

Karin Wesslander

Swedish Meteorological and Hydrological Institute Oceanographic Laboratory 2015-09-07 Dnr: S/Gbg-2015-121

Report from the SMHI monitoring cruise with R/V Aranda



Survey period:2015-08-31 - 2015-09-07Survey area:Skagerrak, Kattegat, the Sound, the Baltic Proper and the Gulf of FinlandPrincipal:SMHI and the Swedish Agency for Marine and Water Management

SUMMARY

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

The water temperature in the surface layer had now increased and was substantially normal for the season. In the southern and southeastern Baltic Proper relatively high concentrations of phosphate and silicate were measured. The large inflow that occurred in December 2014 could not be seen further north than at the last expedition and the oxygen levels in the inflowing water had also declined even more. In the northern and western Gotland basin and in the western part of the Gulf of Finland the oxygen situation remains severe as completely oxygen free conditions are found at depths exceeding 70-80 metres. Acute hypoxia was found from 60 metres in the western Gotland basin. In the bottom water in the Bornholm basin and in the Hanö Bight, oxygen levels had declined compared to the previous sampling in July and acute hypoxia was experienced. Oxygen levels in the Arkona basin had increased to >2ml/l and acute hypoxia did no longer prevail.

The next cruise is planned to start October 12, 2015.



PRELIMINARY RESULTS

The cruise, performed on board the Finnish research vessel Aranda, began in Helsinki on August 31 and ended in the same port on the 7th September. Winds during the expedition were mainly weak to moderate. In parts of the Baltic Proper however, the wind increased to gale force on a few occasions. Air temperatures ranged from 11-18°C.

In the Gulf of Finland and the northern Baltic Proper four additional stations were visited this time which usually are sampled by the Finnish Environment Institute (SYKE). This extended monitoring is part of a new collaboration between SYKE and SMHI with the aim to i.e. increase the sampling frequency at Swedish and Finnish monitoring stations.

During the cruise, a scientist from the Danish Technological University collected water samples for iodine isotope analyses. Aim of this project is to investigate how discharge water from nuclear power plants spreads in the Baltic Sea. Also, two scientists from SYKE joined the cruise and made multi net sampling from different layers in the water column to investigate how the salt water intrusion December 2014 affected the zoo plankton community.

The Skagerrak

The temperature in the surface water had increased since last expedition and was now about the normal for the season and varied between 16.03 and 17.34°C, highest near the coast. The surface salinity varied between 22.14 and 33.87 psu, lowest along the coast. The salinity was higher than normal off shore and near the coast it was lower than normal. The stratification was found around 35 meter off shore and the coast it was found shallower at 10-20 metres depth.

The nutrients in the surface waters were still very low both at the coast and offshore, and had started to increase at some stations which is normal for the season. Phosphate concentrations in the surface waters were in the interval $0.03 - 0.08 \mu mol/l$, inorganic nitrogen (nitrite+nitrate and ammonia) <0.1-0.37 and <0.20-0.67 $\mu mol/l$ respectively, while silicate varied between 0.8-1.8 $\mu mol/l$.

The lowest oxygen concentration in the bottom water was found at Släggö in the mouth of the Gullmar fjord, 3.31 ml/l.

Fluorescence measurements showed biological activity with higher intensity just above the pycnocline. For more details see the separate phytoplankton report.

The Kattegat and the Sound

In Kattegat, the temperature in the surface water was around 17°C which is normal for the time of year. The salinity in the surface layer was a bit lower than normal for the season and varied between 16.45 and 11.46 psu with the lowest salinity in the Sound. The halocline and the thermocline were found at 10-20 metres depth.

The concentration of nutrients in the surface water was low or almost exhausted, which is normal for the season. The phosphate concentration varied between 0.05-0.11 μ mol/l and had increased some since the last visit in July. Silicate also showed low concentrations around 0.4-1.0 μ mol/l. In the Sound, the concentrations of nutrients were also normal; phosphate was 0.19 μ mol/l and silica was 6.7 μ mol/l. Inorganic nitrogen was below the reporting limit in both Kattegat and the Sound.



The lowest oxygen concentrations in the bottom water were measured at Anholt E in Kattegat, 4.09 ml/l and 2.66 ml/l at W Landskrona in the Sound.

The plankton activity was low in the surface water, but some higher around the pycnocline. For more details see the separate phytoplankton report.

The Baltic Proper

The temperature in the surface water had increased since last expedition and was normal or somewhat above normal for the season and varied between 17.0 and 18.5°C. The eastern parts were somewhat warmer than the western parts. The surface salinity was around the normal for the season and varied between 5.51 psu in the central Gulf of Finland to 7.87 psu in the Arkona basin. The halocline was found at 60-80 metres depth in the western and eastern Gotland basin, while it was shallower in the southern parts. In the Arkona basin it was found at 30-40 metres depth. The thermocline was found at 20-30 metres depth and was well developed.

The concentration of phosphate and silicate in the surface water was now lower than at the last visit but still above normal in the southern and in the south eastern Baltic Proper. The high concentrations of phosphate and silicate in the surface waters could be attributed to the inflow, and nutrient rich bottom water consequently reaching the surface water. In the remaining parts the concentrations were normal for the season. Phosphate concentrations varied between 0.05-0.34 μ mol/l and silicate between 7.9-13.7. The high phosphate concentration was observed at Hanö Bight in the south western Baltic Proper and the highest silicate concentration at BCSIII-10 in the south eastern Baltic Proper. The inorganic nitrogen was completely consumed down to 20 metres depth except at the coastal station RefM1V1 where inorganic nitrogen increased from 15 meters depth.

To monitor the inflow to the Baltic Sea that occurred during December 2014 extra sampling points were visited in the northern Gotland basin north of Fårö Deep (BY20). No markable signs of the inflow were to be seen north of BY20 but just as last visit in July weak signs of the inflow were found intermediary at BY20.

In the western and northern Baltic Proper, and in the western Gulf of Finland, the oxygen situation was still severe. Completely oxygen free conditions were found at depths exceeding 70-80 metres. In the Gotland Deep, in the eastern Gotland basin, acute hypoxia was found at depths exceeding 70 metres. Hydrogen sulphide was now found at two intermediate thin layers; 80-95 metres and around 125 metres. Below the oxygen free layer, the deep water was still oxygenated, but the concentrations had declined even more since last expedition in July.

Acute hypoxia was found in the western Gotland basin from 60 metres depth. In the northern and eastern Gotland basin and in the western Gulf of Finland hypoxia was found from 70-80 metres depth. The oxygen content in the bottom water in the Bornholm basin and the Hanö bight had declined further compared to the last measurements in July, and also here acute hypoxia was observed. The oxygen concentration in the Arkona basin had increased since the last visit to >2 ml/l and it were no longer acute hypoxia.

Fluorescence measurements showed biological activity with higher intensity just above the pycnocline. For more details see the separate phytoplankton report. For more information about the algal situation, please see the separate phytoplankton report.



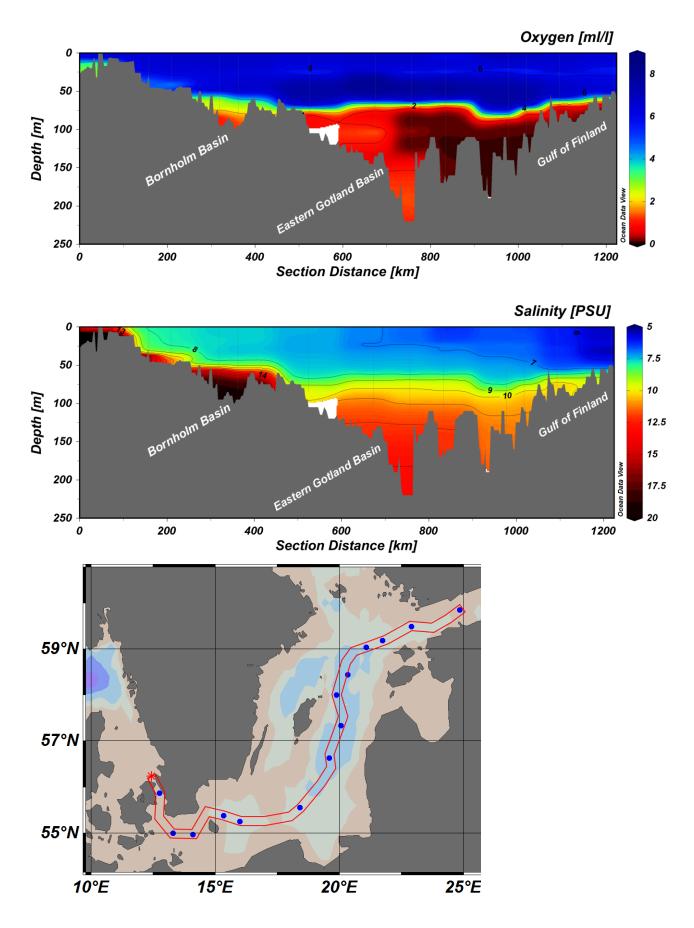


Figure 1. Transect showing the oxygen and salinity from the Sound to the Gulf of Finland.



PARTICIPANTS

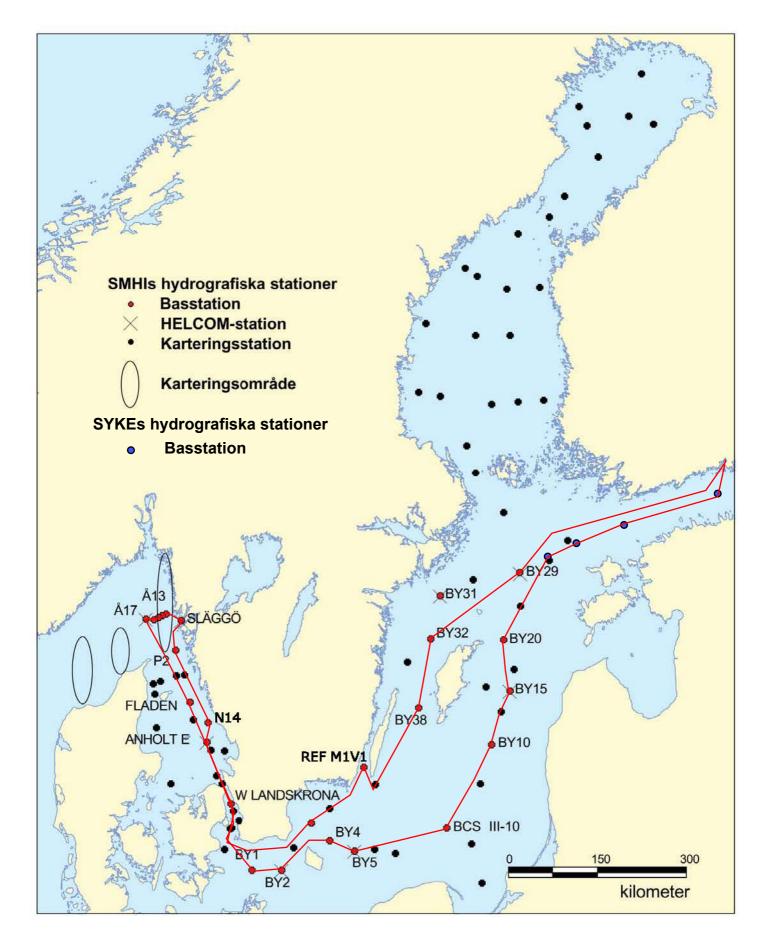
	Institute
Chief Scientist	SMHI
	SYKE
	SYKE
	DTU
	Chief Scientist

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: 20150831-20150907 Series: 0544-0575



