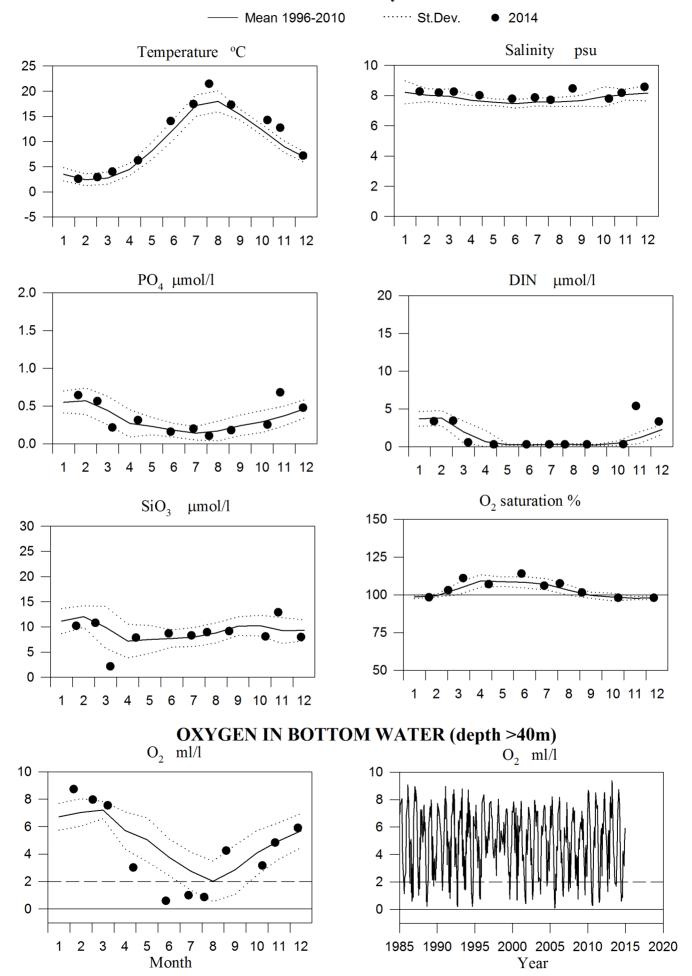
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— Mean 1996-2010 St.Dev. ● 2014

