SMHI

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Annual report 2015

Annual Report 2015

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1. Exceptional events

- Lowest maximum ice extent since 1957 when more extensive measurements started

- Inflow of 30 km^3 to the Baltic Sea in January and a series of inflows, 10-30 km^3, during autumn

- The major inflow December 2014 improved oxygen conditions in the Eastern Gotland Basin but not in the western and northern Gotland Basins

- Elevated levels of phosphate and silicate in parts of the Baltic Proper

2. Meteorological conditions

The year 2015 ended up in third place among the warmest years in Sweden.
2014 was on average clearly warmer than 2015 and 1934 slightly warmer than 2015. The precipitation was generally above normal except from areas in southern coastal Norrland, northern Uppland and southeastern Götaland. The maximum ice extent was the lowest since 1957 when more extensive measurements started.

January was warmer and wetter than normal in virtually all of Sweden. The storm “Egon” passed over southern Sweden during the 11th to 12th of January and up to 70 000 households were without power. “Egon” was followed by a colder period but in February the mild weather continued. The spring began with a very wet and predominantly warm March. April offered a mix of warm and cold periods. In May, the spring weather was definitely off and it was windy, chilly and very wet. As a whole, the spring was wetter than normal in most parts of the country. It was also warmer than normal, despite the chilly ending in May. The summer began with a chilly, and in many places also rainy, June. During the first week of July the summer heat finally arrived. The warmer weather did not last long and a greater part of July was dominated by cool, unstable weather. August was the warmest and driest month during the summer period. The summer as a whole was fairly normal in terms of both temperature and precipitation. In early September, Sweden was affected by several very heavy rainfalls and it was very warm, especially in the north. October was drier than normal and November was warmer than normal throughout Sweden. Two named storms passed during November, “Freja” 8th November and “Gorm” 29th to 30th of November. The predominantly mild weather continued in December and this month contributed on many places to the high average annual temperature.

The ice season 2014/2015

The ice season 2014/2015 was mild with a maximum ice extent of 45 000 km^2 reached as early as on 24th of January. Because of the unusual high sea surface temperatures, the ice did not began to form until the days before Christmas. In early January it went colder and the Bothnian Bay was almost completely ice covered on 24th of January. The area was ice-free on the 10th of May, which is three weeks earlier than usual.

3. Hydrographic conditions

Sea water levels

The year began with high water levels caused by the largest inflow to the Baltic Sea in 20 years. Associated with the storm “Egon” in January, extremely high water levels along the west coast were observed which was followed by a spring and summer with water levels around the mean value. Towards the end of the year, the water level rose above normal because of the low pressure weather. In late November, the storm “Gorm” delivered extremely high water levels in the southern Kattegat and a record high water level of +230 cm was recorded in Halmstad. The highest water level measured by SMHI was +154 cm in Viken and the lowest was -111 cm Skanör.

Inflows to the Baltic

The inflows to the Baltic Sea during 2015 summed up to 331 km^3 and the summed outflow was 670 km^3. The average for inflows and outflows during the period 1977-2014 is 325 km^3 respectively 641 km^3. Both inflows and outflows during 2015 were thus slightly larger than normal. The large inflow in December 2014 was followed by an inflow of 30 km^3 in January 2015 caused by the storm “Egon”. During the period February to June winds were relatively weak due to high pressure weather and no larger inflows occurred. A minor inflow in early July and also in late August/early September pushed another 10-20 km^3 through the Sound. From September to December about ten minor inflows, of short duration, of 10-30 km^3 each entered through the Sound.

a. Skagerrak, Kattegat and the Sound

Sea surface temperatures and salinities in Skagerrak and Kattegat were about normal for most of the year, except for some occasions. In January, the sea temperature was above normal and these high temperatures were also associated with high salinities and the storm “Egon”. The surface salinity in August was below normal and could be linked to an outflow of Baltic water. The year ended with warmer surface water than usual and also salinities were higher due to stormy weather.

All nutrients showed normal concentrations throughout the year. Nutrients decreased substantially between the cruises in February and March which indicates that the spring bloom occurred between these occasions. The nutrients had again increased in October/November. The lowest oxygen concentration in the bottom water was measured in September, at the station W Landskrona, in the Sound, 2.66 ml/l. In the open Skagerrak there is normally no shortage of oxygen in the deep water.

The spring bloom was ongoing in the middle of February in both Skagerrak and Kattegat with many species of diatoms in large quantities. In April and May, different organisms from the group Prymnesiales were observed. Several species within the group are potentially harmful for fish and other organisms. In June, there was a bloom dominated by the diatoms *Skeletonema marinoi* and *Phaeodactylum tricornutum*. *P. tricornutum* is a very tolerate species that for examples thrive in rock pools. At the end of the year, there was a bloom of the potentially toxic diatom *Pseudo-nitszchia* spp.. *Pseudo-nitszchia* spp. can produce AST (Amnesic Shellfish Toxin) which, when it accumulates in filtering blue mussels, makes them poisonous to consume. AST was observed for the first time in Swedish blue mussels during spring 2014 and the toxin was found again during spring 2015.

b. Baltic Proper

Sea surface water temperatures in the Baltic proper were slightly above normal throughout the year, except from July when it was slightly colder than normal. Salinity in the surface layer was normal to slightly above normal, except in the northern parts of the Eastern Gotland Basin where it was below mean for parts of the year. In January and December, surface salinities in the southeastern area were higher due to stormy weather and inflows.

The concentrations of inorganic nitrogen were at typical levels throughout the year in the whole area. In the Arkona- and Bornholm Basins, Hanö Bight as well as in the southeastern parts of the Baltic Proper, phosphate and silicate showed well above normal levels the whole year and particularly during the summer months. In November and December, however, silicate was well below normal in the southwestern parts probably due to inflowing water from Kattegat. In the Eastern-, Western- and Northern Gotland Basins silicate and phosphate also showed enhanced values but mainly during the first half of the year.