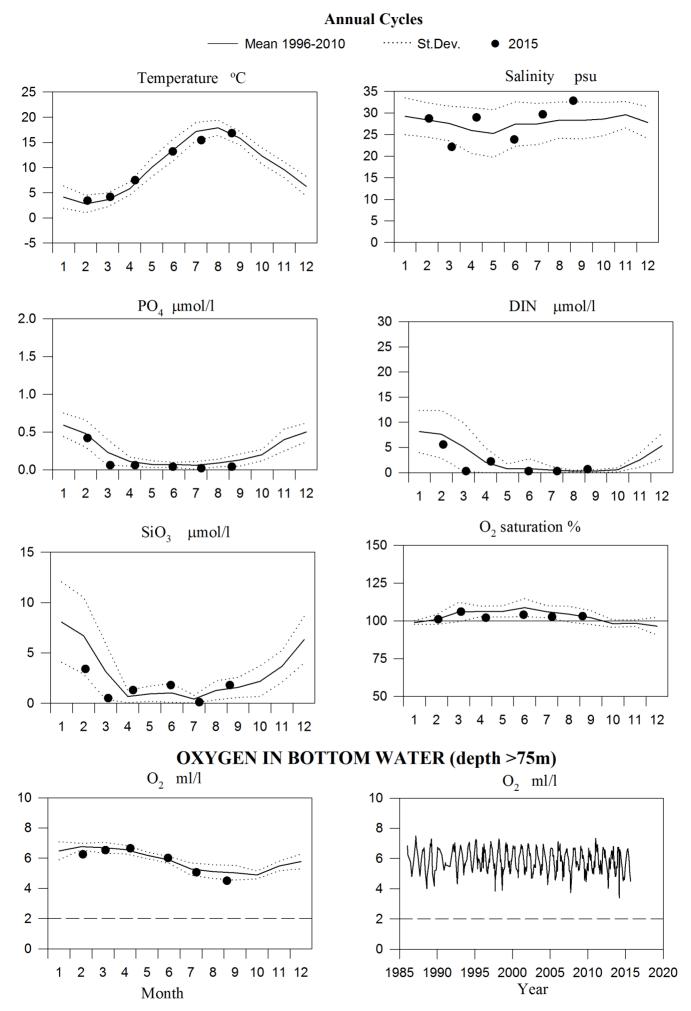
SMHI Ocean enh	***** Hydro **** serie	graphic s	Ship: 01 Year: 20			**** ***	Date: 2015-09-07 Time: 14:00
Ser Stat P Station no code r o j	- Lat Lon	- Date Tim yyyymmdd hhm utc	-	Secchi W depth d m		tu motPBw pig PPNN	holiui0000 4tkOmgNCCm NNa3un m
0544 GFXX29EXT BY23/LL7 0545 BPNX60EXT LL12 0546 BPNX00EXT LL15 0547 BPNX00EXT LL17		20150831 172 1 20150831 213 7 20150831 235	0 83 0 130 0 170	2	52 72	hd PrP 1 n 17.1 1018 1420 x 12 - - - - - 17.6 1016 1210 x 12 x x x -	x x
0548 BPNX27EXT BY21 0549 BPEX26BAS BY20 FÅRÖDJ 0550 BPEX21BAS BY15 GOTLANDSDJ 0551 BPEX21EXT BY15 GOTLANDSDJ	N5826.5E2020N5800E1953N5720E2003N5720E2003	20150901 050 20150901 090 20150901 143 20150901 163	0 195 0 240 0 240	6 0 0	9 15 9 10 9 9	16.7 1010 2830 x 14 x x x 16.4 1007 6850 x -xx 17 x x - x x x x x x 17.4 1004 1640 xxxx 19 x x x x x x x x x x 17.8 1004 1130 x 12 x x - x x x x x x	x x - x x x x x x x x x - x -
0552 BPEX13BAS BY10 0553 BPSE11BAS BCS III-10 0554 BPSB07BAS BY5 BORNHOLMSDJ 0555 BPSB06BAS BY4 CHRISTIANSÖ 0556 BPSA03BAS BY2 ARKONA	N5638 E1935 N5533.3 E1824 N5515 E1559 N5523 E1520 N5500 E1405	20150901 234 20150902 073 20150902 160 20150902 193 20150903 014	0 89 0 90 0 92	2 7 2	59 611	18.0 1004 9990 xx 15 x x - x - x x x 17.1 1008 2740 xx 12 x x - x - x x x 17.3 1012 1140 x -xxxx 12 x x - x - x x x 17.6 1012 9930 xx 12 x x - x - x x x 16.5 1013 9990 xxxx 8 x x - x - x x x	X X - X X X X X
0557 BPSA02BAS B12 ARKONA 0558 SOCX39BAS W LANDSKRONA 0559 KAEX29BAS ANHOLT E 0560 KANX25BAS FLADEN	N5500 E1318 N5552.0 E1245.0 N5640.0 E1207.0 N5711.5 E1140	20150903 053 20150903 120	0 47 0 51 5 62		1 7 7 7 3 5		X X - X X X - X
0561 SKEX18BAS Å17 0562 SKEX17BAS Å16 0563 SKEX16BAS Å15 0564 SKEX15BAS Å14	N5816.5 E1030.8 N5816 E1043.5 N5817.7 E1051 N5819 E1056.5	20150904 044 20150904 071 20150904 082	5 348 0 202 5 138		8 1 6 3	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	X X X X X X X X - X -
0565 SKEX14BAS Å13 0566 FIBG27BAS SLÄGGÖ 0567 SKEX23BAS P2 0568 KANX50BAS N14 FALKENBERG	N5820.2 E1102 N5815.5 E1126.0 N5752 E1118 N5656.40 E1212.7	20150904 172 0 20150904 232	5 77 0 94 5 30	10 2	1 3	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	x x - x x x x - x x x x x x
0569 KAEX29BAS ANHOLT E 0570 BPSH05BAS HANÖBUKTEN 0571 BPWK01BAS REF M1V1 0572 BPSE00EXT 4.5NE ÖLANDS SÖDRA	N5640.0 E1207.0 N5537 E1452 N5622.25 E1612.3 N5610.06 E0906	20150905 171 20150905 231 20150906 020	0 78 5 20 6 57	2	1 4	13.4 999 6990 xxxx 10 x x x x - x x x x 11.6 998 6840 xx 11 x x - x - x x x x 11.6 996 9990 xxxxx 5 x x x x - x x x x 11.0 997 9999 x 9 x x - x	X X - X X X X X
0573 BPWX45BAS BY38 KARLSÖDJ 0574 BPWX38BAS BY32 NORRKÖPINGSDJ 0575 BPNX35BAS BY29	N5707 E1740 N5801 E1759 N5853 E2019	20150906 090 20150906 151 20150906 235	5 199	6 0 5 0 3	6 6	14.5 999 1630 xx 14 x x - x x x x x x 13.5 1004 1740 xx 17 x x - x x x x x x 13.6 1005 6990 x 16	x x - x x

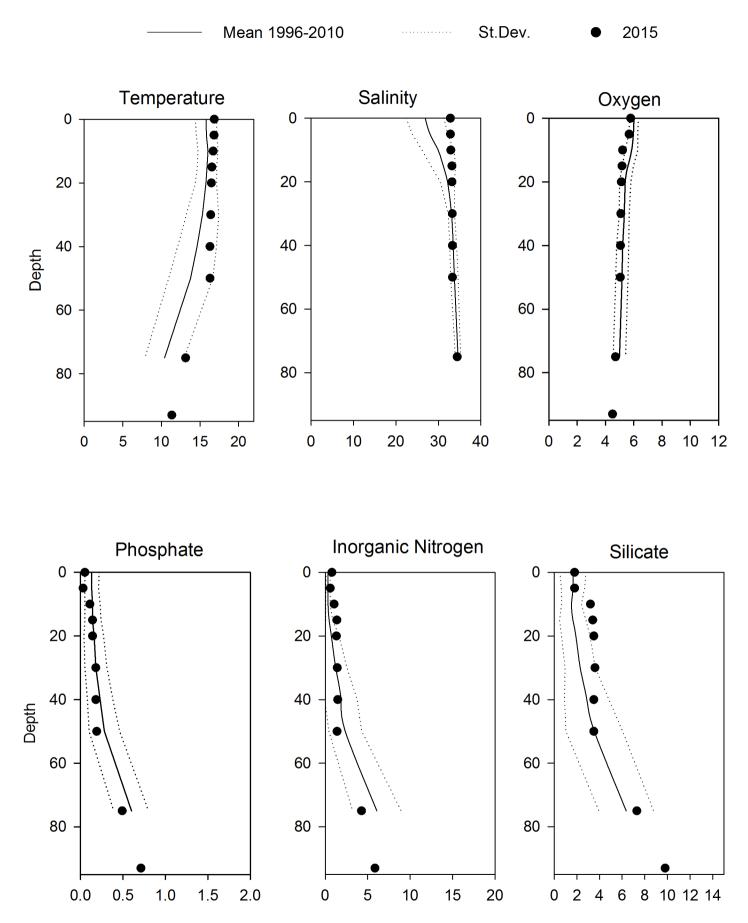
Bottom water oxygen concentration (ml/l)

		Finland
Ship	:	Aranda
Date	:	20150831-20150906
Series	:	0544-0575



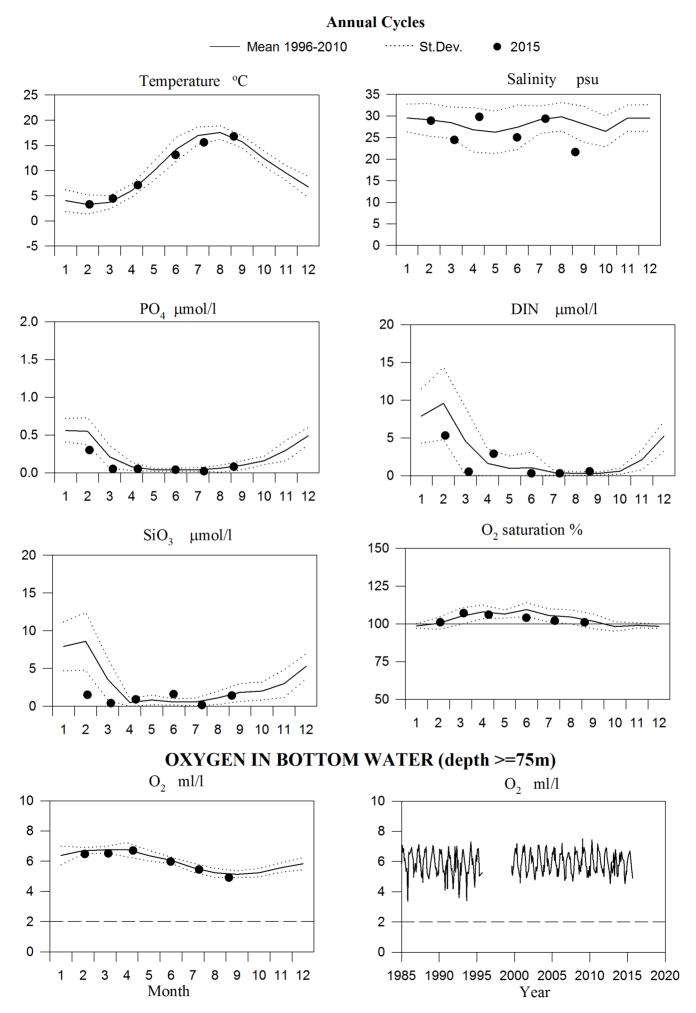
STATION P2 SURFACE WATER

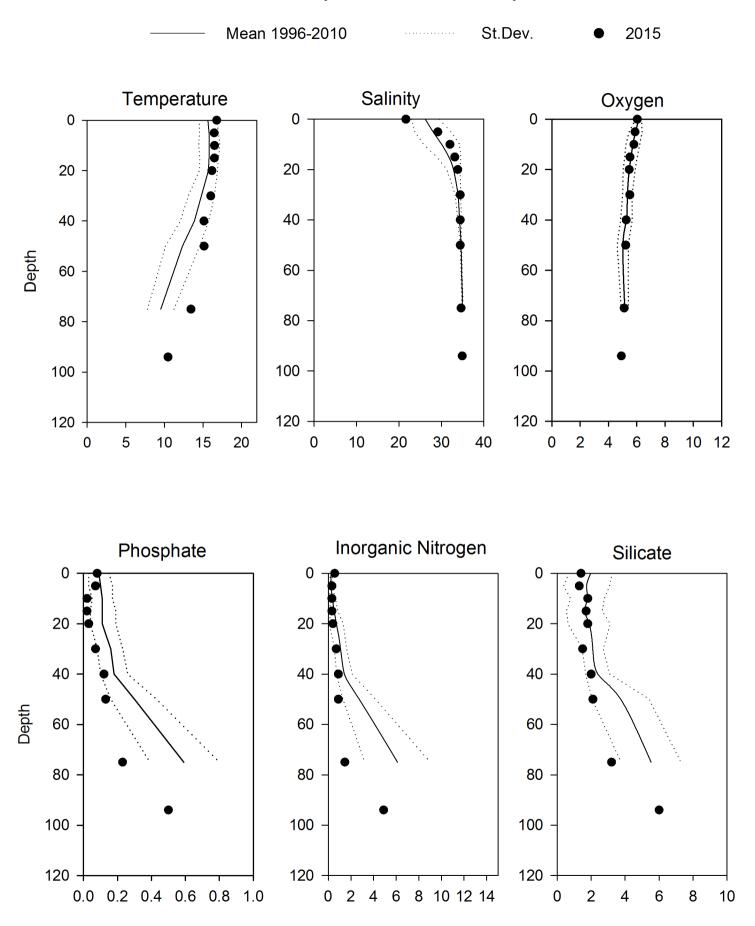




Vertical profiles P2 September

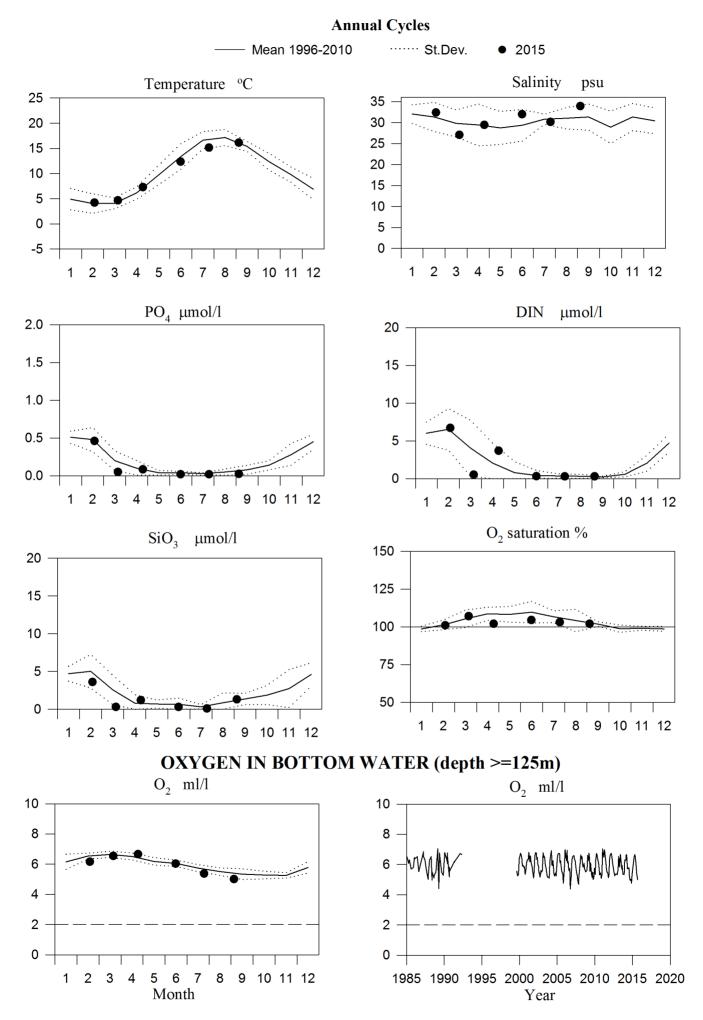
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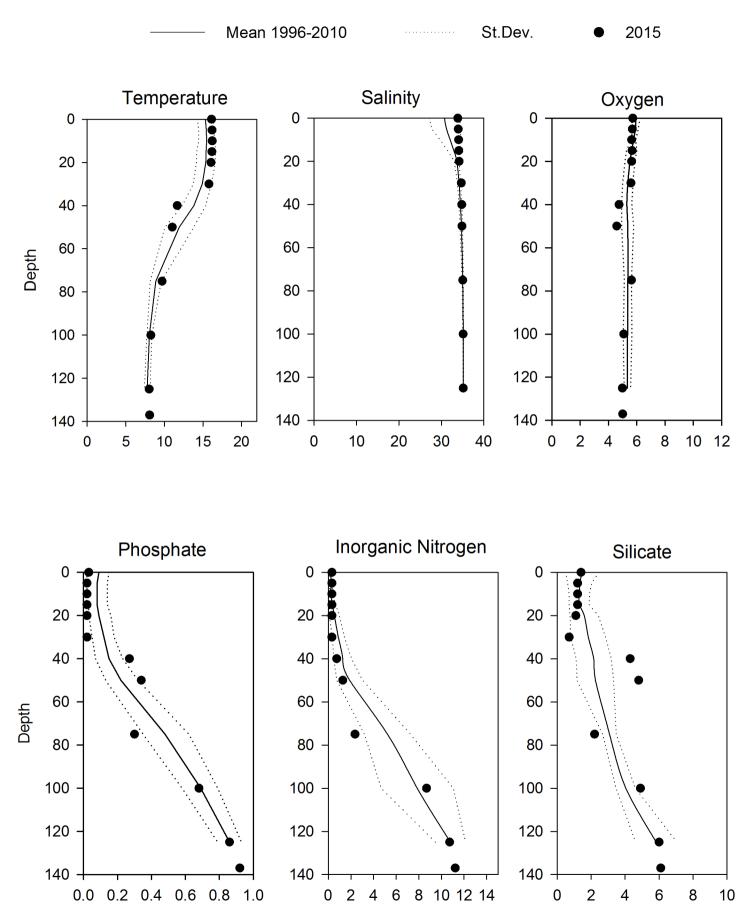