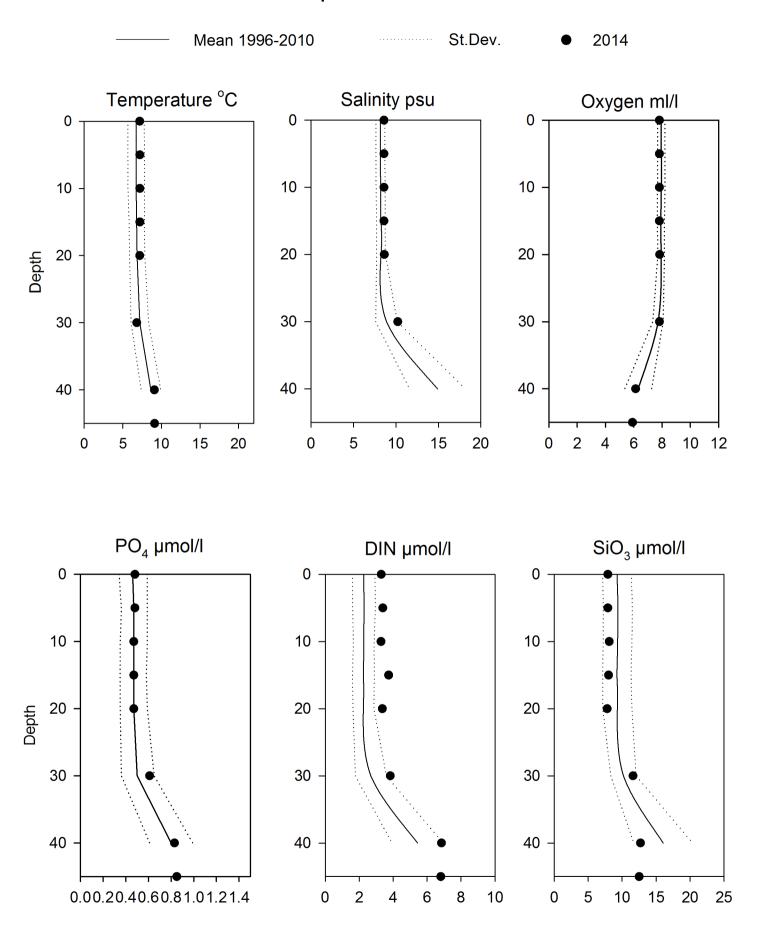




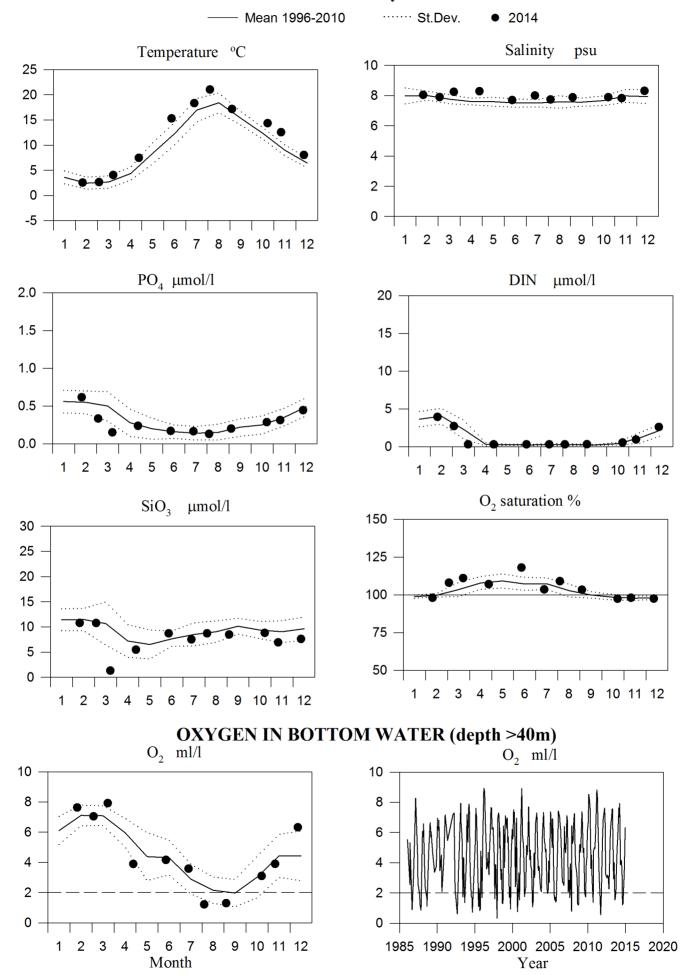
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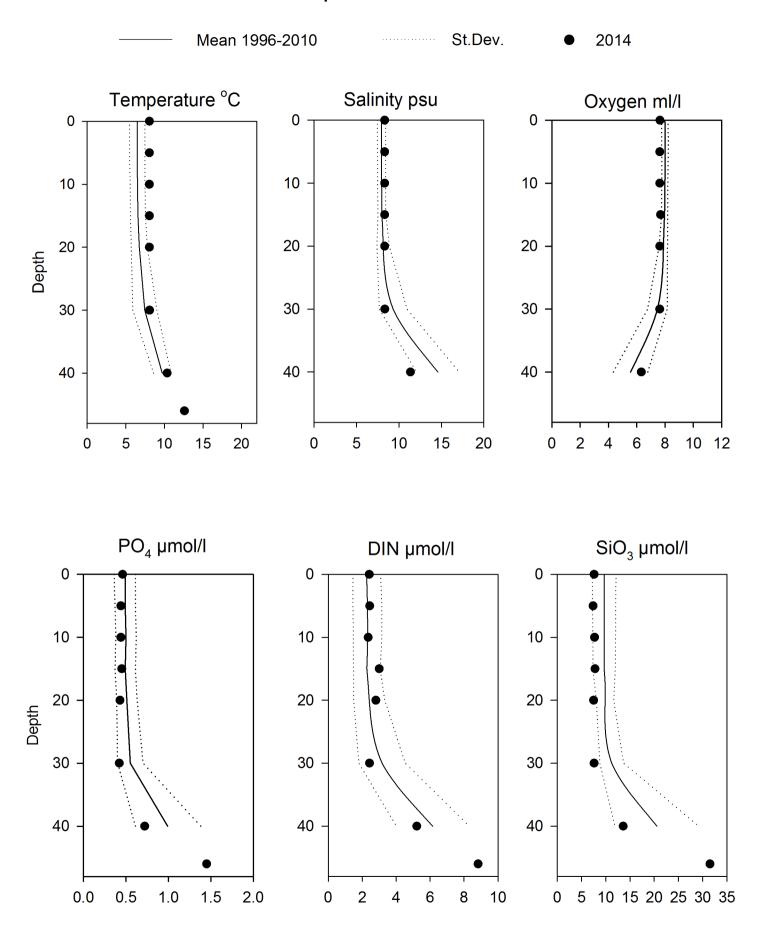
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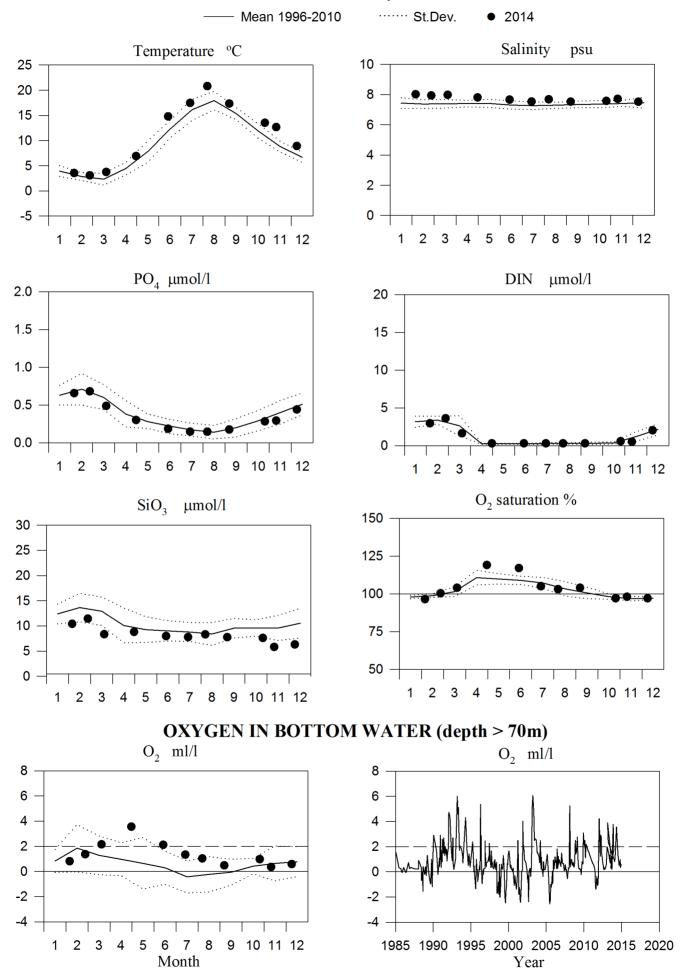
### STATION BY2 SURFACE WATER



# Vertical profiles BY2 December

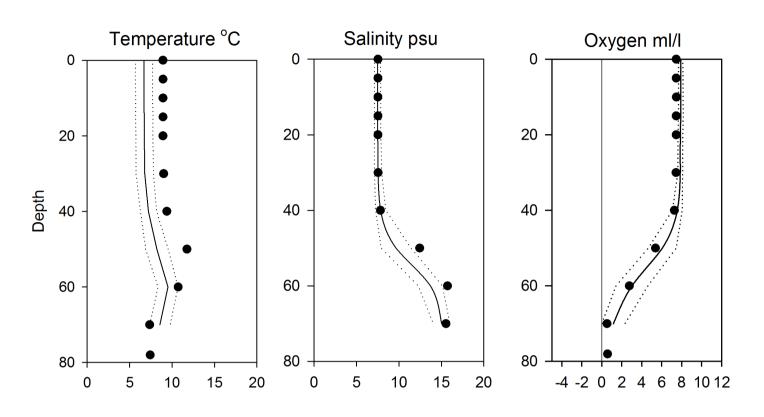


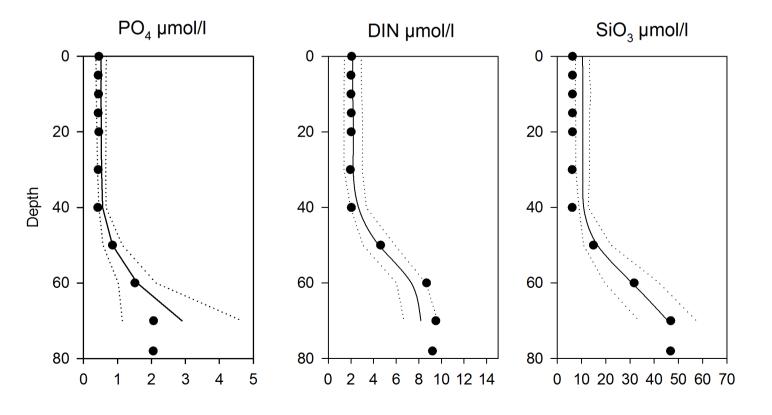
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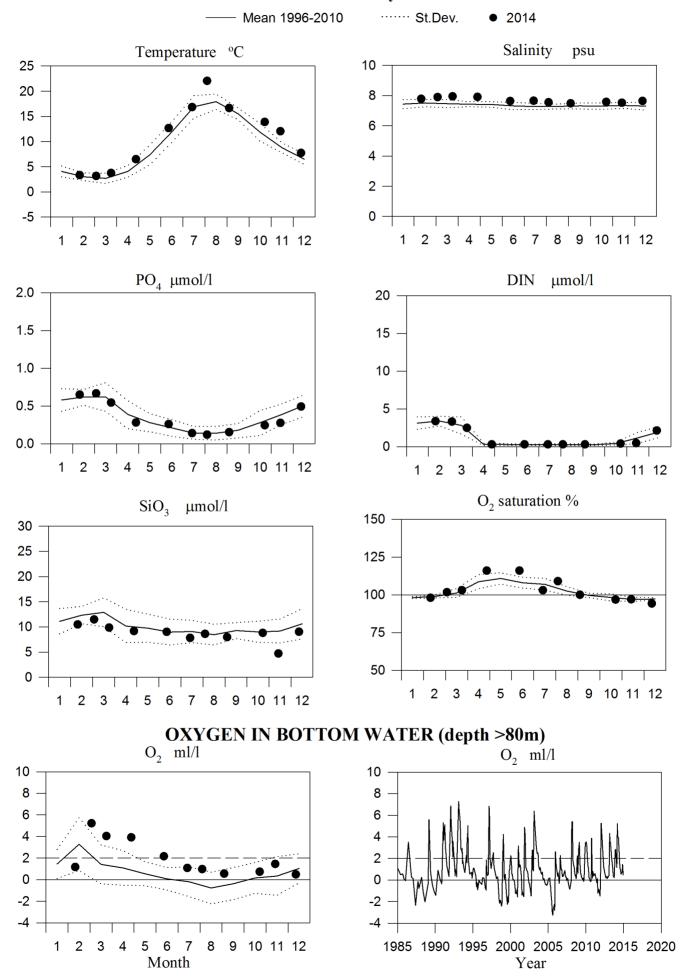
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—— Mean 1996-2010 St.Dev. ● 2014