In December 2014, the storm Alexander passed over the Baltic region and caused a major Baltic inflow event. A total of approximately 200 km^3, including the Belts, is estimated to have entered the Baltic Sea. Another inflow of 30 km^3 entered through the Sound in January 2015. These inflows were thought to improve the oxygen situation in the Baltic Sea considerably, even though the water was slightly warmer than normal for the season, and then also less oxygen-rich. The salinity of the inflowing water was also slightly lower than during the inflow in winter 1993. The inflow has been followed on its way through the Baltic deep basins. In March, oxygenated water had reached the Gotland Deep even though it was still a layer of hydrogen sulphide above it. In April, the maximum concentration of oxygen at the Gotland Deep was measured; 2.61 ml/l at 220 m. During summer, the intermediate layer of hydrogen sulphide at the Gotland Deep was oxygenated and its position moved upwards. In October, the whole water column at the Gotland Deep was oxygenated and no hydrogen sulphide was observed. As the anoxic water is oxygenized, ammonia, phosphate and silicate decreases and nitrate plus nitrite increases. However, oxygen concentrations in the Eastern Gotland Basin slowly decreased for the rest of the year and in January 2016 hydrogen sulphide was again present nearest the bottom. The effect of the inflow could be seen in the northern parts of the Eastern Gotland Basin, at the station Fårö Deep, in terms of less hydrogen sulphide in the bottom water. The oxygen situation in the Northern- and Western Gotland basins did not improve during the year. In December 2015, hypoxia was found from ~65 meters depth and anoxia from ~75 meters depth in the Western Gotland basin. However, both temperature and salinity increased in the Northern- and Western Gotland Basin deep water, which indicates that the effect of the inflow has reached also these parts as the inflowing water pushes older water in front of it.

The reason why the inflow did not reach further than it did might be the high temperature and low salinity of the inflowing water. The storm “Egon” also mixed the inflowing water in the Arkona Basin which then was lifted up closer to the surface. After the storm, much of this water ran out from the Baltic again.

Preliminary results for 2015, after the autumn oxygen survey, showed that anoxic conditions affected around 16% of the bottom areas in the Baltic Proper, including the Gulf of Finland and the Gulf of Riga and approximately 29% suffer from hypoxia.

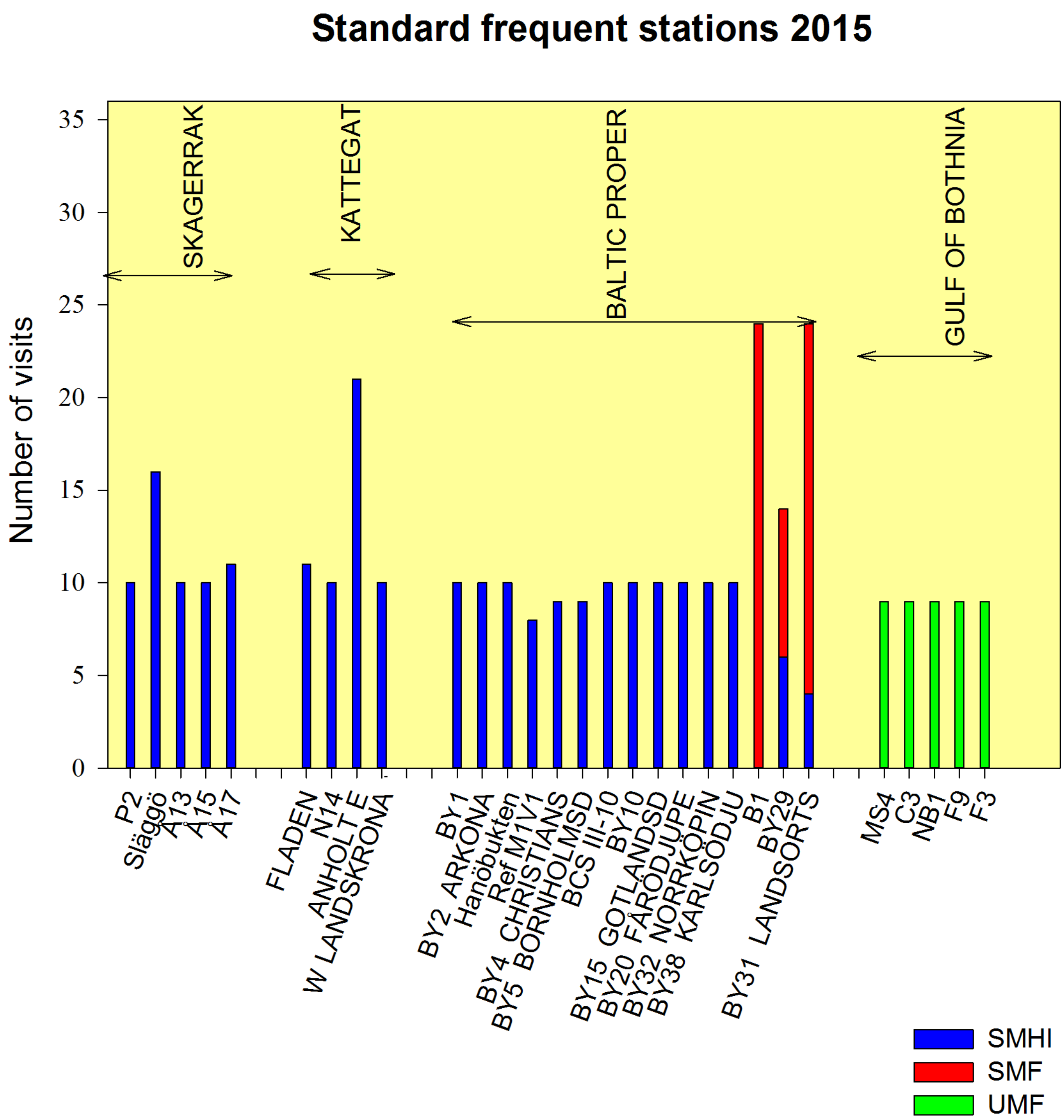
In the Arkona basin the spring bloom occurred during the beginning of March. In the Bornholm basin and further north and east, the bloom started later which is normal for these areas. In June, the cyanobacteria *Aphanizomenon flos-aquae* and the potentially toxic dinoflagellate *Dinophysis norvegica* dominated. A minor autumn bloom was observed at most stations, with consequently high chlorophyll concentrations, and phytoplankton samples dominated by diatoms and colonies of small cyanobacteria.