Vertical profiles Å13 September

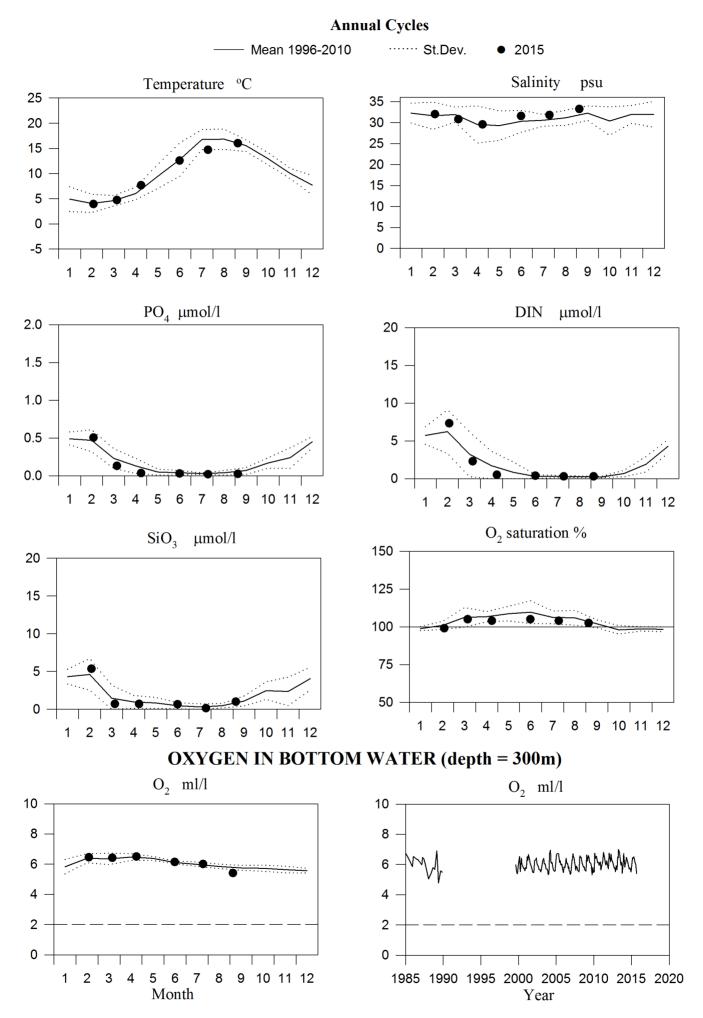
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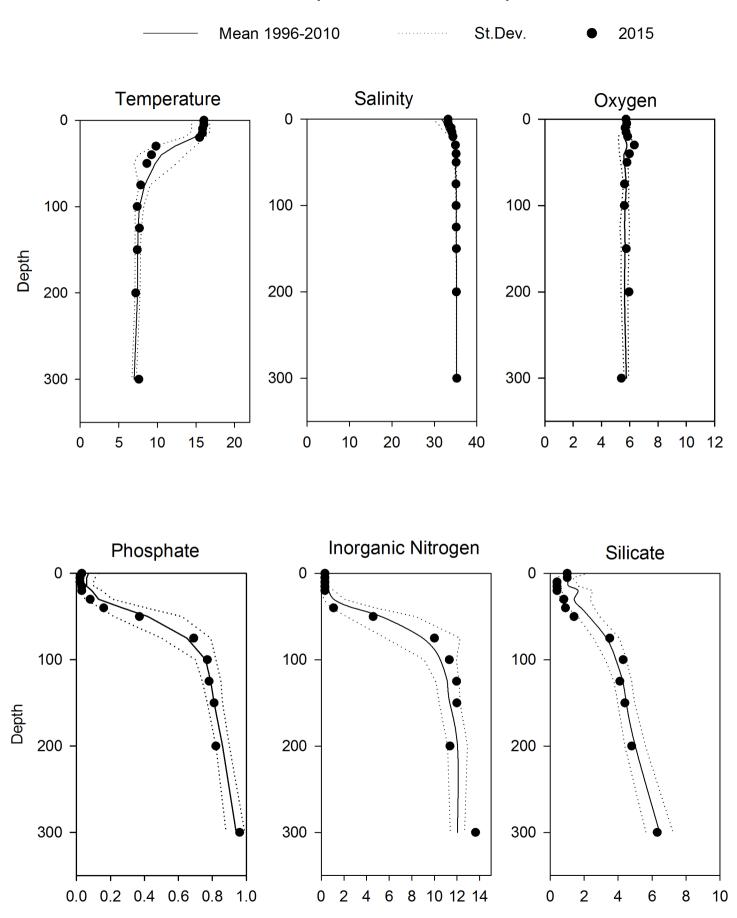




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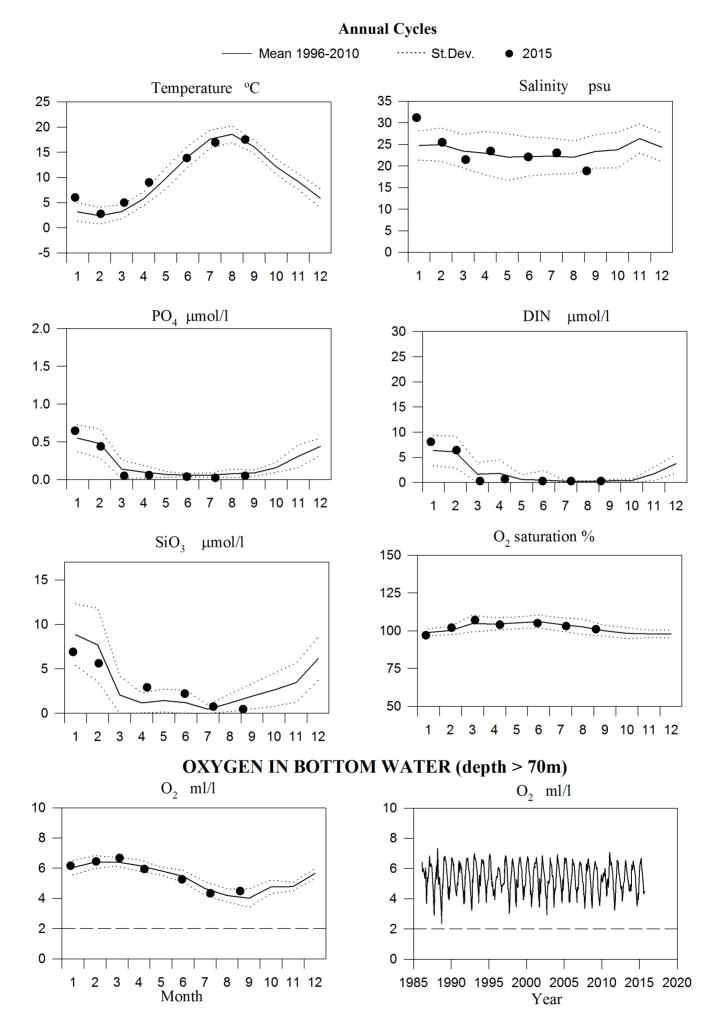
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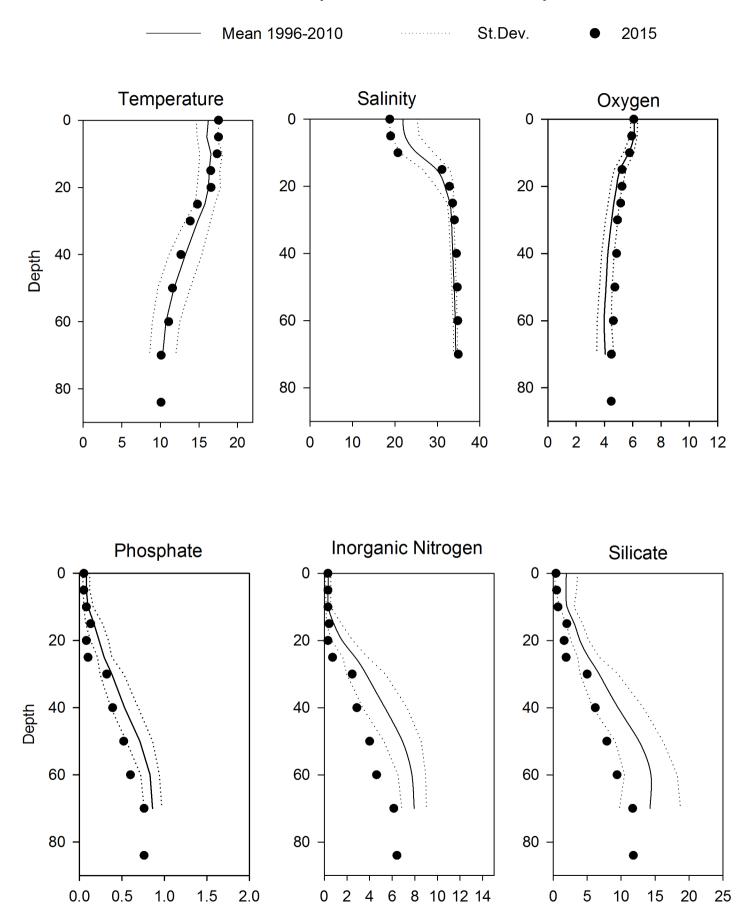




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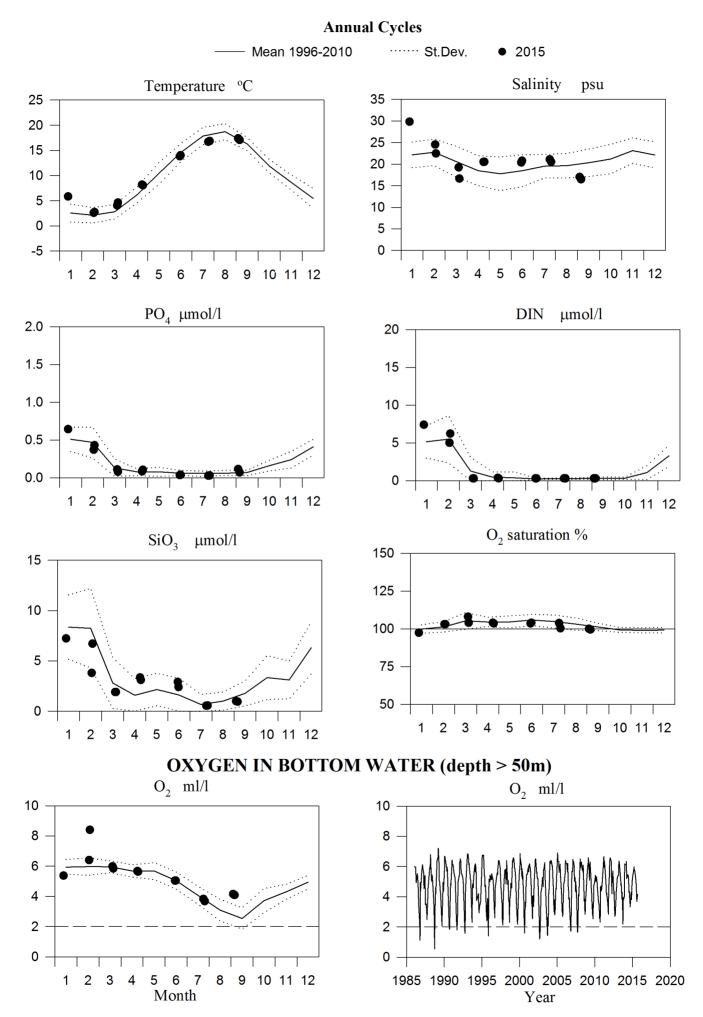
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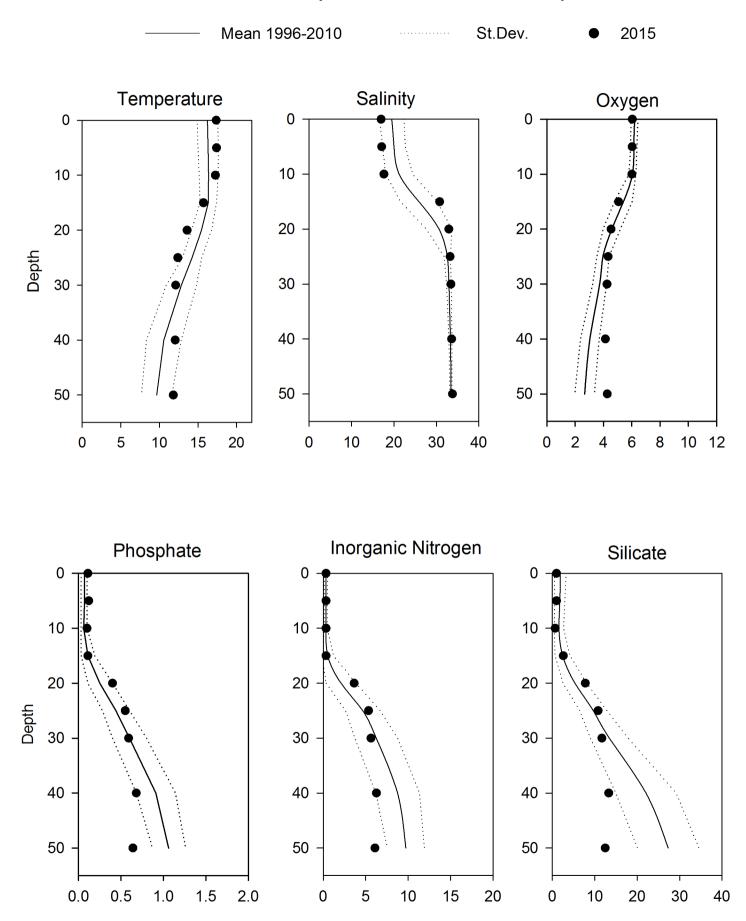