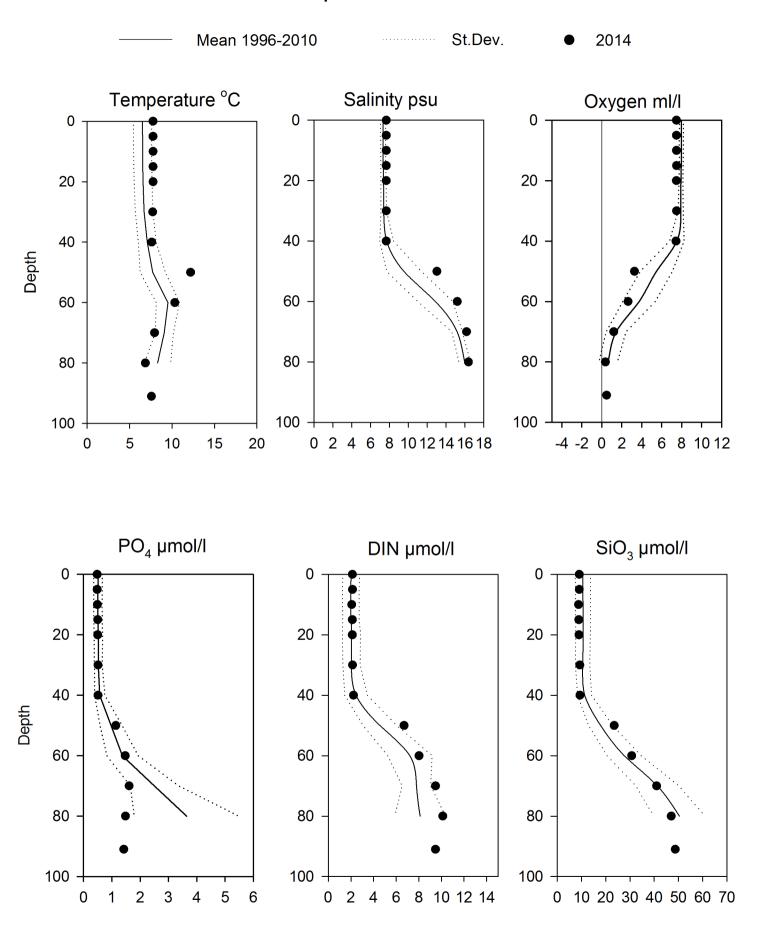




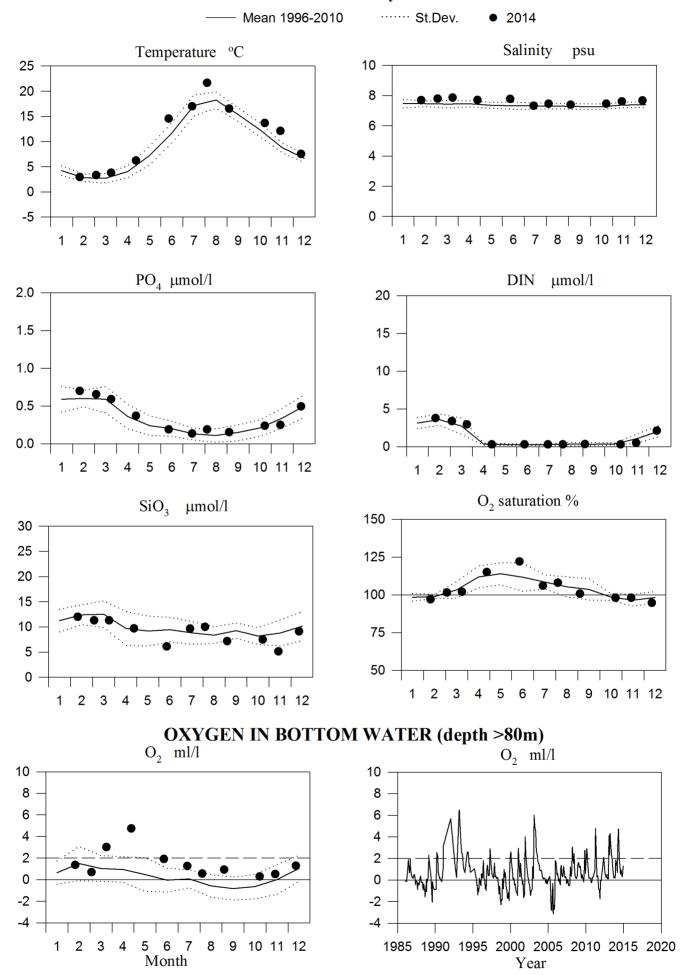
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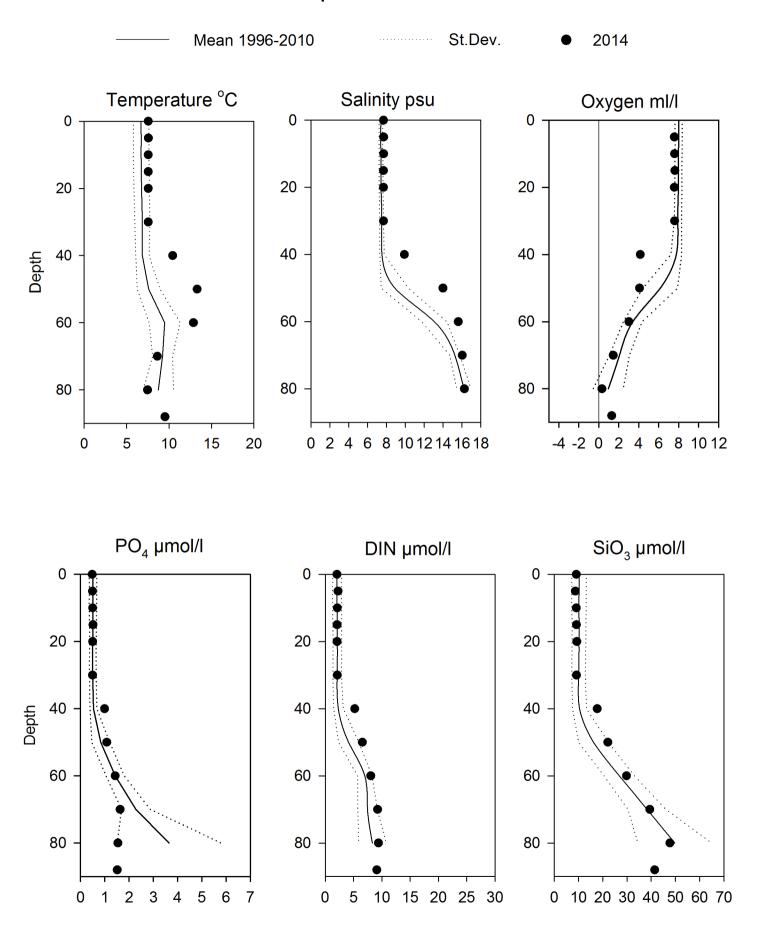
### Vertical profiles BY4 December