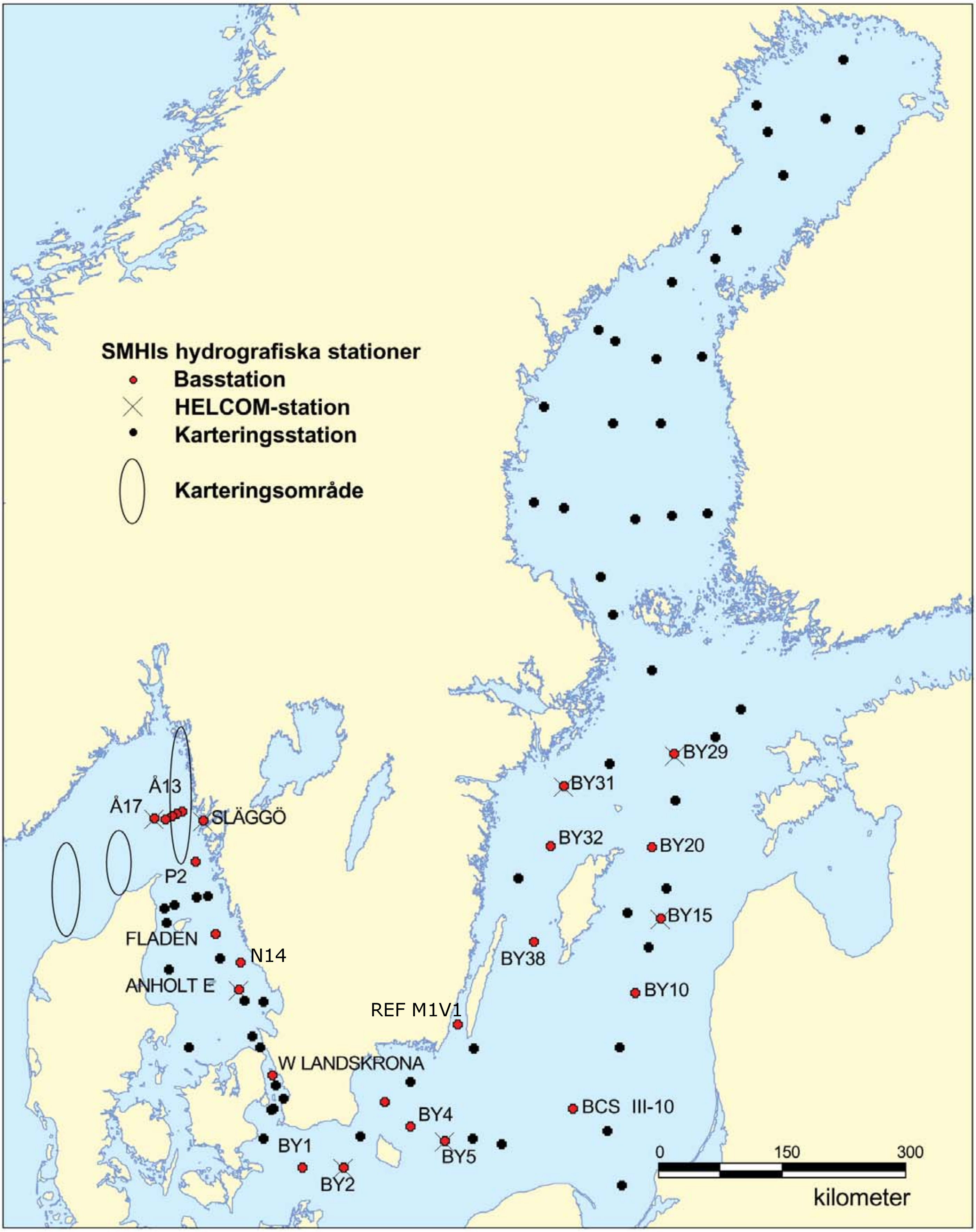
Cyanobacteria

In 2015, surface blooms of cyanobacteria were observed uninterruptedly for four weeks, from 31st of July to 25th of August. The major bloom started unusually late but still had an average spatial extent. The Northern Baltic Proper was the most affected sea area by intensive blooms. In all, this year's bloom was about average in comparison with previous years, with the three indices of normalized duration, extent, and intensity on medium levels.

Both June and July were unusually cold, except for the first week of July. In this week surface blooms formed along the eastern side of the Eastern Gotland Basin. However, as the cold and windy weather returned, the major bloom did not start until the very last day of July. The blooms increased in the first two weeks of August to reach its peak on the 14th of August, when about 125 000 km^2 of cyanobacteria blooms were recorded from satellite data. This date also marked the start of the bloom in the Bothnian Sea, where cyanobacteria usually bloom in August-September. The blooms in the first half of August were observed in most parts of the Baltic Proper, when the blooms declined in the latter part of the month they were centered towards the northern Baltic Proper and the southern half of the Bothnian Sea. The last signs of blooms in the Baltic Proper were on 28th of August whereas the bloom in the Bothnian Sea lasted until the 4th of September.