Vertical profiles Fladen September

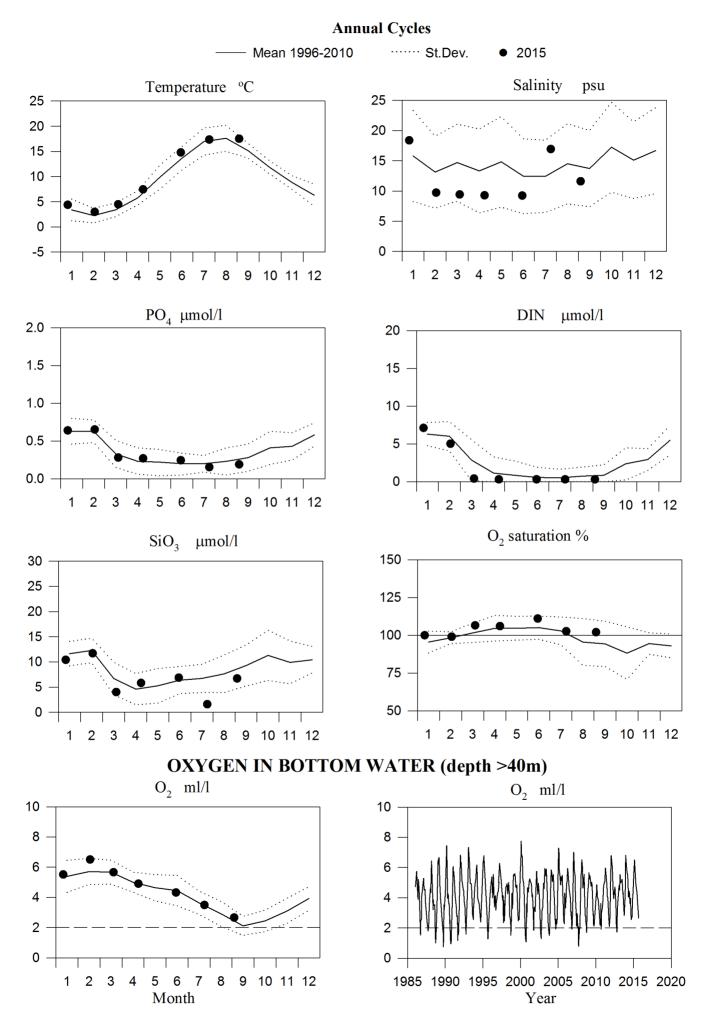
STATION ANHOLT E SURFACE WATER



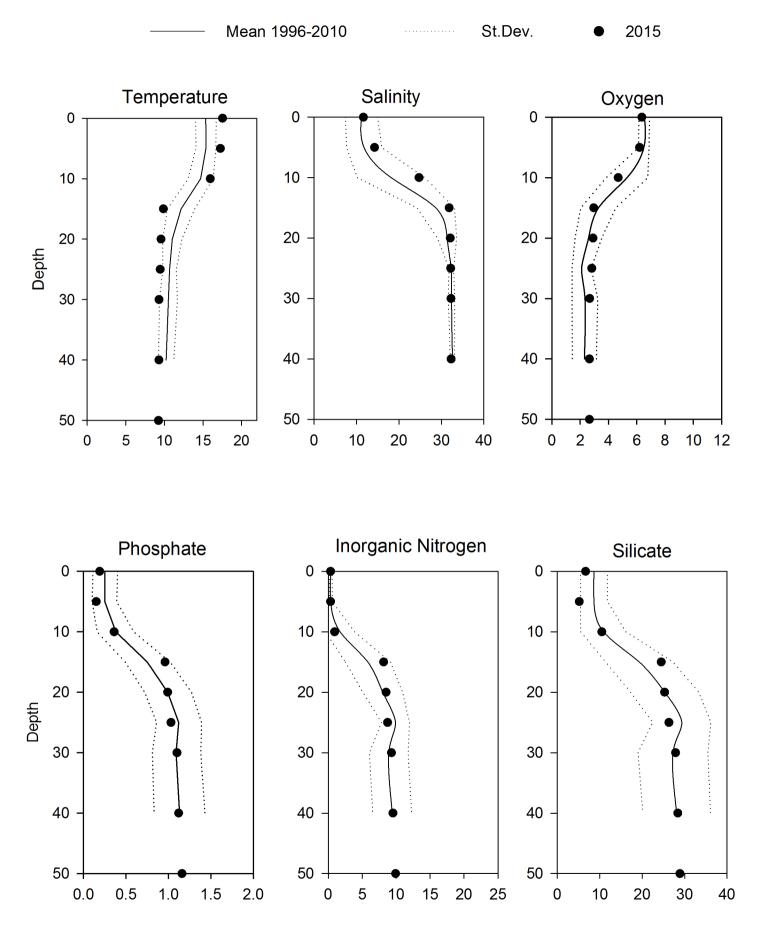


Vertical profiles Anholt E September

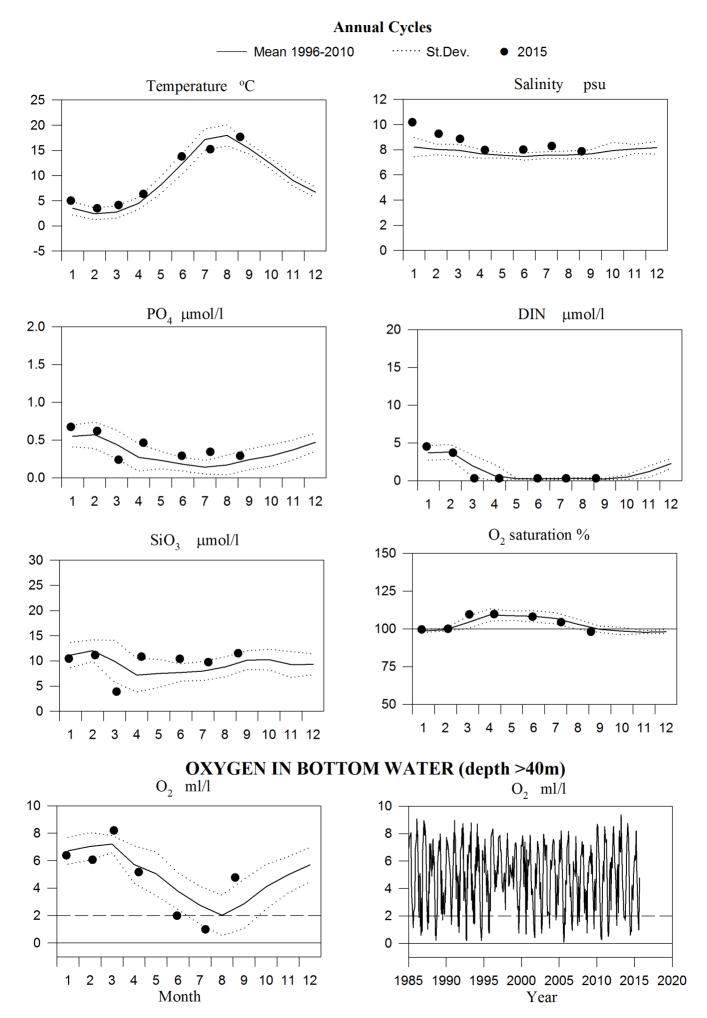
STATION W LANDSKRONA SURFACE WATER

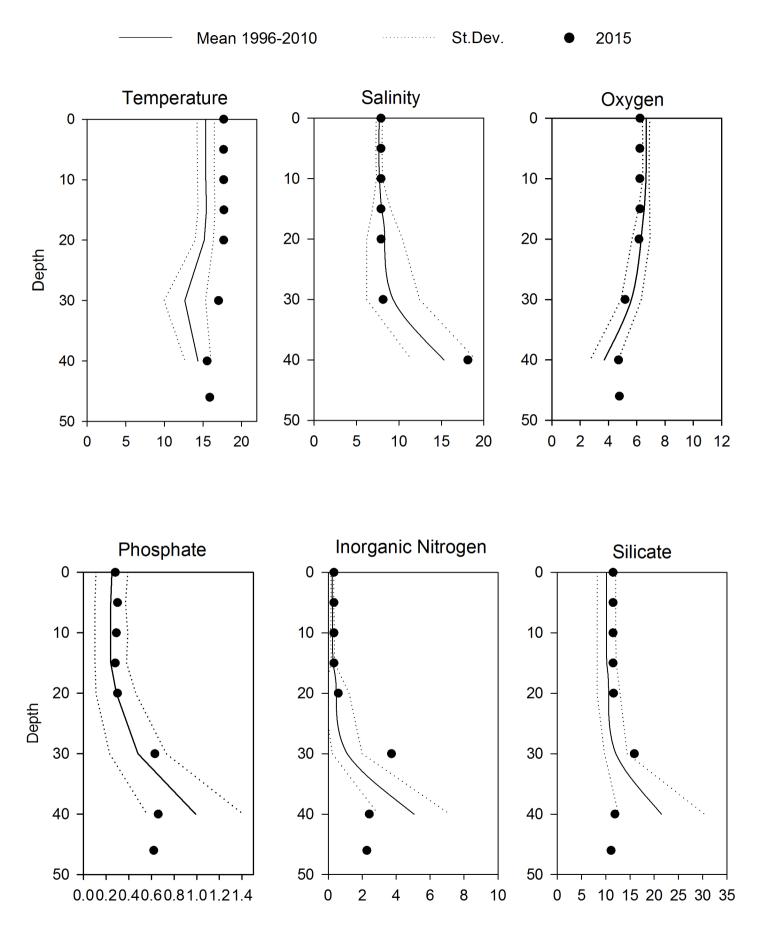


Vertical profiles W Landskrona September



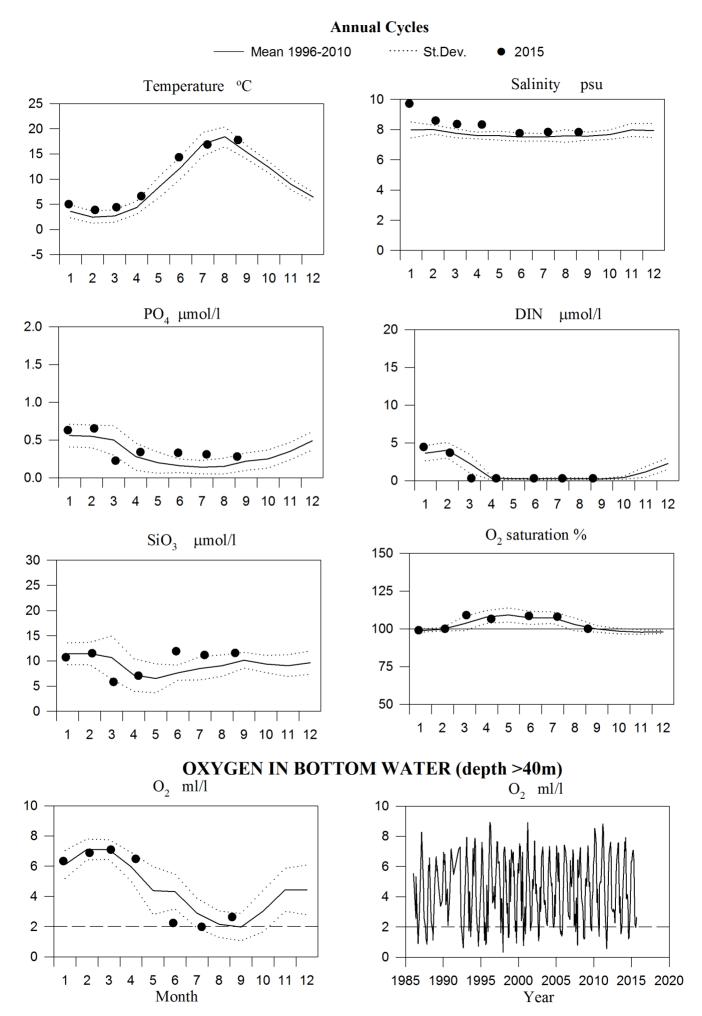
STATION BY1 SURFACE WATER

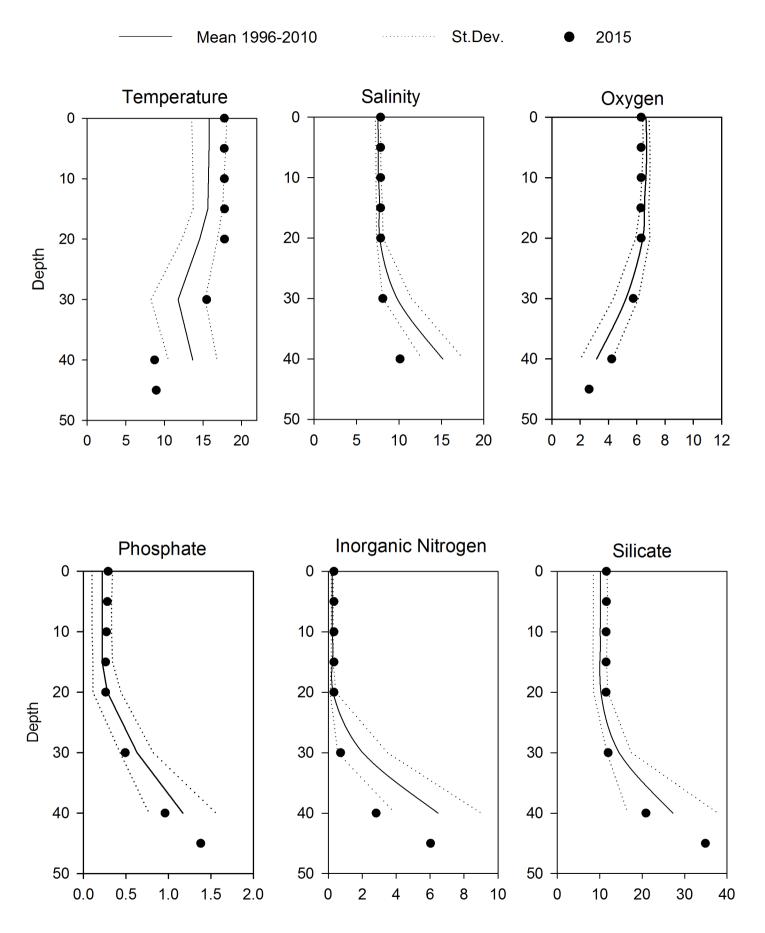




Vertical profiles BY1 September

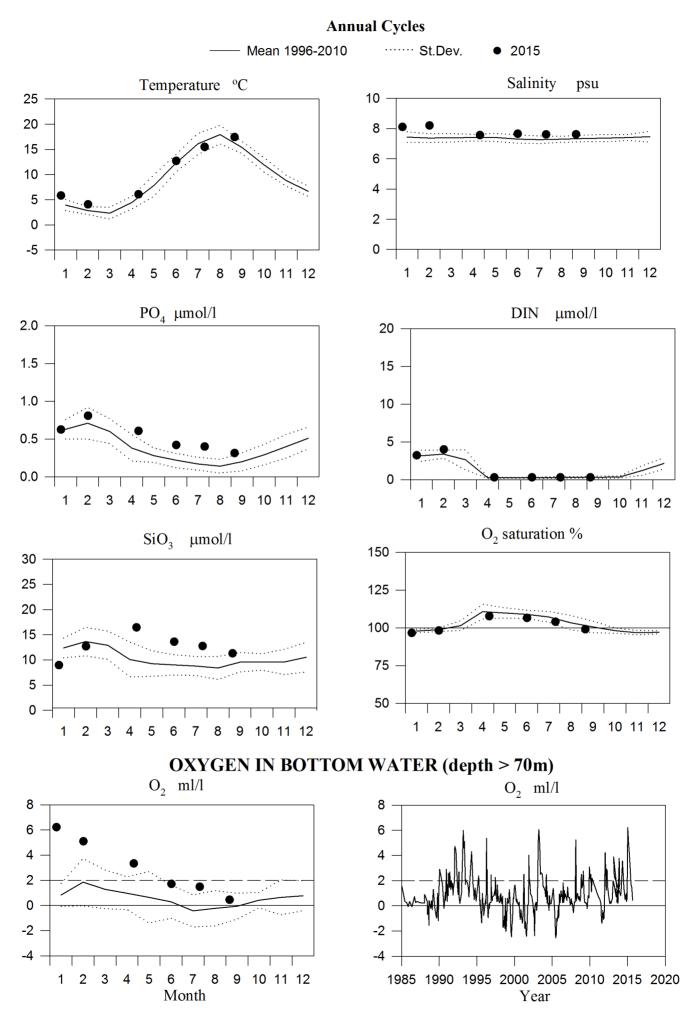