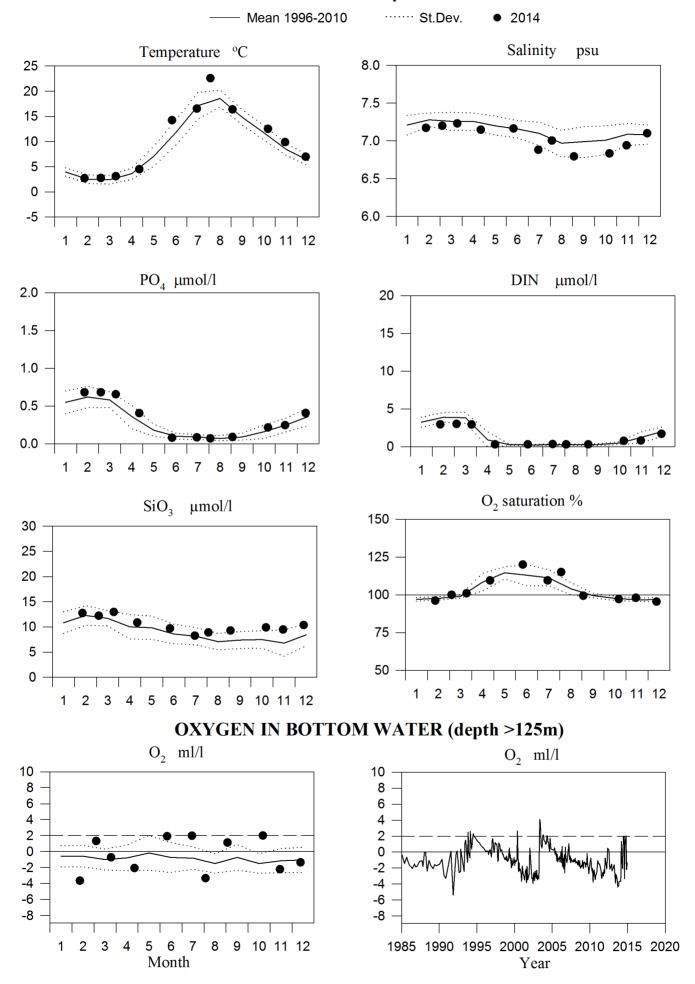
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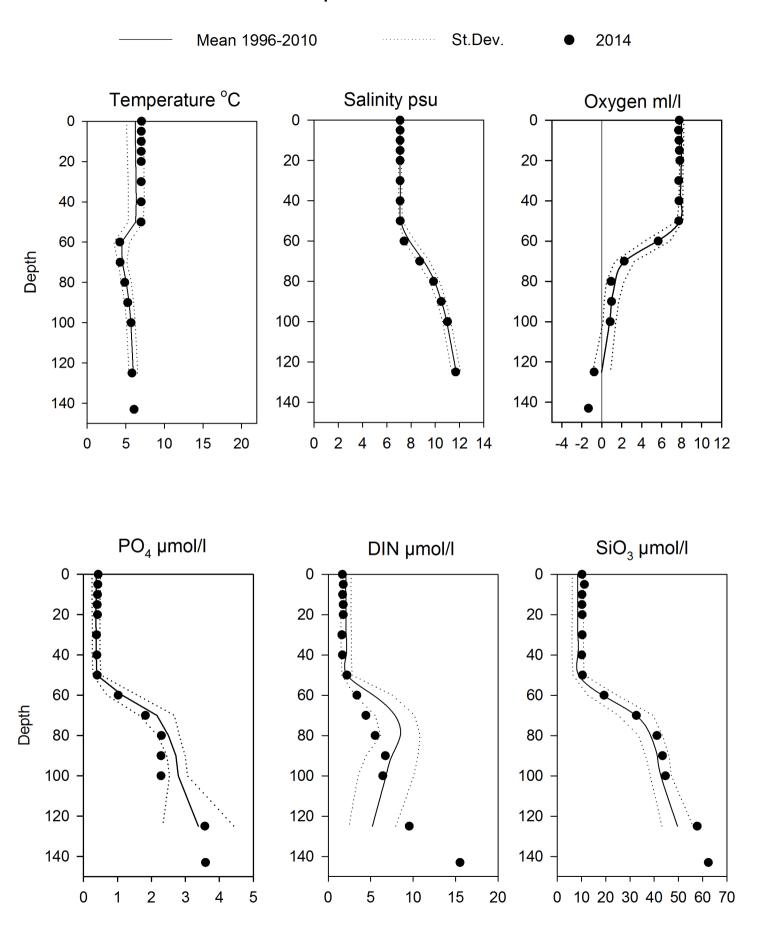
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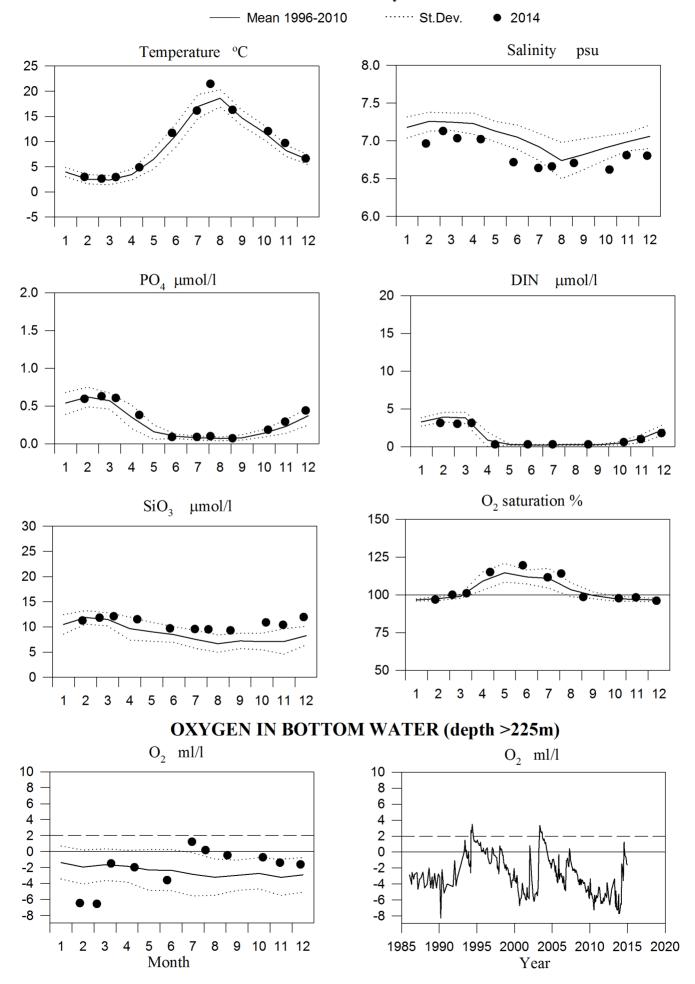
### STATION BY10 SURFACE WATER