Number of visits at standard frequent stations

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Basstation
HELCOM-station
Karteringsstation
Karteringsområde
Å13
Å17
SLÄGGÖ
P2
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N14
ANHOLT E
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REF M1V1
BY1
BY2
BY4
BY5
BCS III-10
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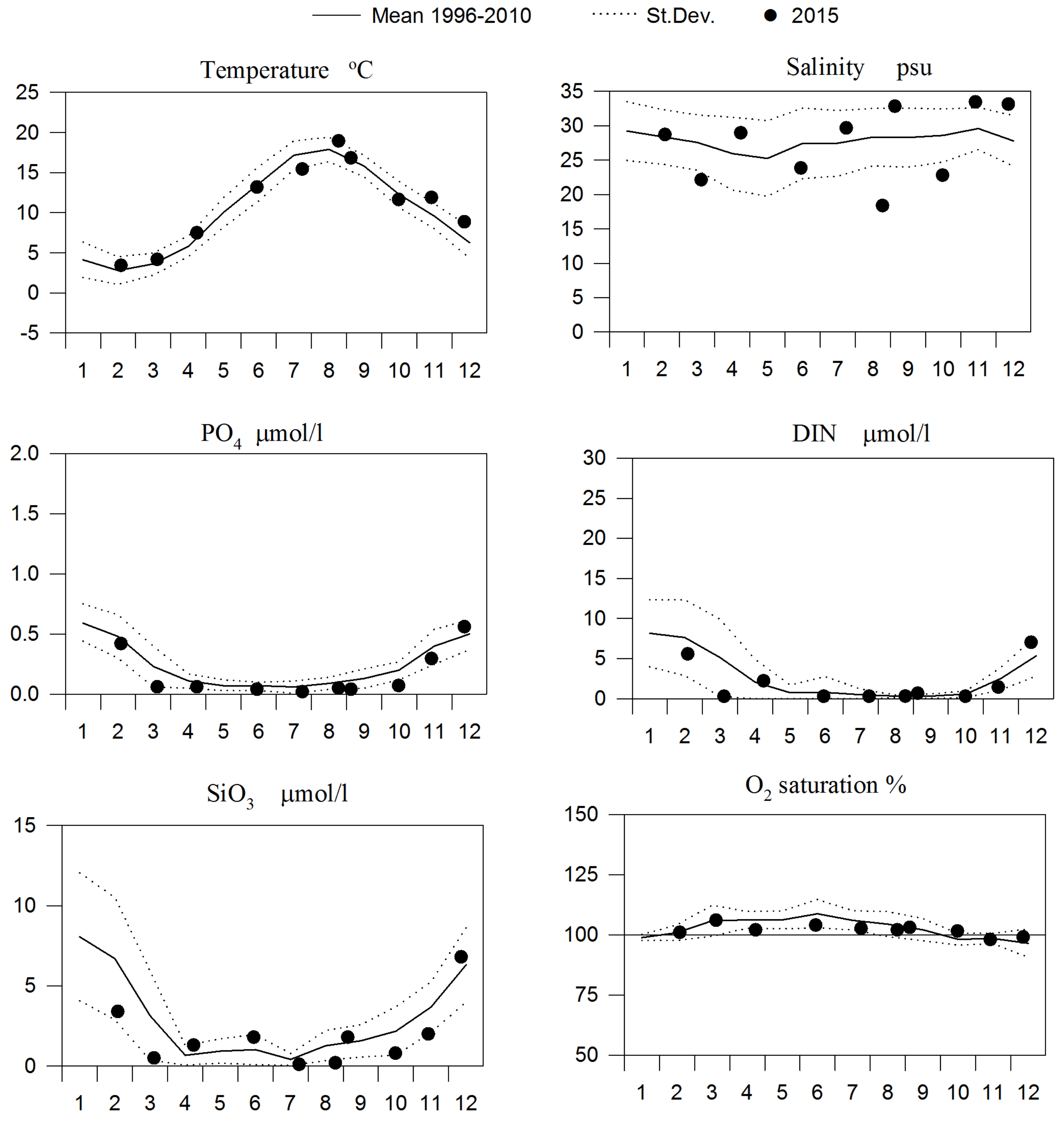
0
150
300
kilometer