STATION BY2 SURFACE WATER





Vertical profiles BY2 September

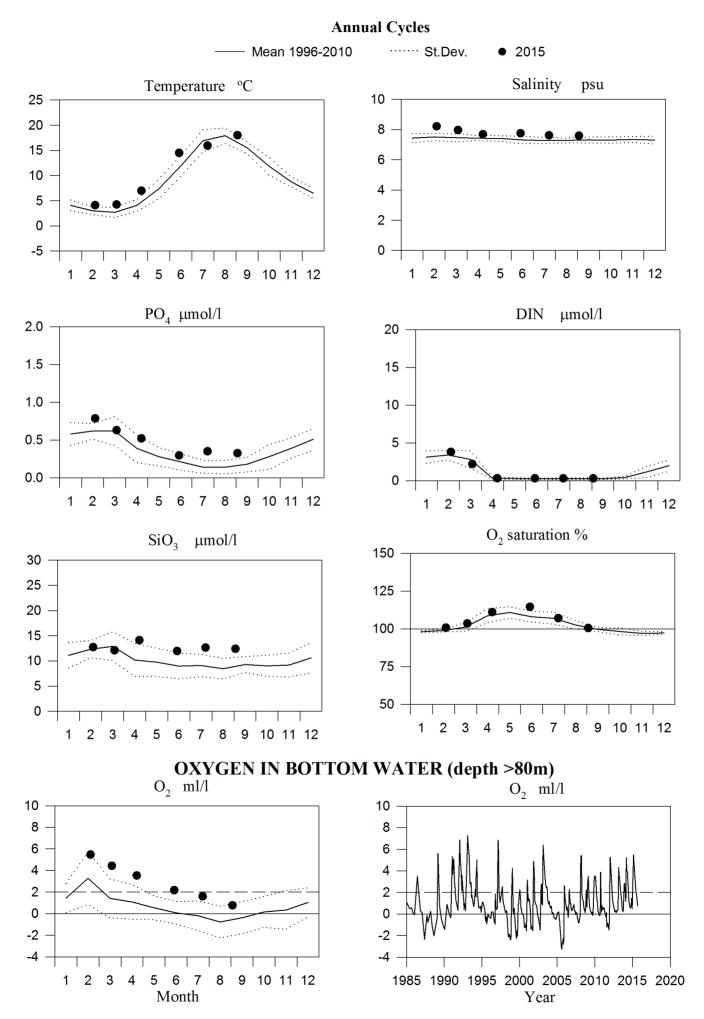
STATION HANÖBUKTEN SURFACE WATER

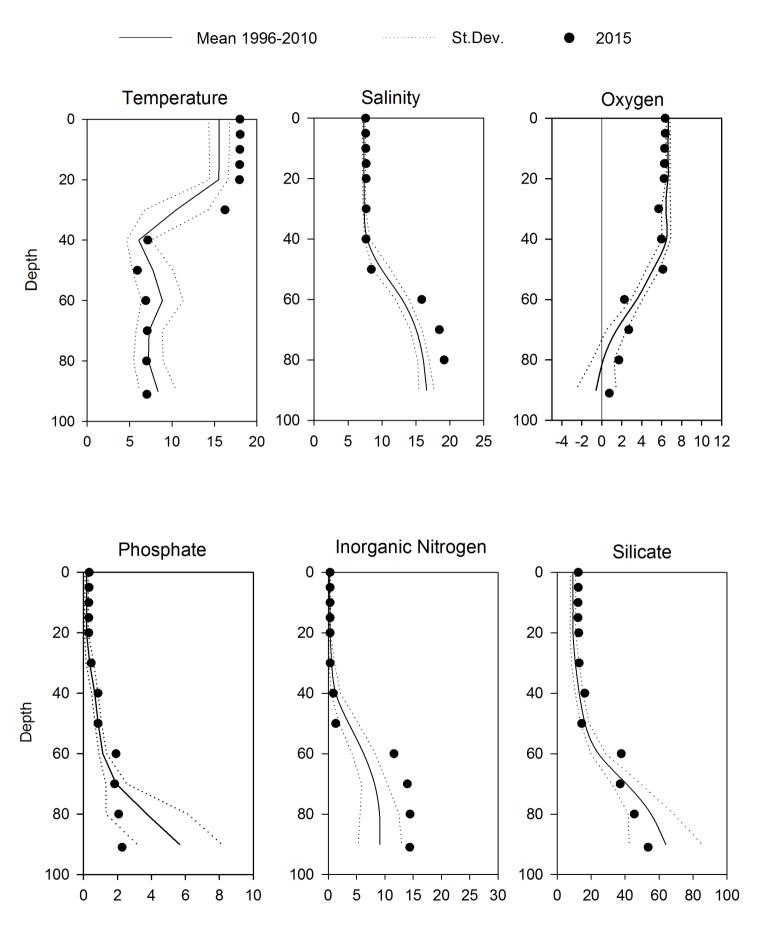


Mean 1996-2010 St.Dev. Salinity Temperature Oxygen Depth -4 -2 0 4 6 8 10 12 Inorganic Nitrogen Phosphate Silicate Depth 80 -8 10 12 14 10 20 30 40 50 60 70

Vertical profiles Hanöbukten September

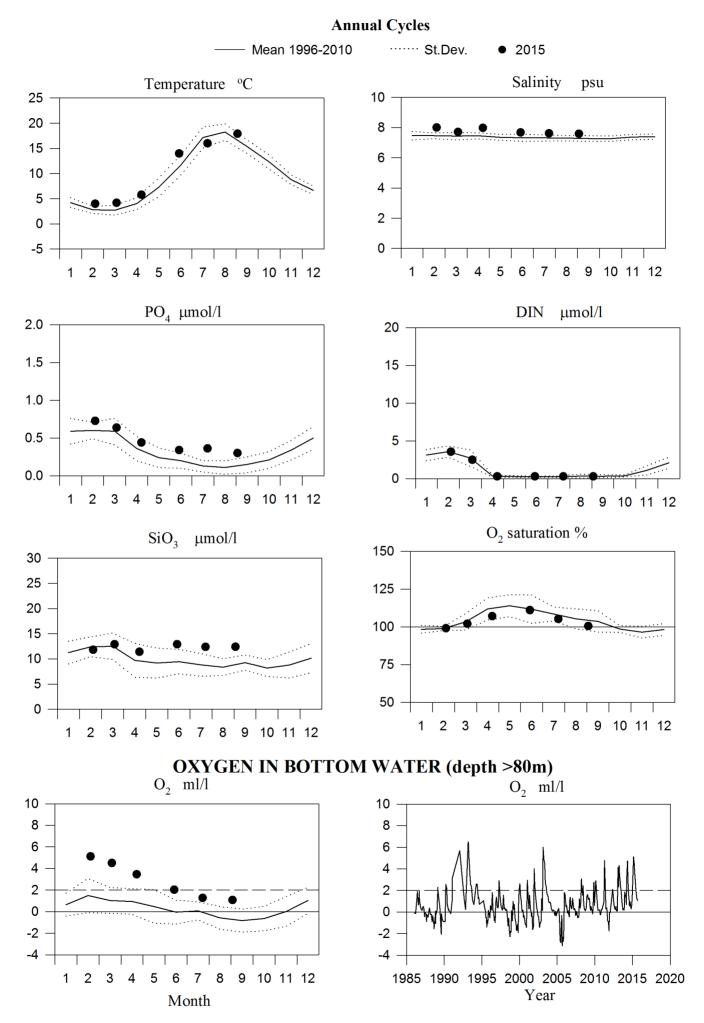
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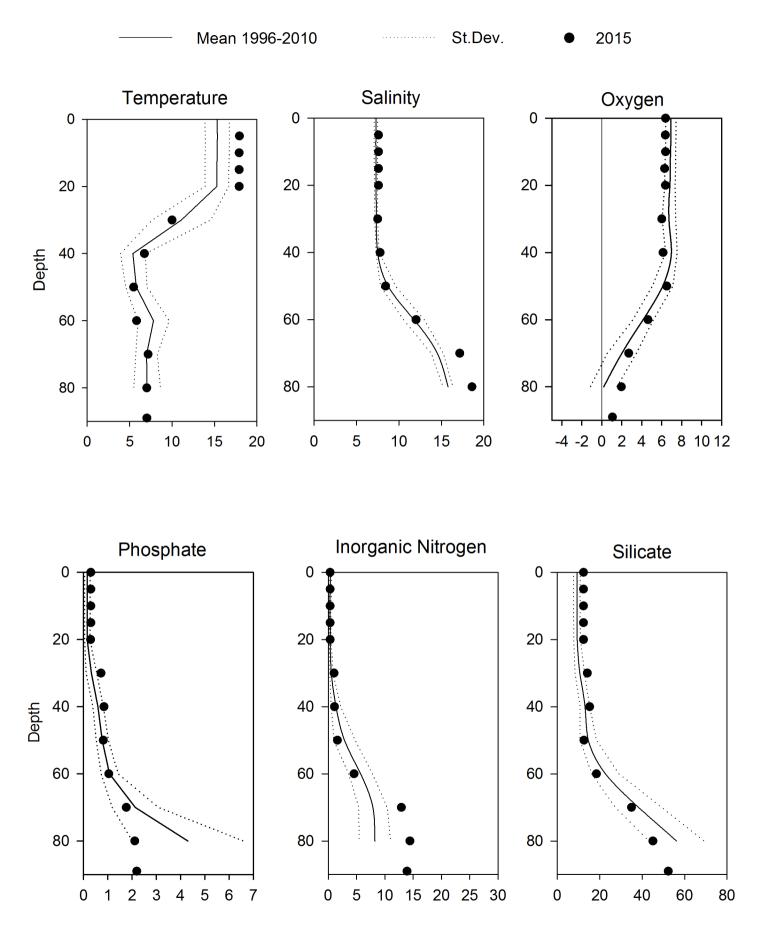