# Vertical profiles BY10 December



### STATION BY15 SURFACE WATER

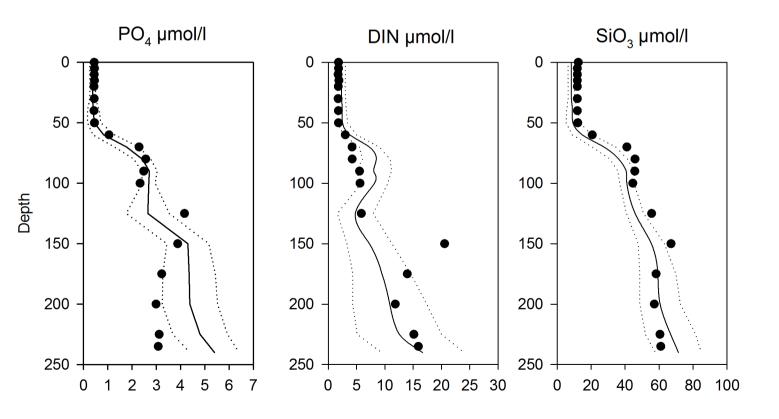


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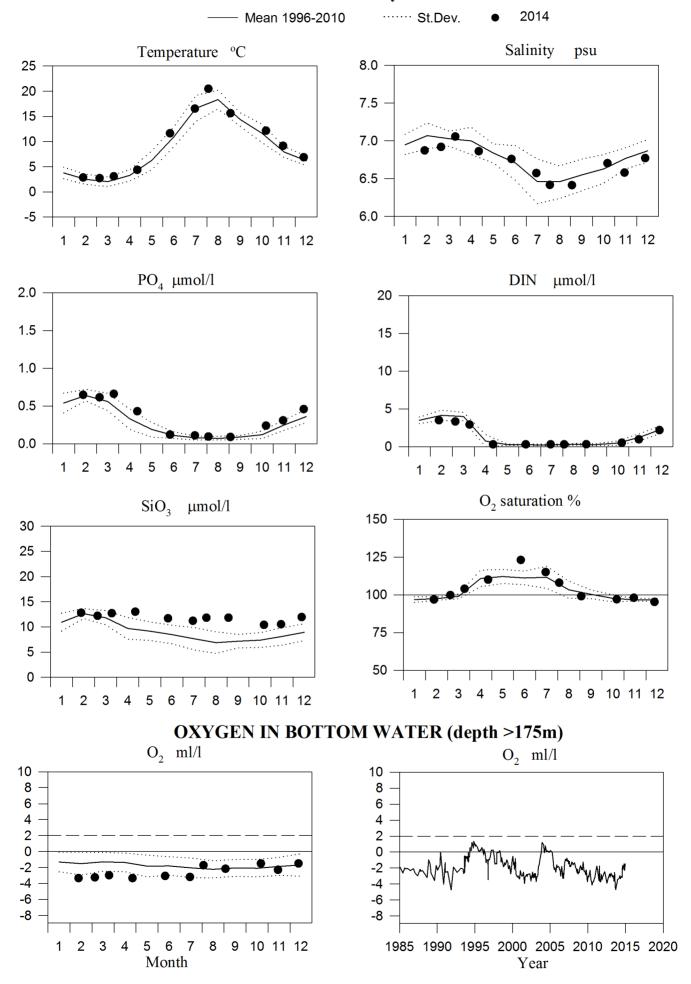
St.Dev.

Temperature °C Salinity psu Oxygen ml/l 10 12 14 -6 -4 -2 0 2 4 6 8 1012 

Mean 1996-2010



### STATION BY20 SURFACE WATER



### Vertical profiles BY20 December

St.Dev.

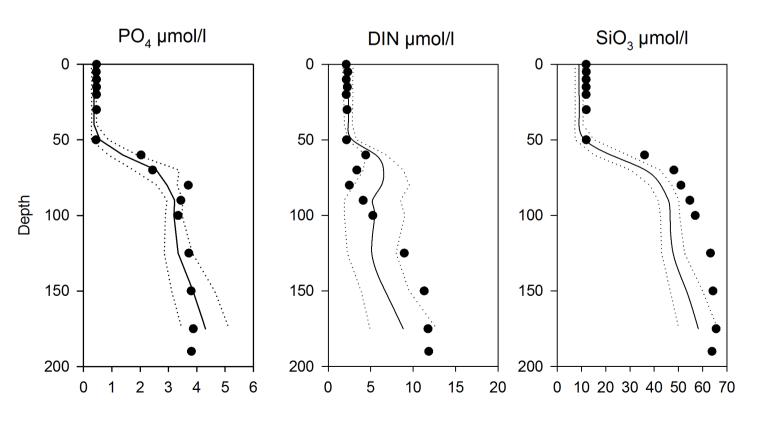
10 12 14

-4 -2 0 2 4 6 8 10 12

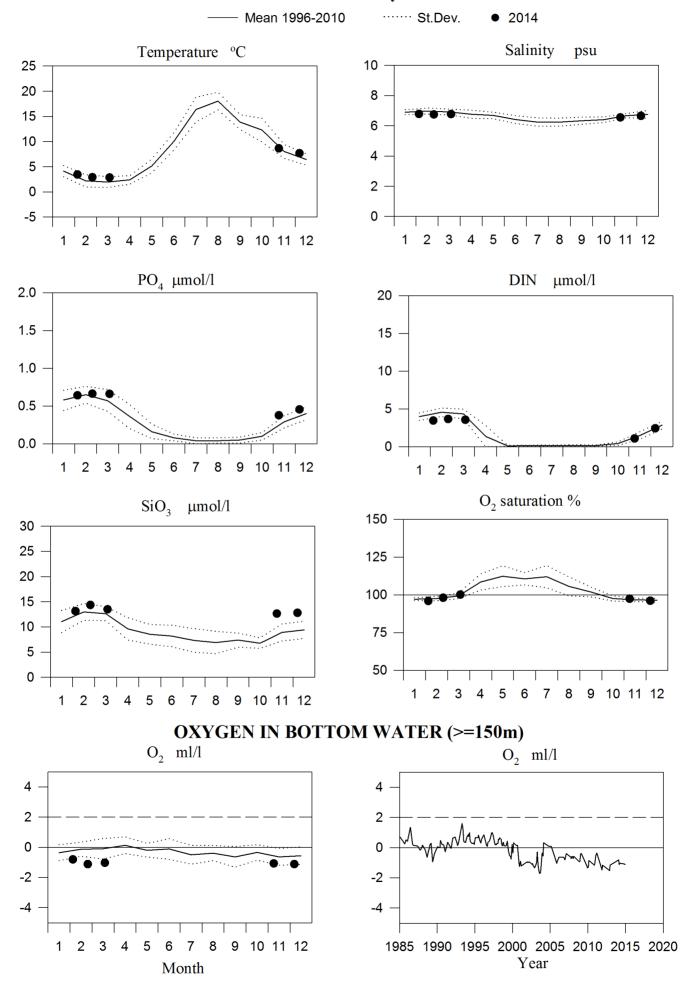
Temperature °C Salinity psu Oxygen ml/l
50 - 50 - 100 - 100 - 150