STATION P2 SURFACE WATER

Annual Cycles



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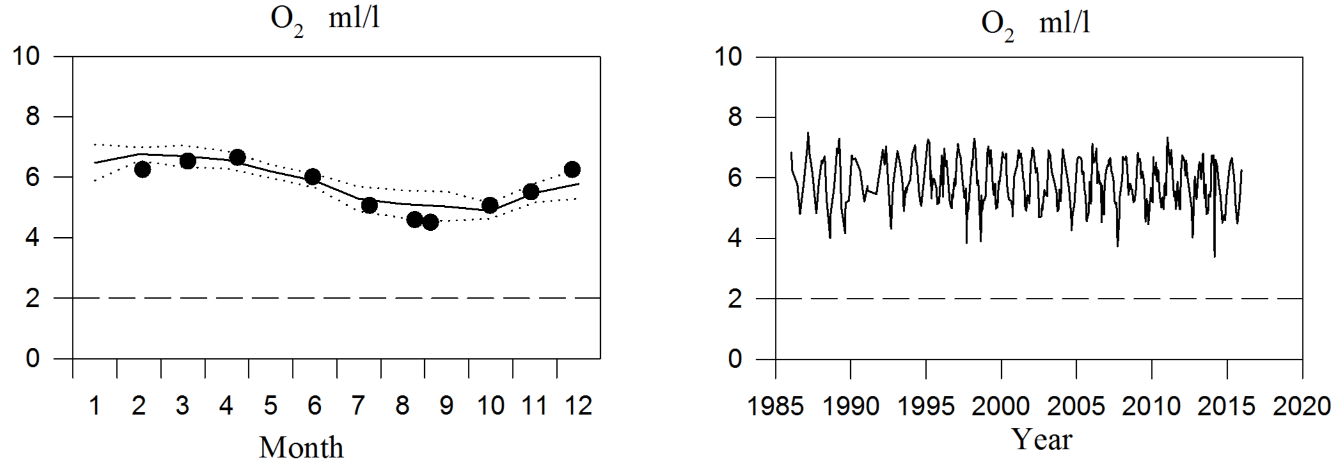
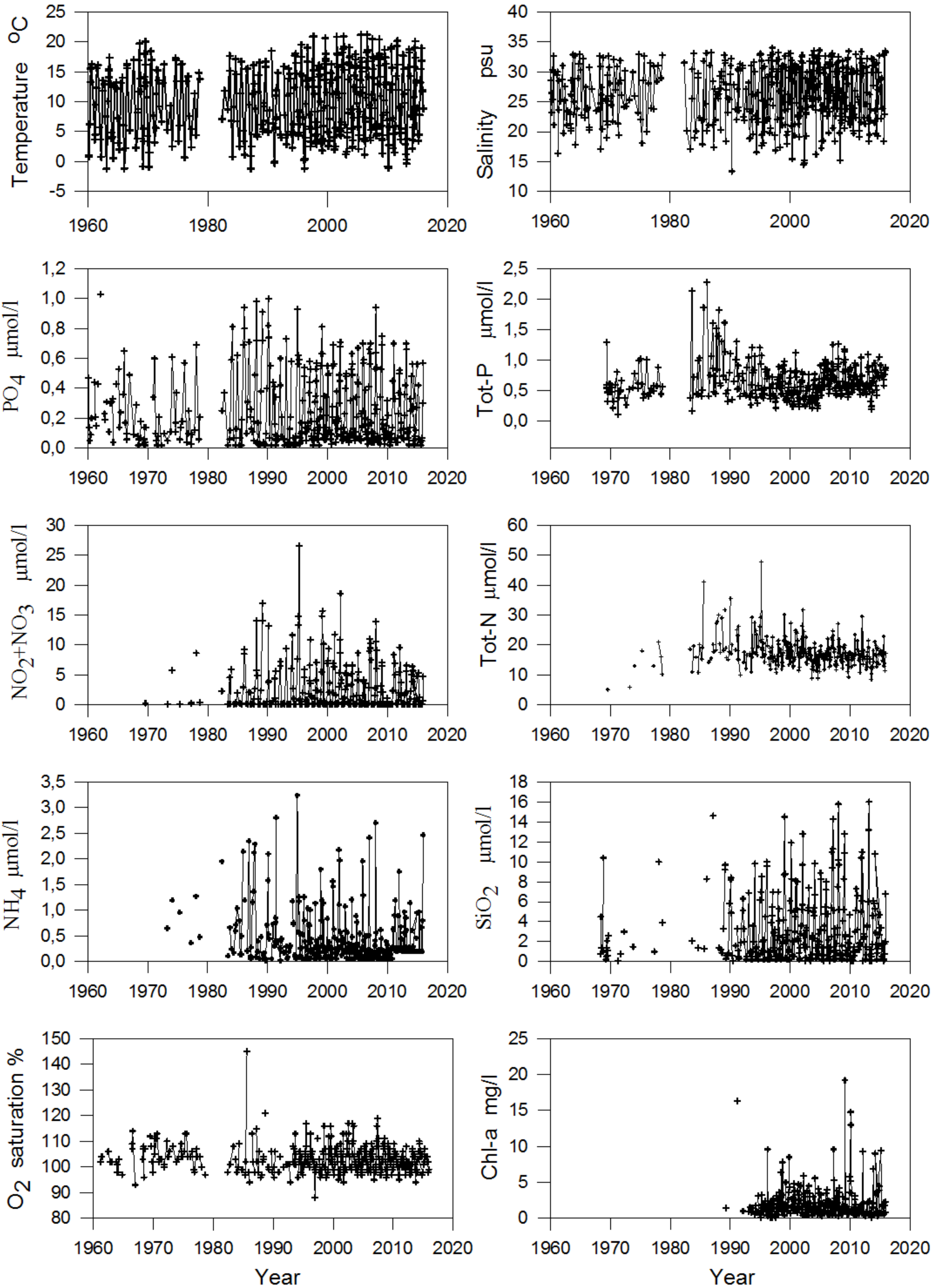
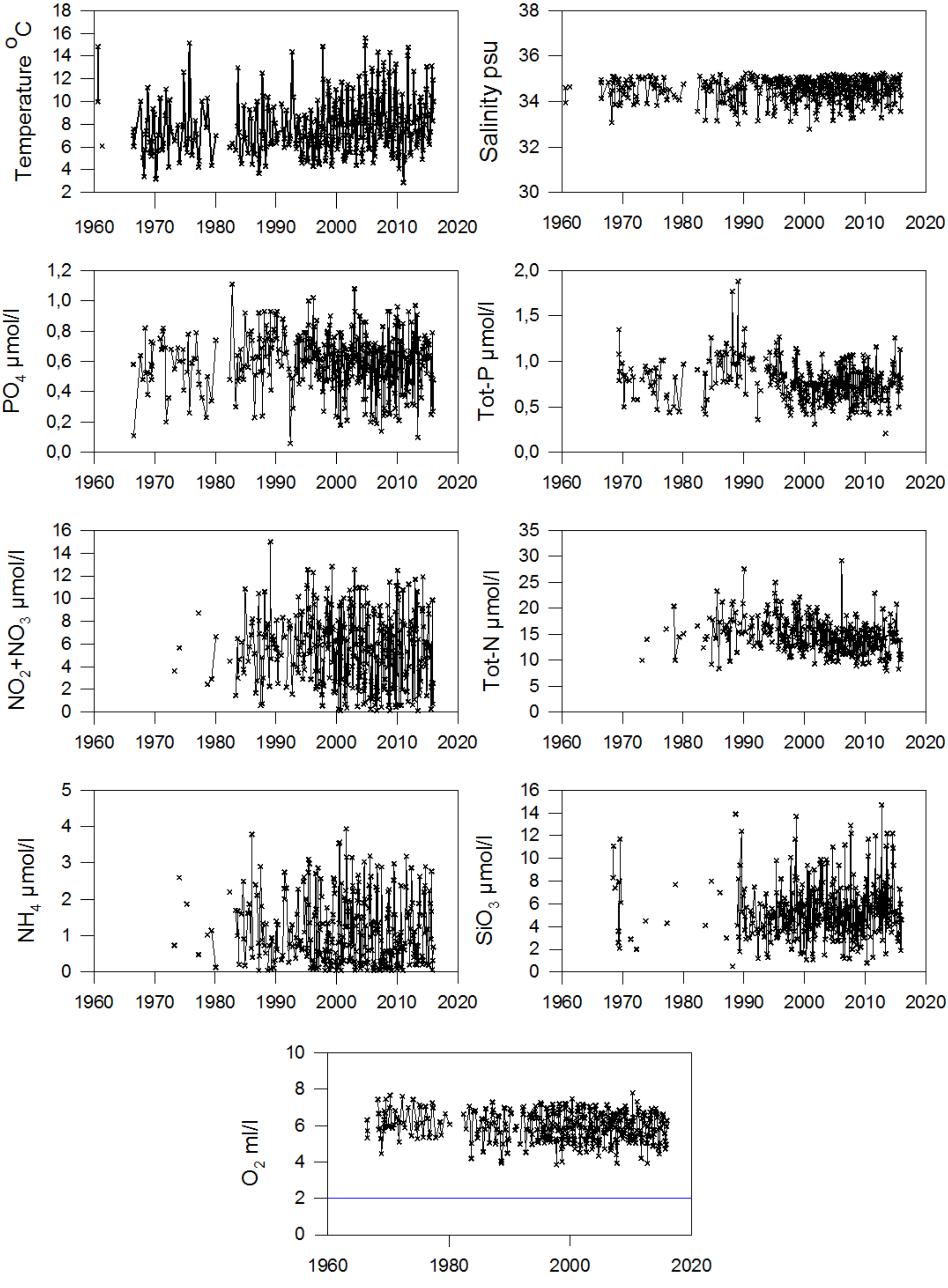