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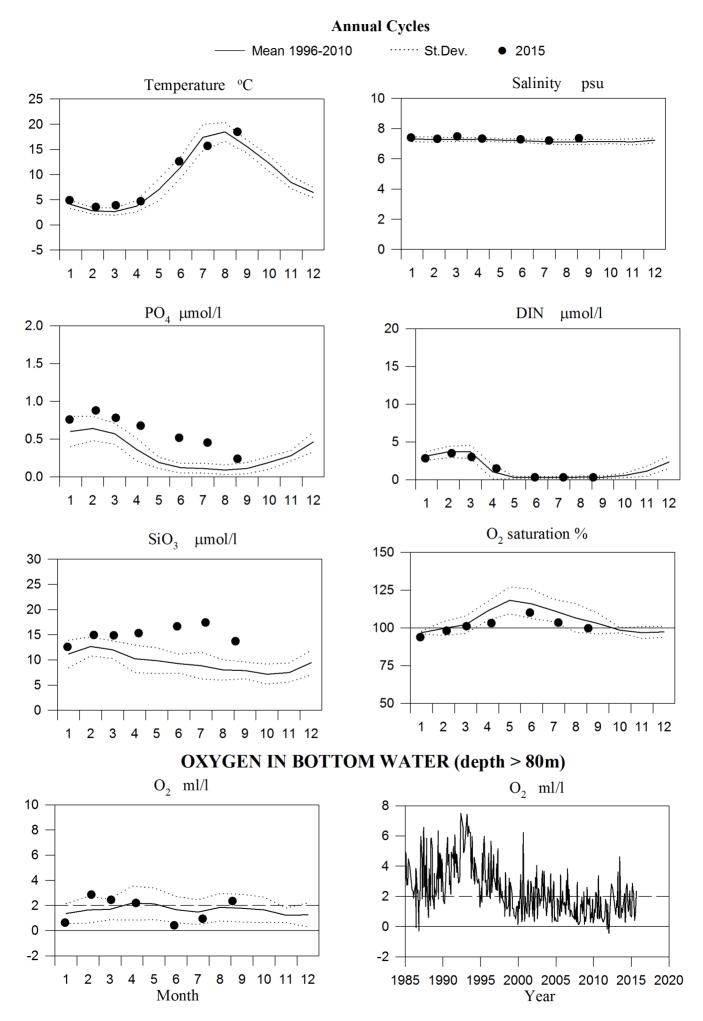
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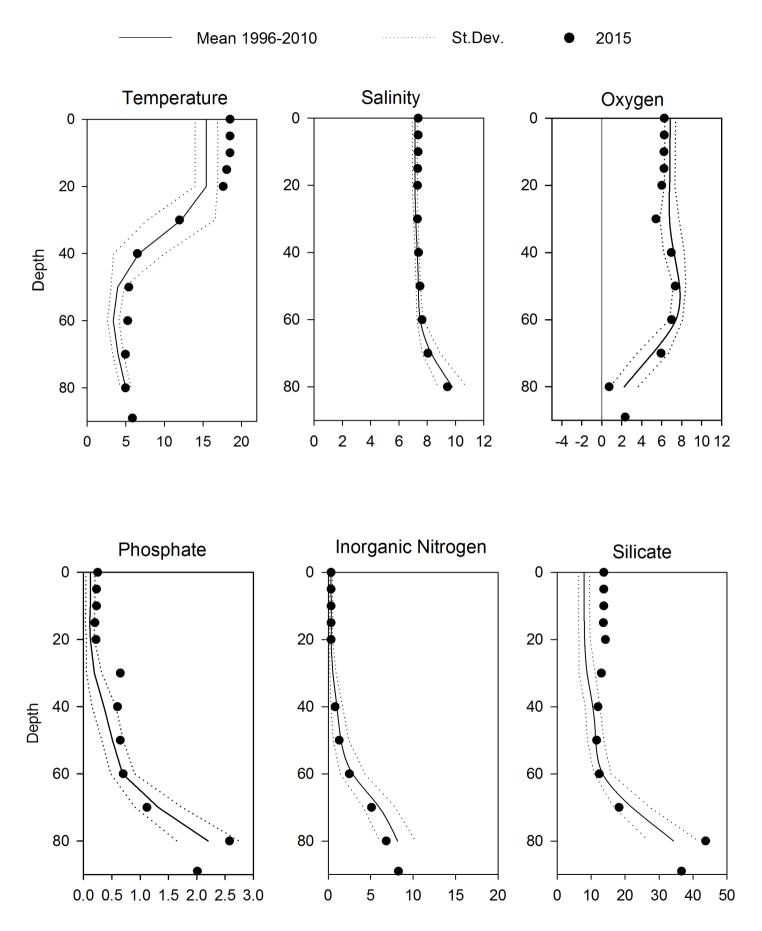




Vertical profiles BY5 September

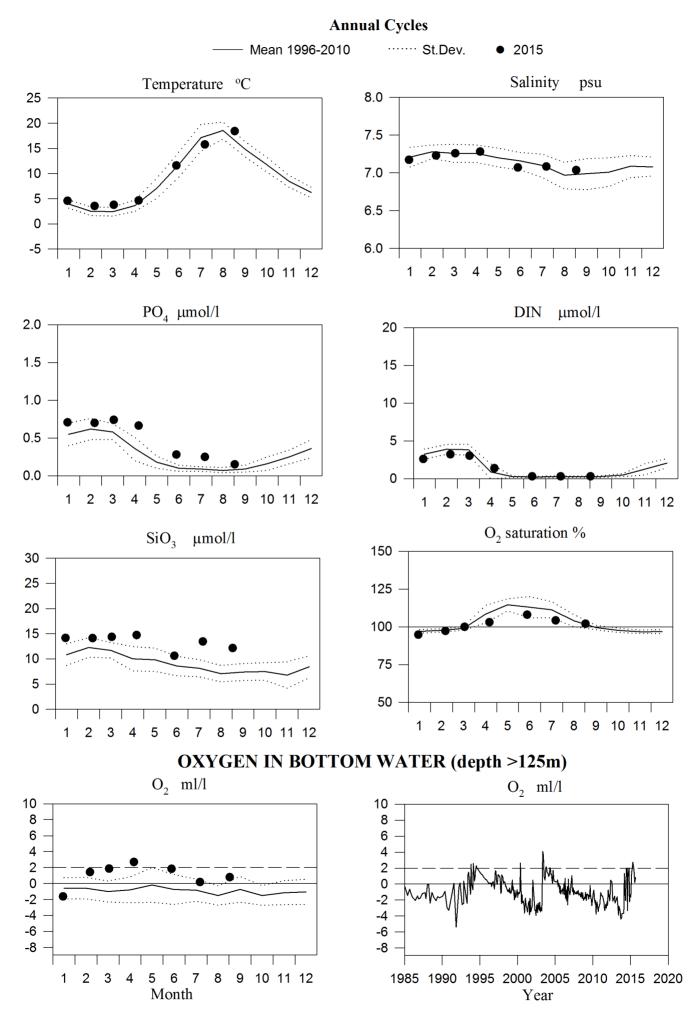
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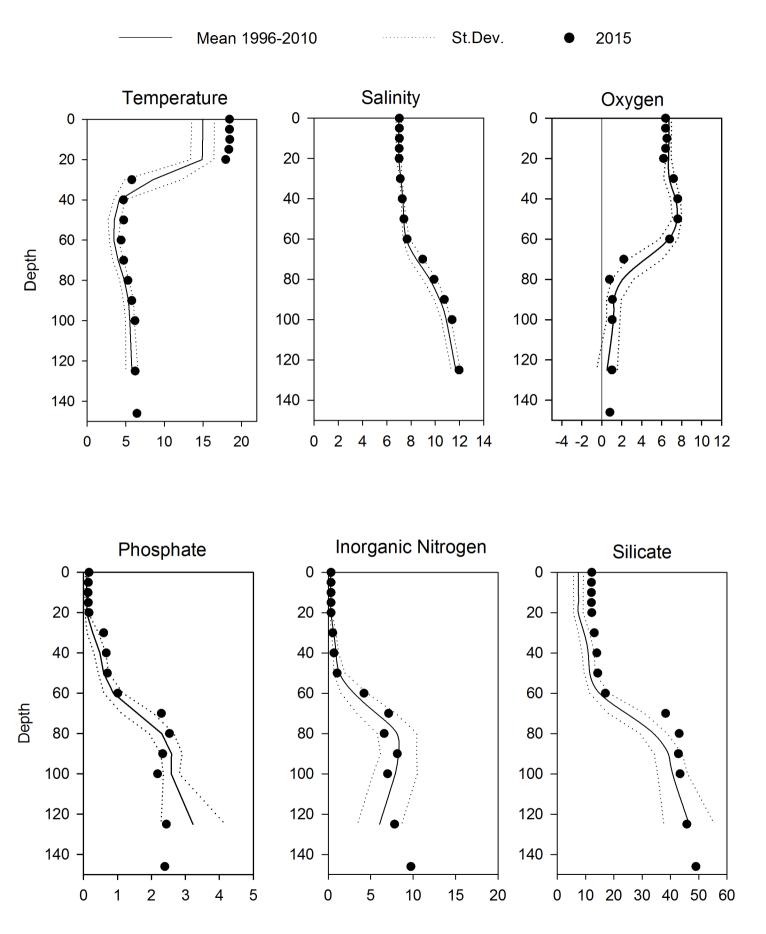




Vertical profiles BCS III-10 September

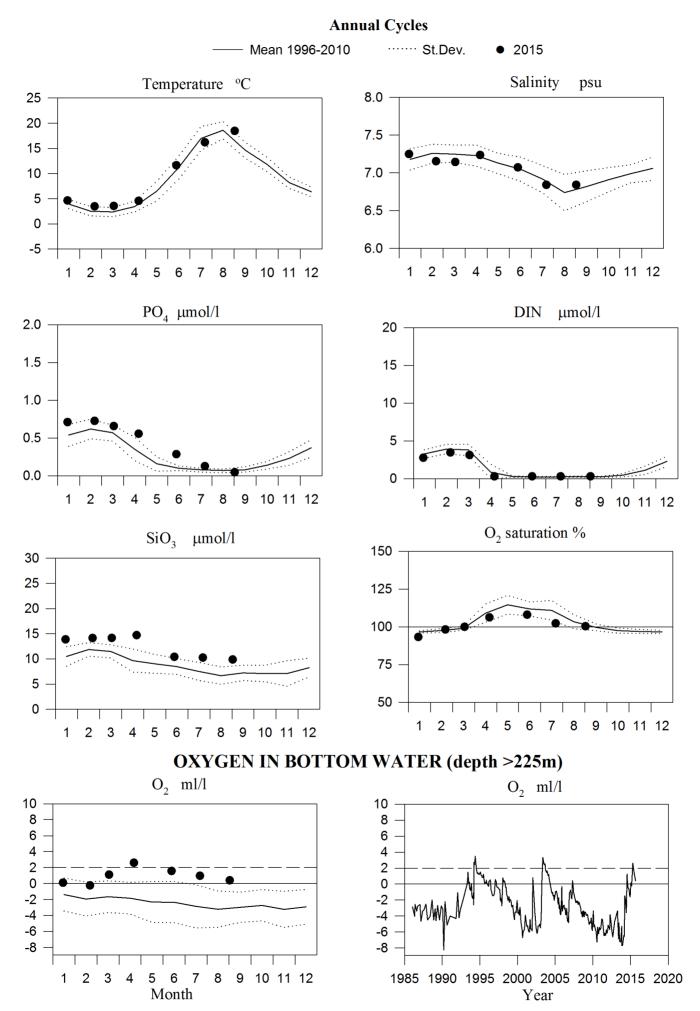
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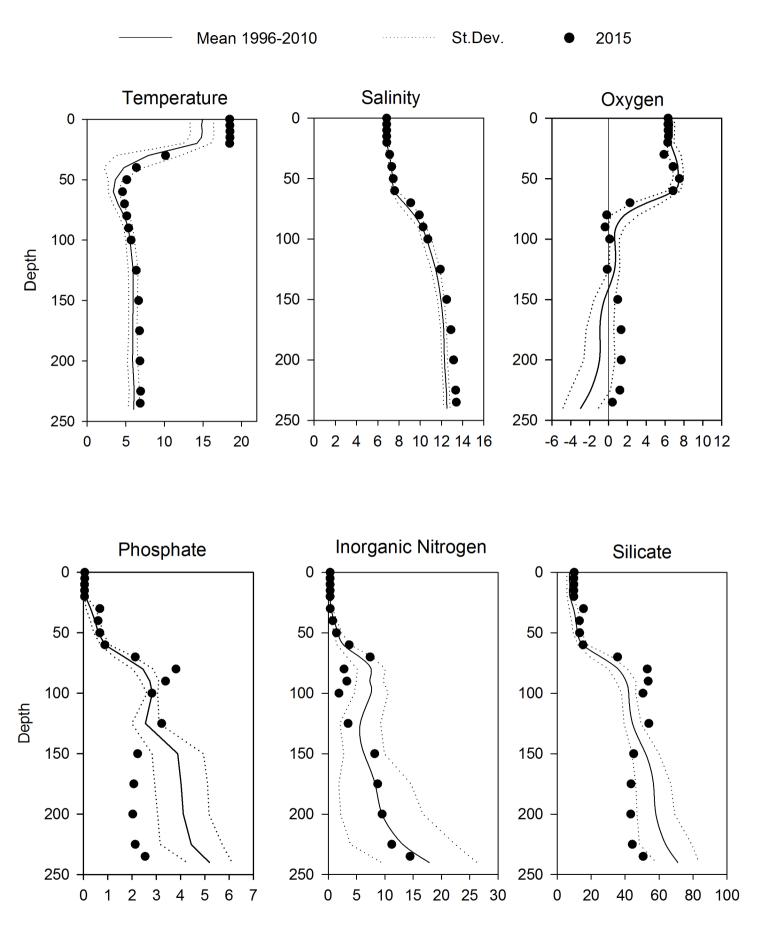