Mean 1996-2010

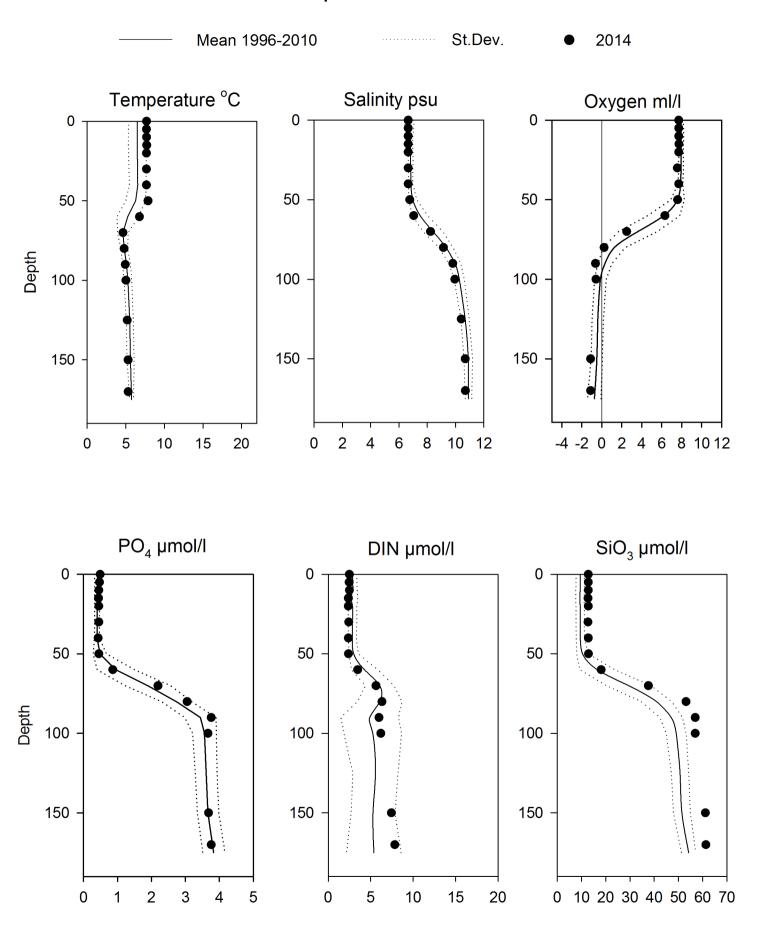
4 6 8



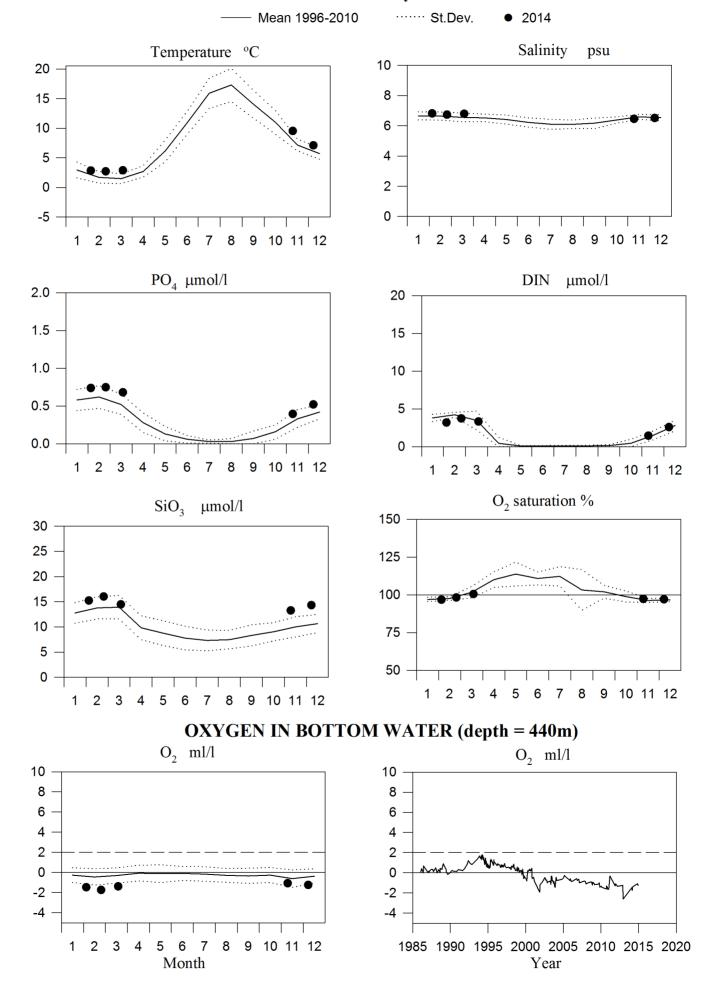
### STATION BY29 SURFACE WATER



# Vertical profiles BY29 December

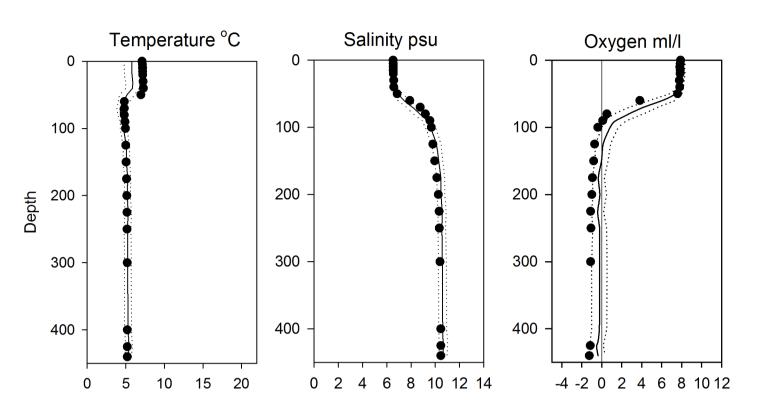


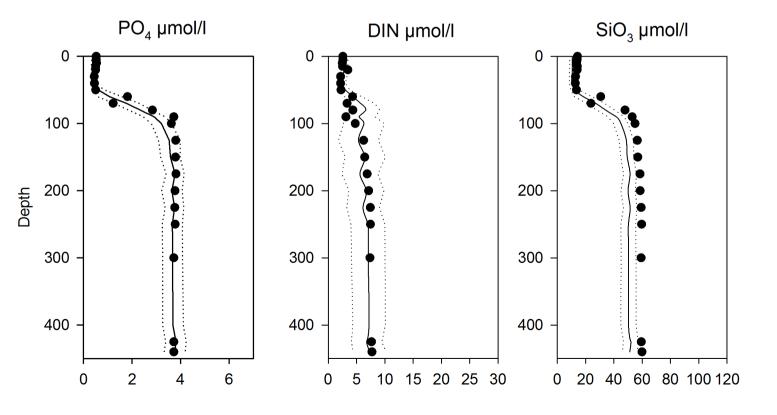
#### STATION BY31 SURFACE WATER



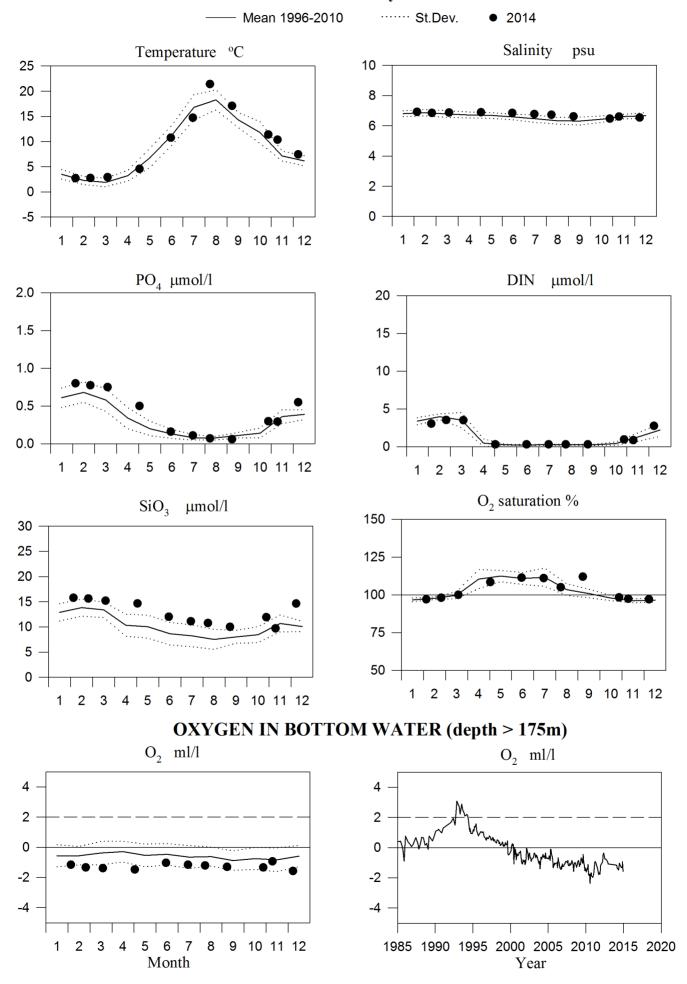