STATION P2 SURFACE WATER

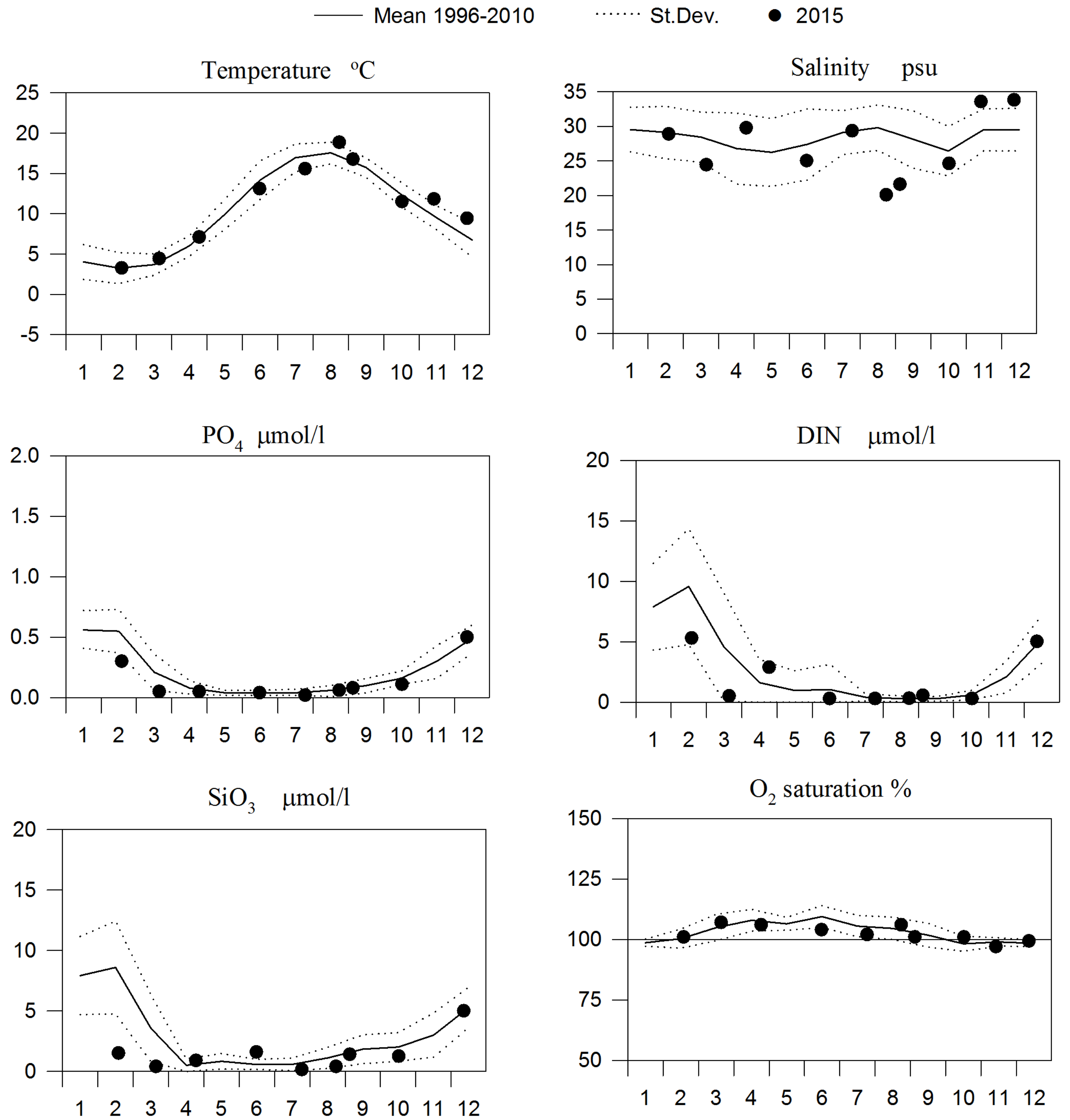


STATION P2 DEEP WATER (75m)



STATION Å13 SURFACE WATER

Annual Cycles



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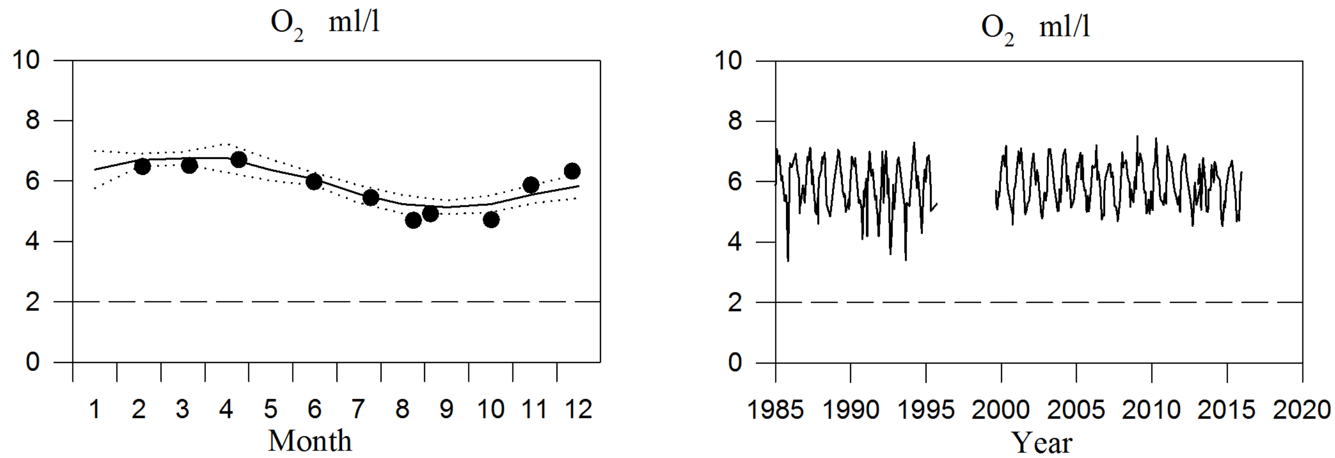