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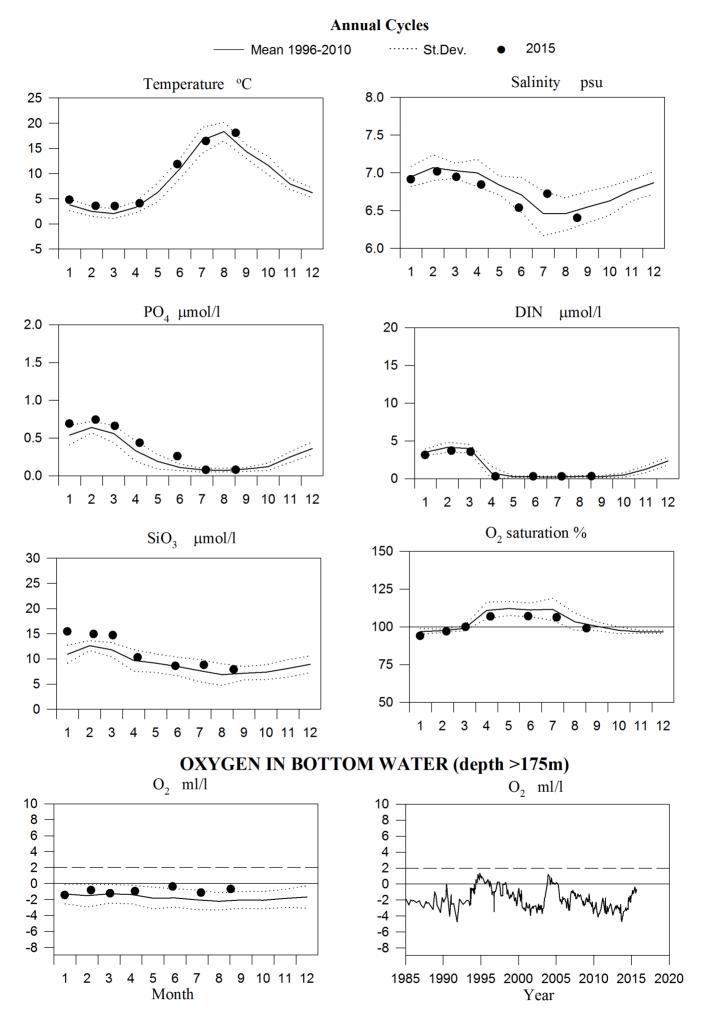
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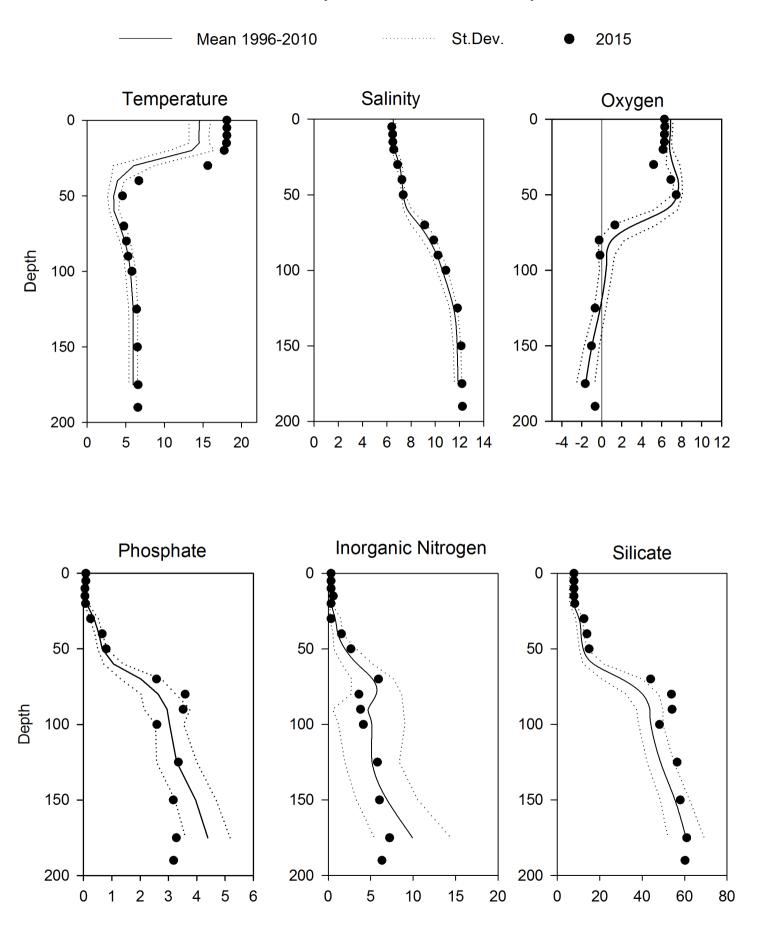




Vertical profiles BY15 September

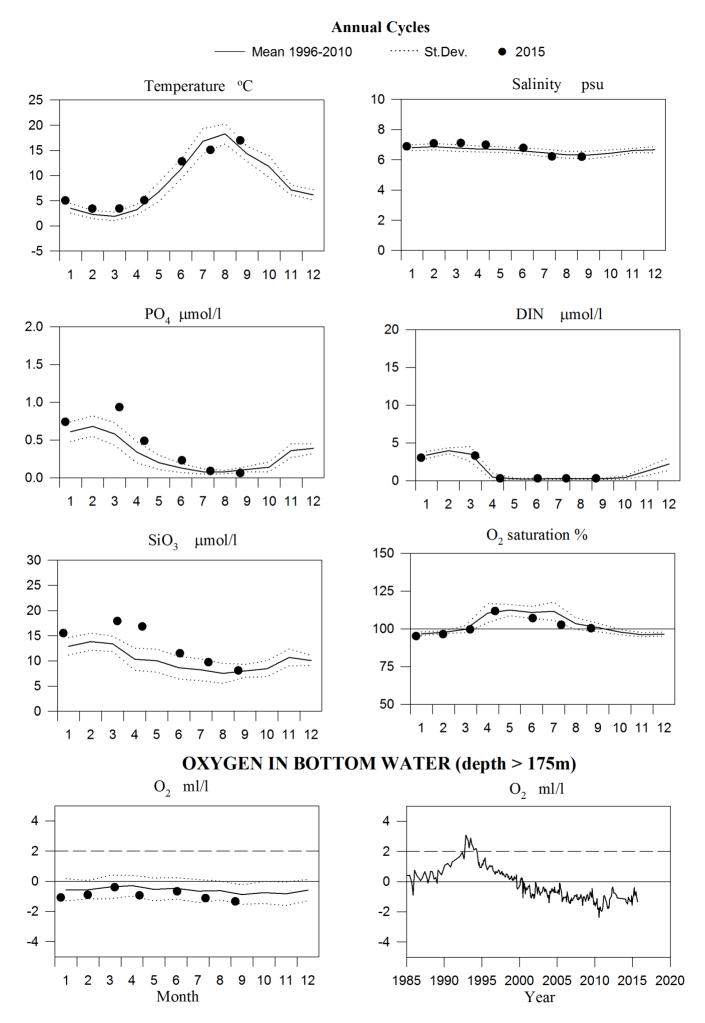
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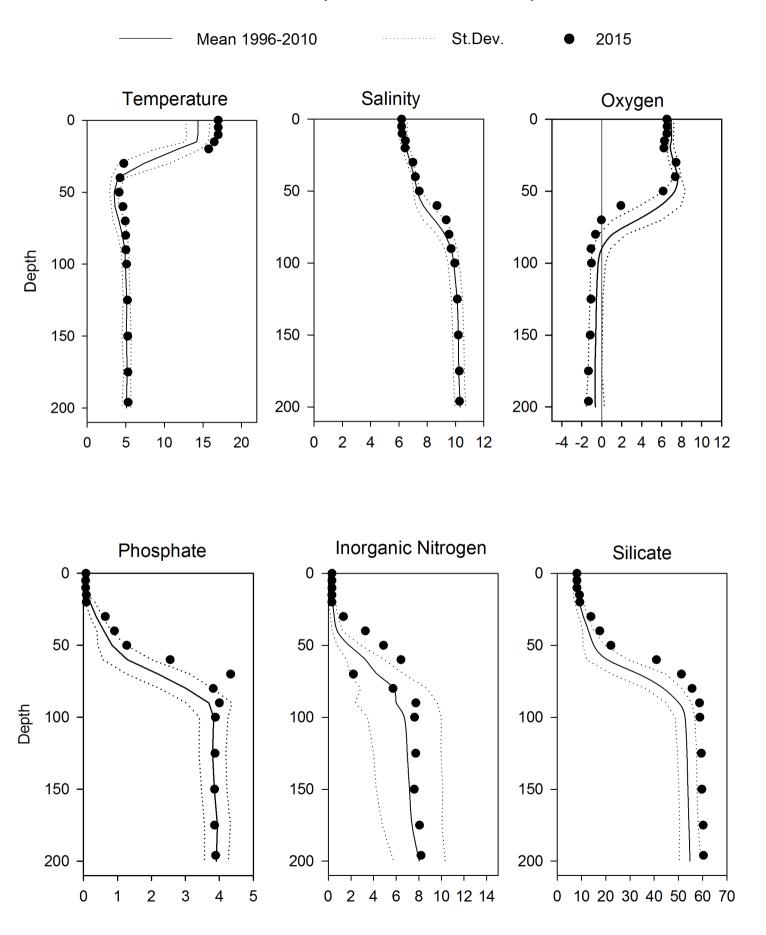




Vertical profiles BY20 September

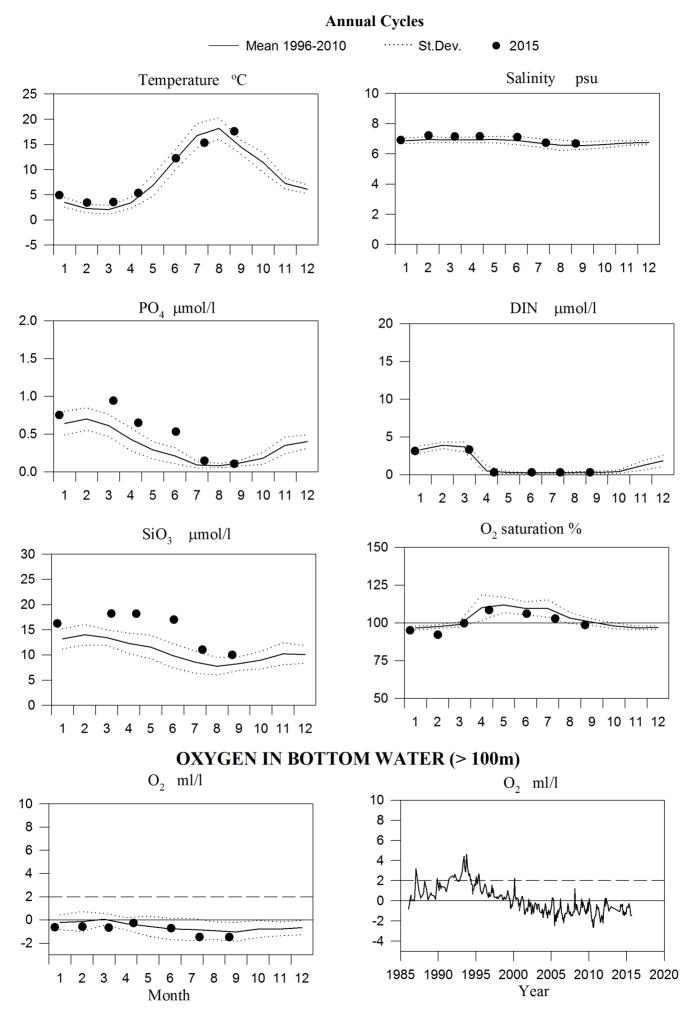
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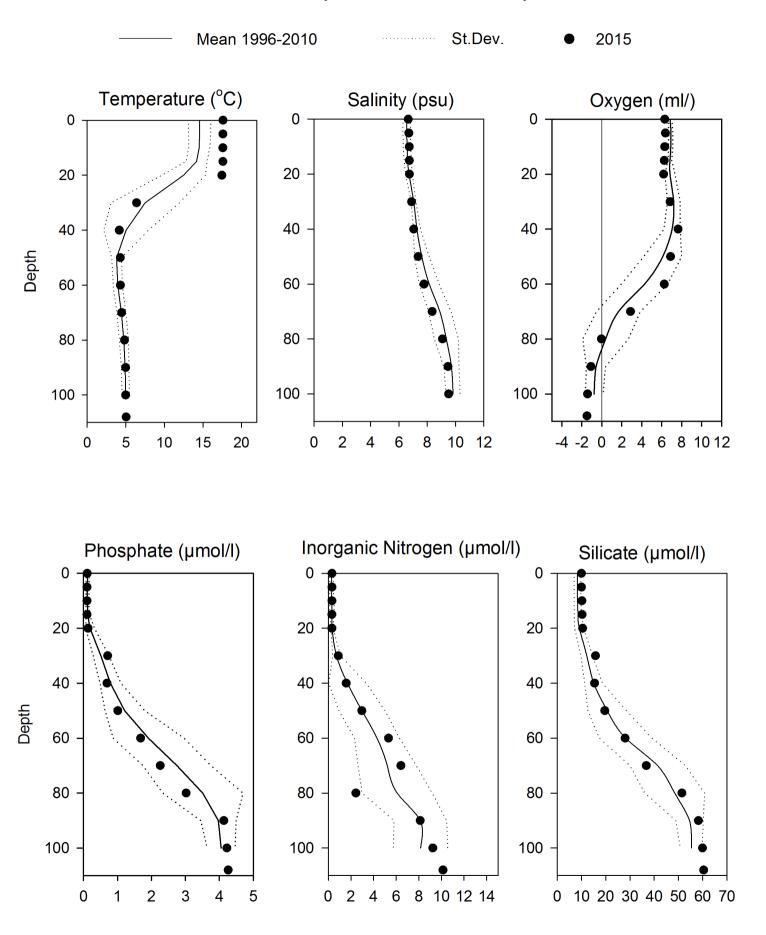