### Vertical profiles BY31 December

——— Mean 1996-2010 St.Dev. ● 2014

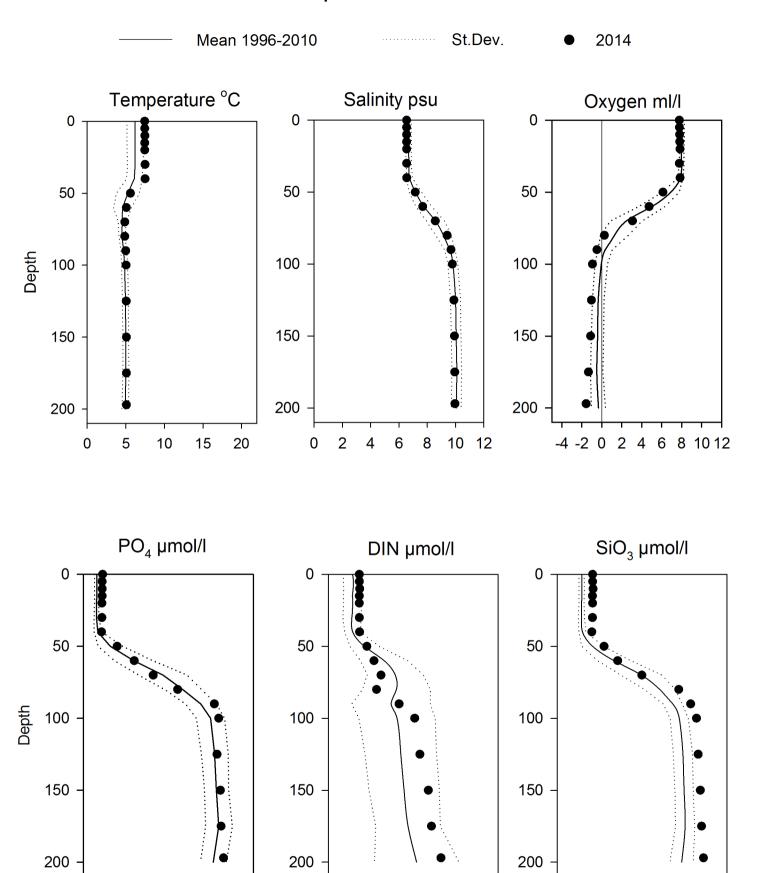




#### STATION BY32 SURFACE WATER



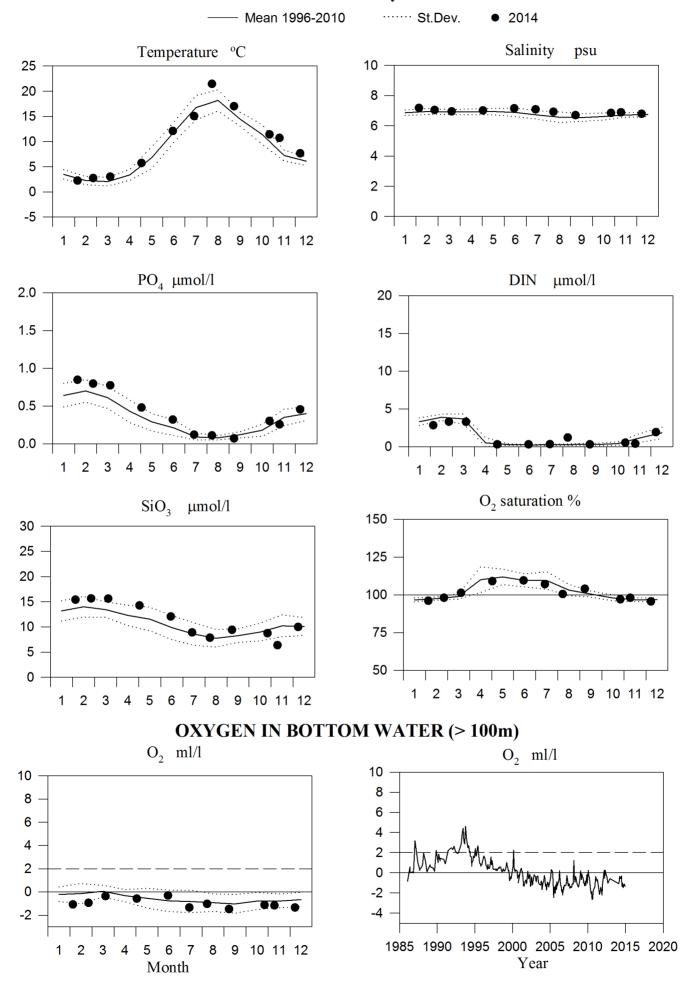
### Vertical profiles BY32 December



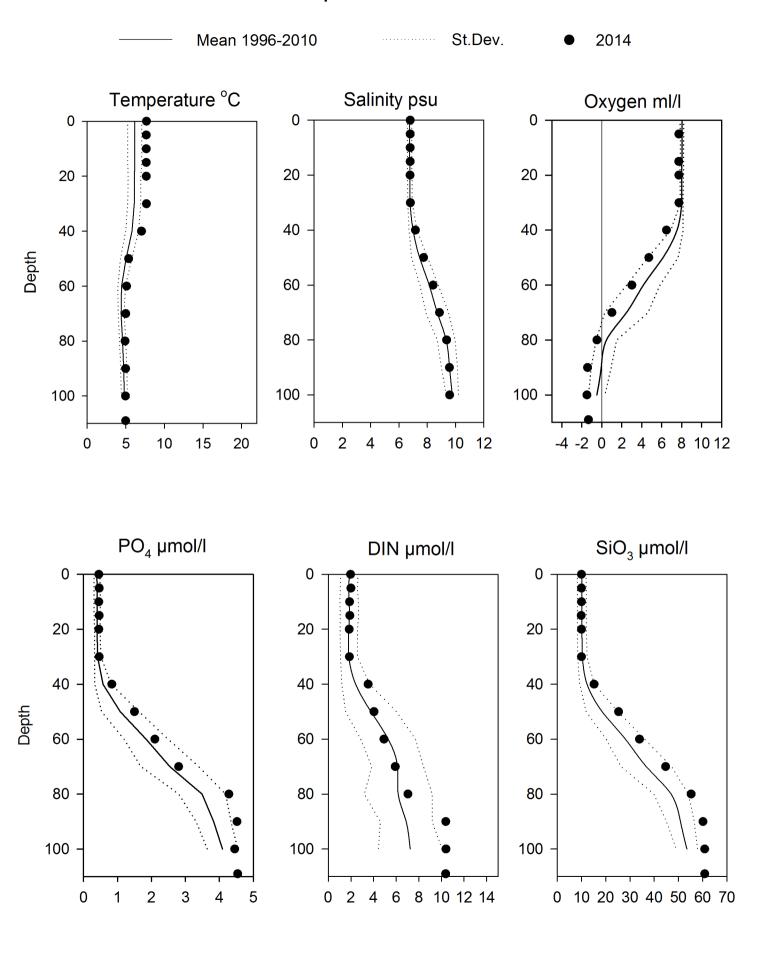
8 10 12 14

10 20 30 40 50 60 70

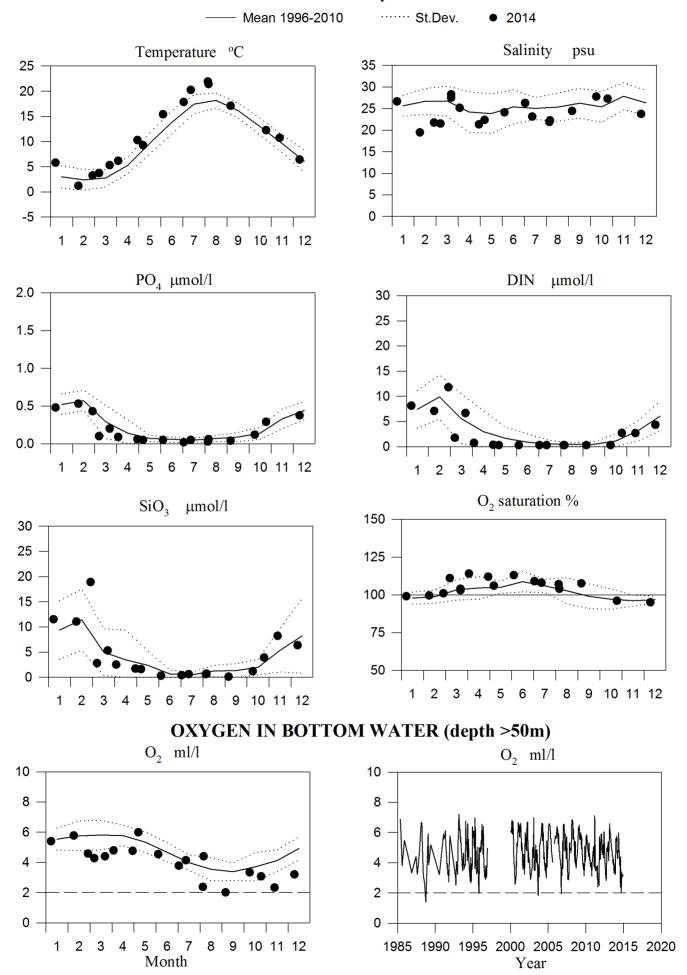