Vertical profiles BY32 September

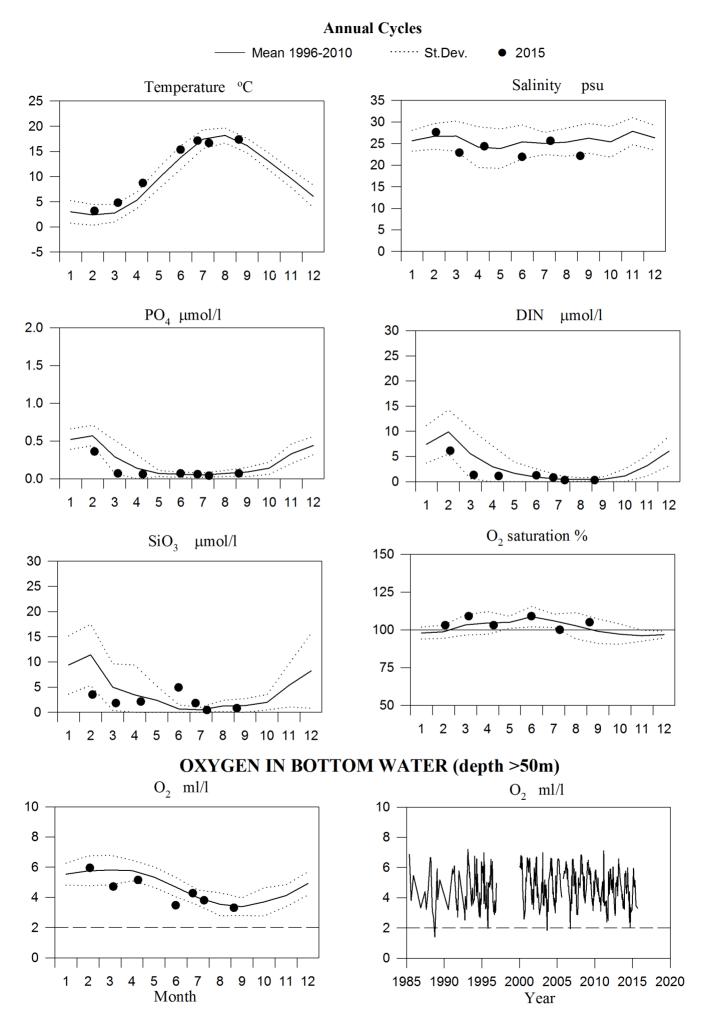
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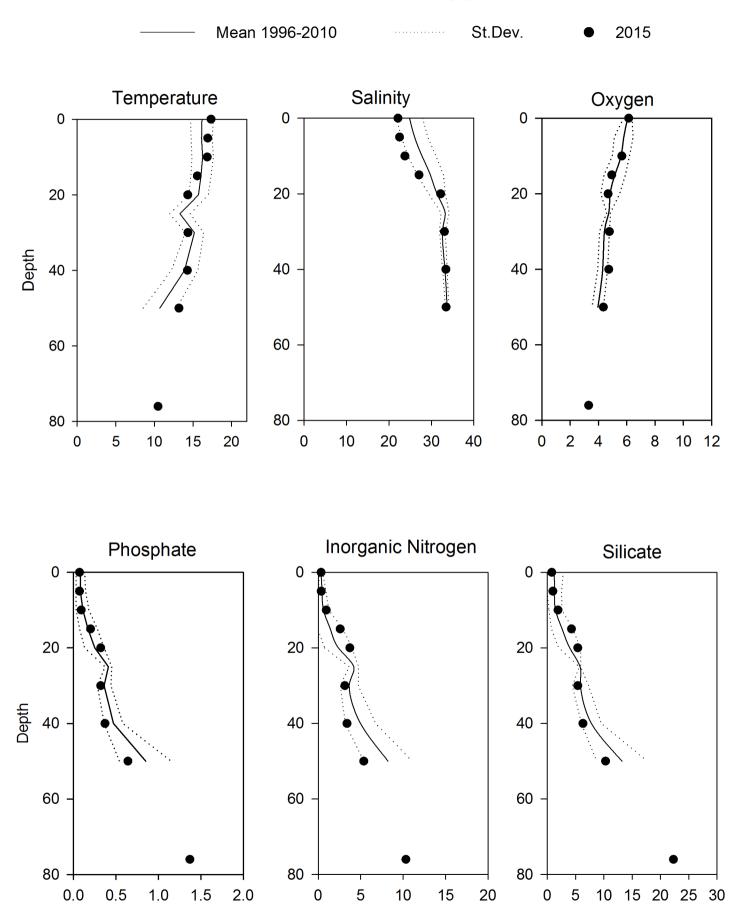




Vertical profiles BY38 September

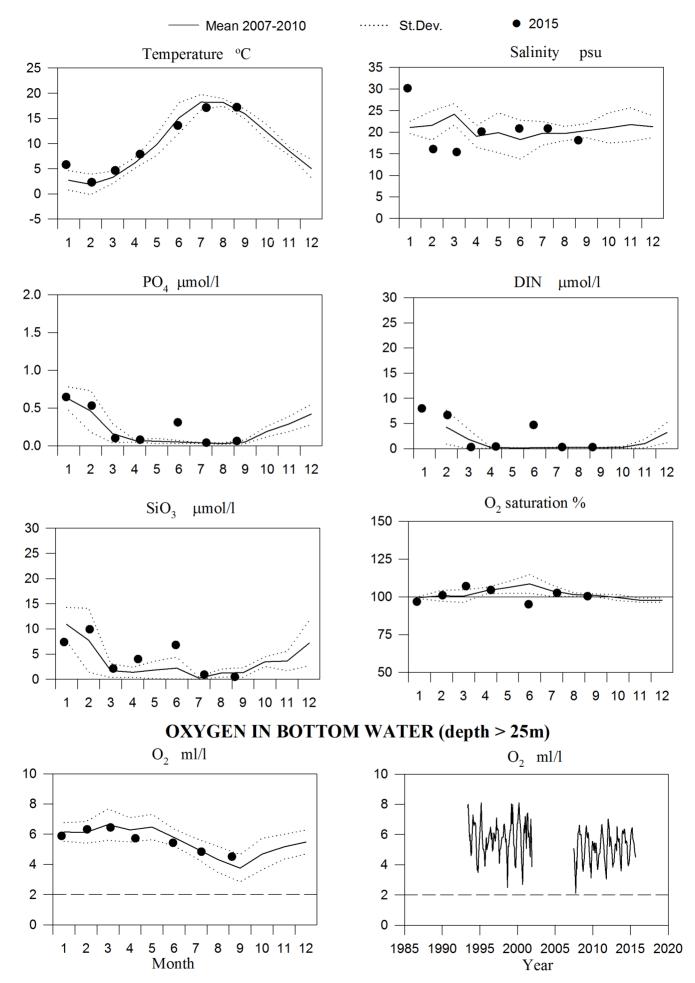
STATION SLÄGGÖ SURFACE WATER





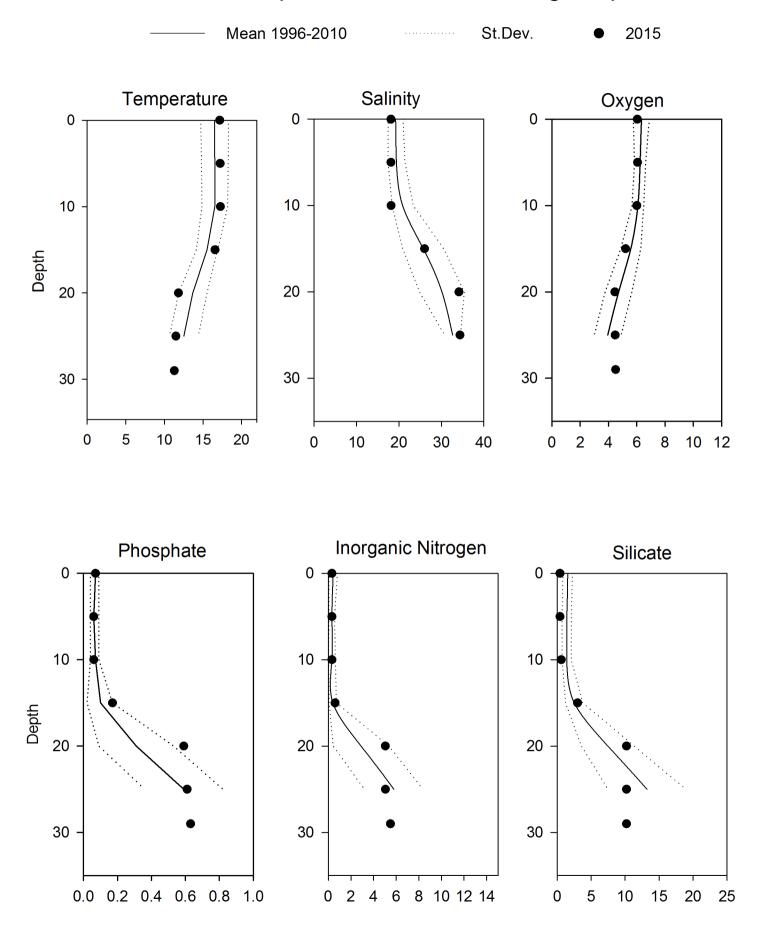
Vertical profiles Släggö September

STATION N14 Falkenberg SURFACE WATER

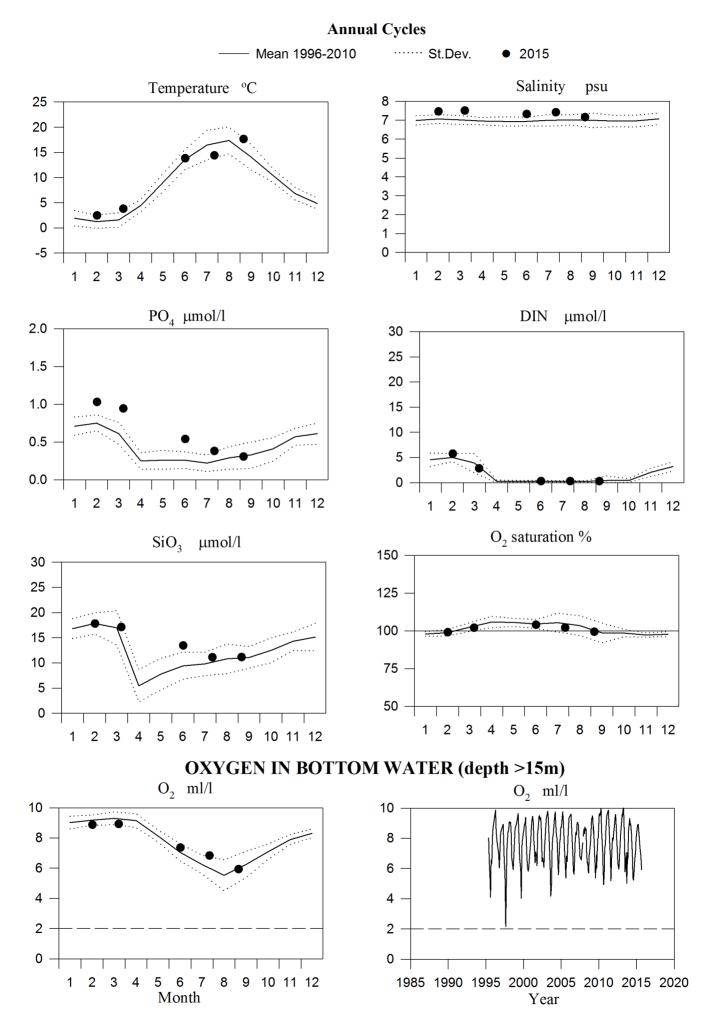


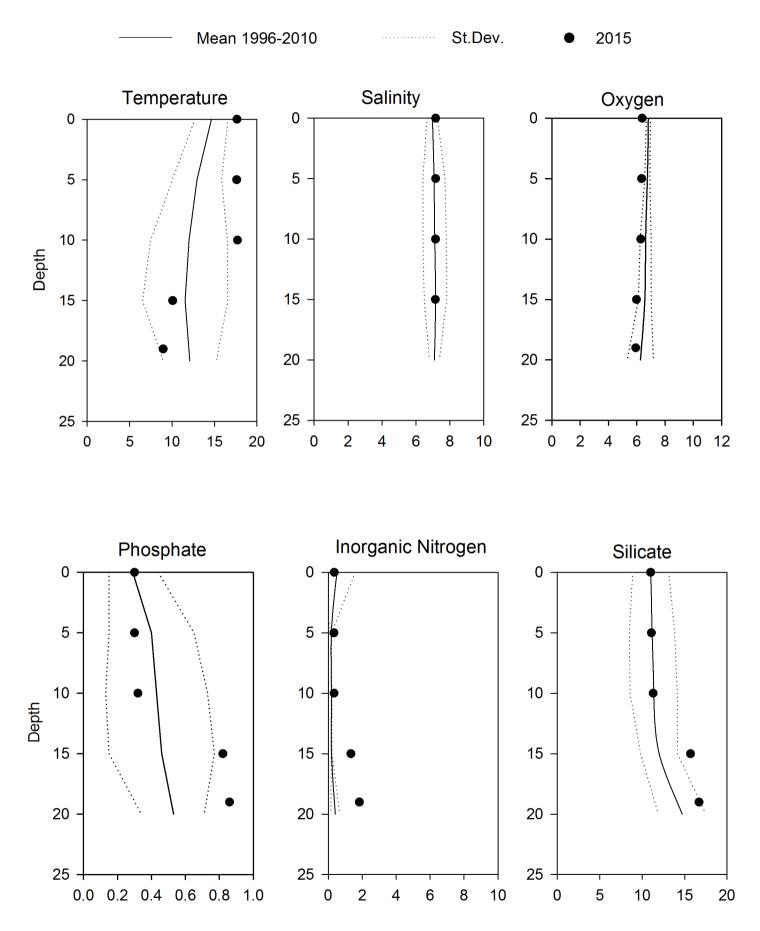
Annual Cycles

Vertical profiles N14 Falkenberg September



STATION REF M1V1 SURFACE WATER





Vertical profiles Ref M1V1 September