#### STATION BY38 SURFACE WATER



### Vertical profiles BY38 December

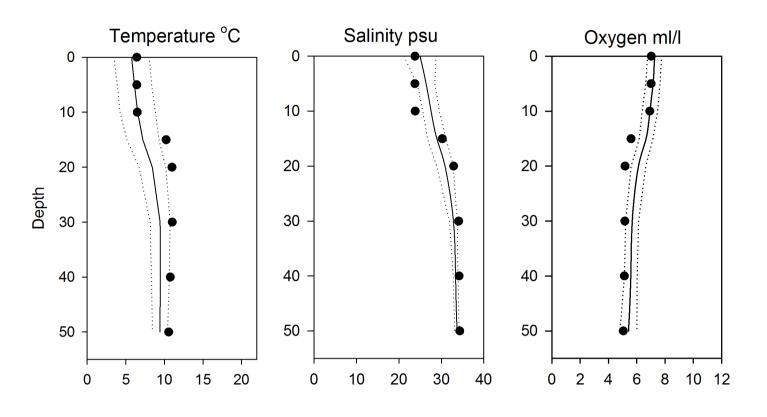


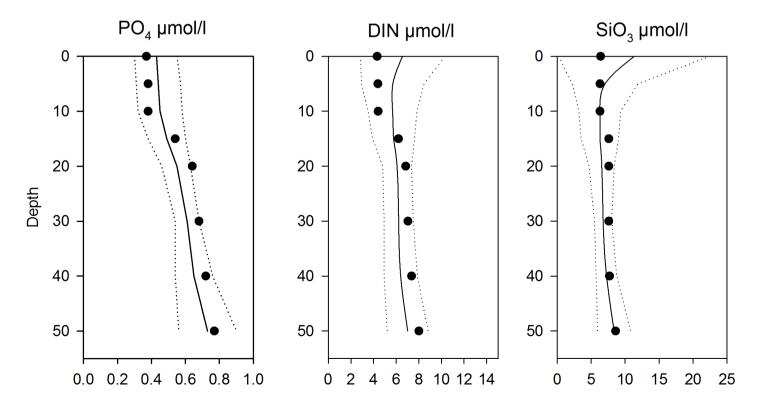
### STATION SLÄGGÖ SURFACE WATER



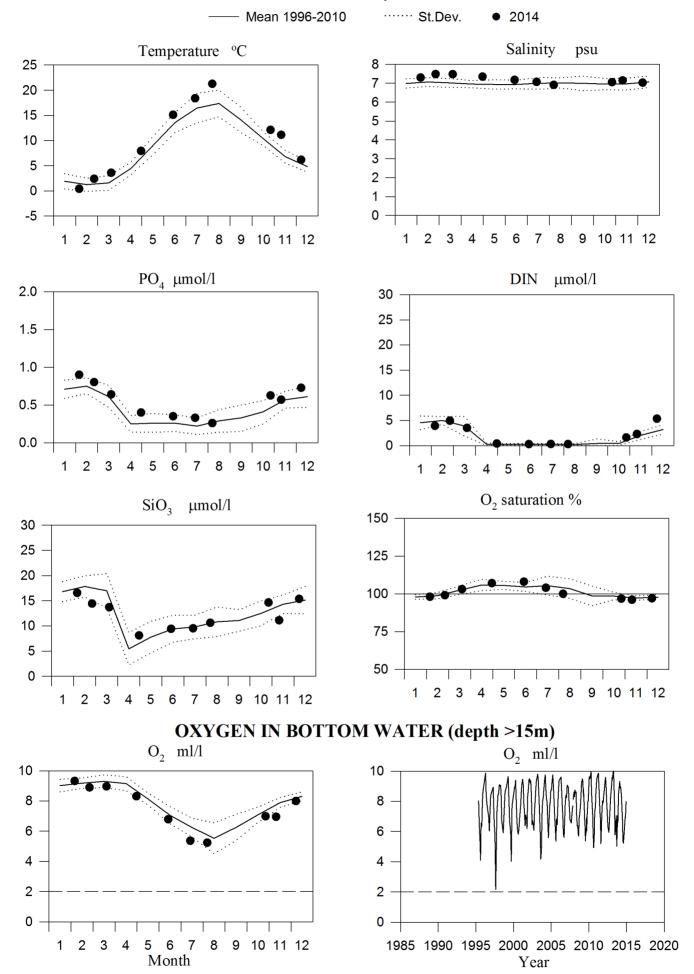
# Vertical profiles Släggö December

— Mean 1996-2010 St.Dev. ● 2014





#### STATION REF M1V1 SURFACE WATER



### Vertical profiles Ref M1V1 December

—— Mean 1996-2010 St.Dev. ● 2014