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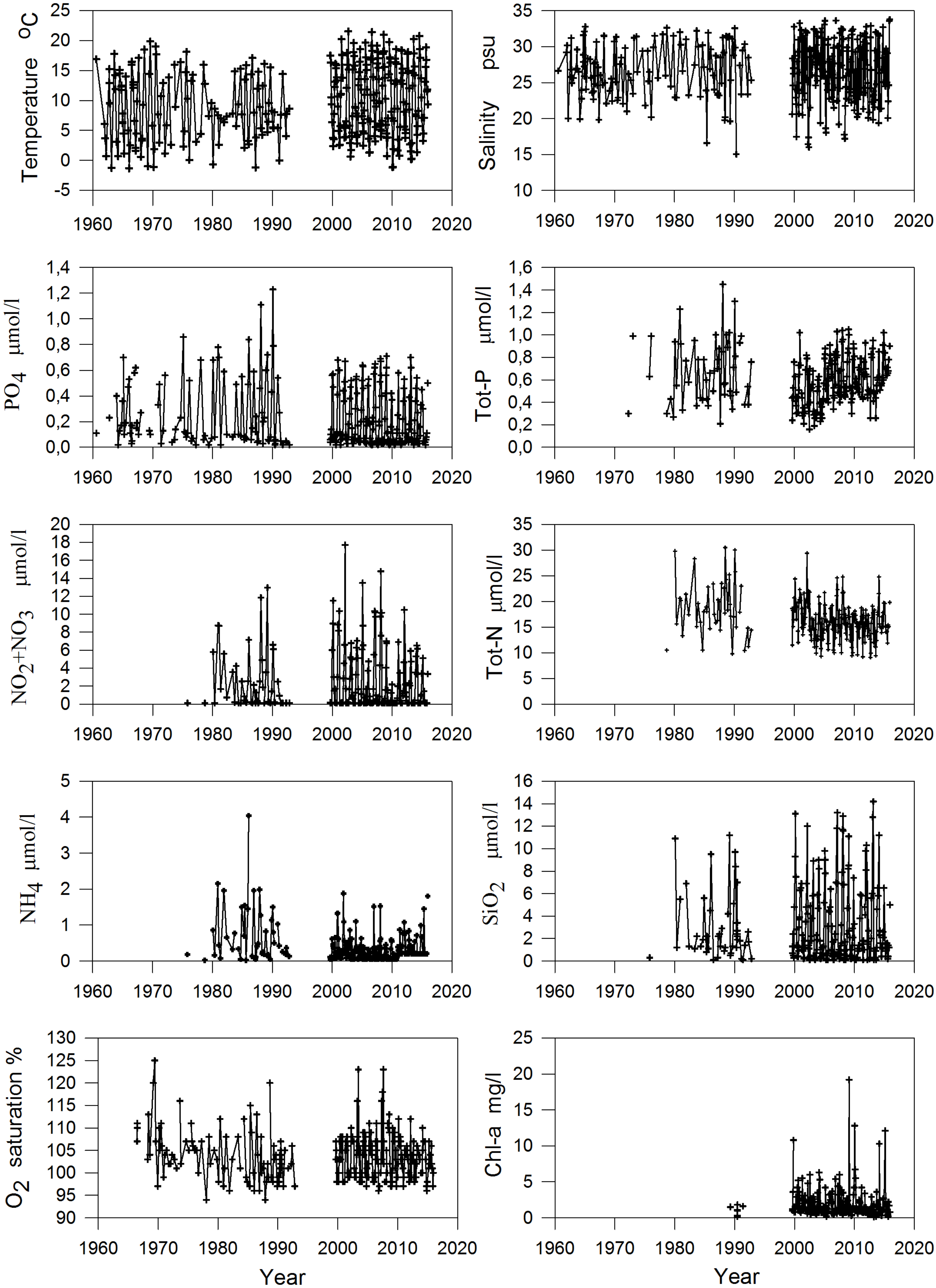
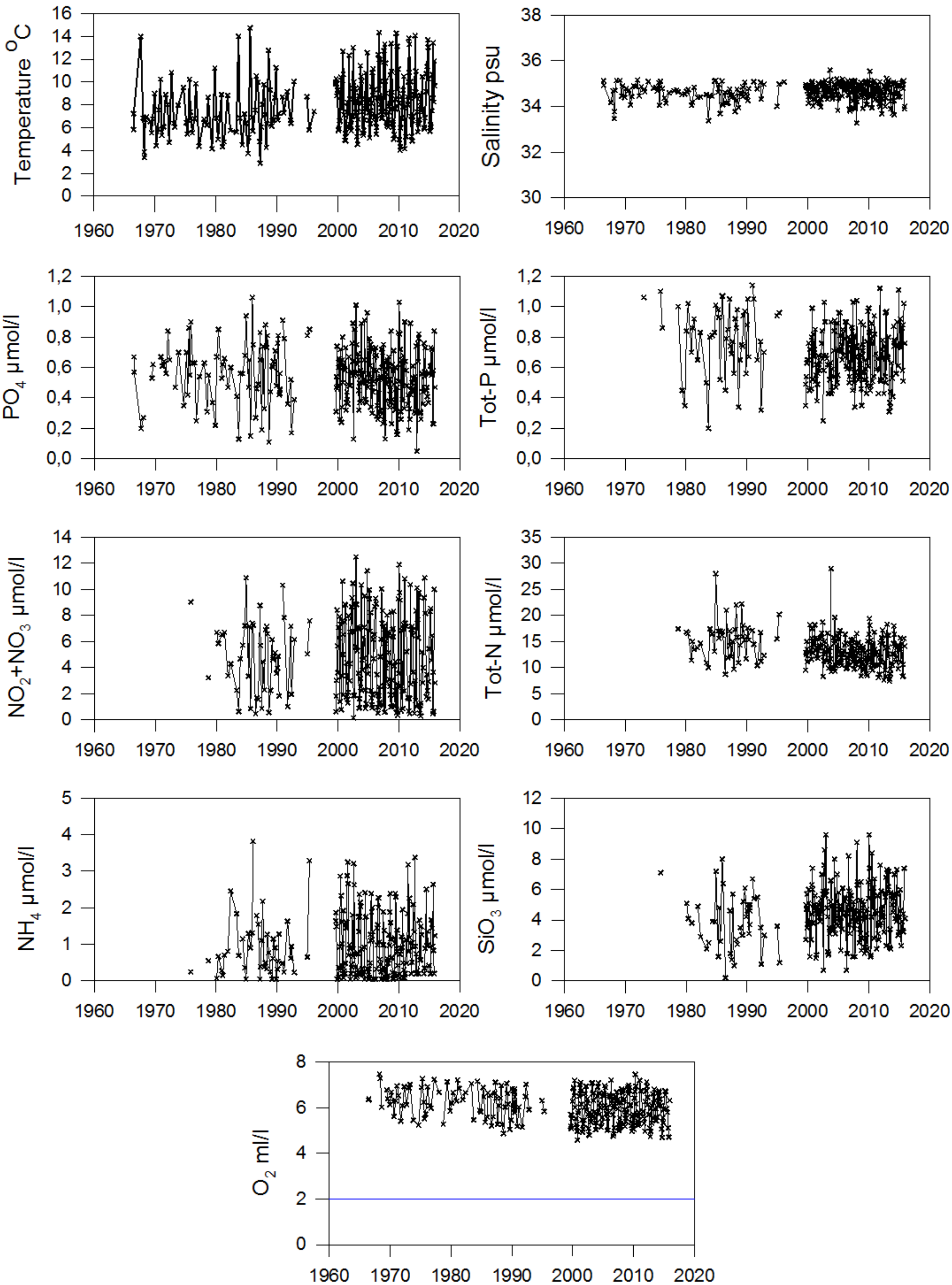
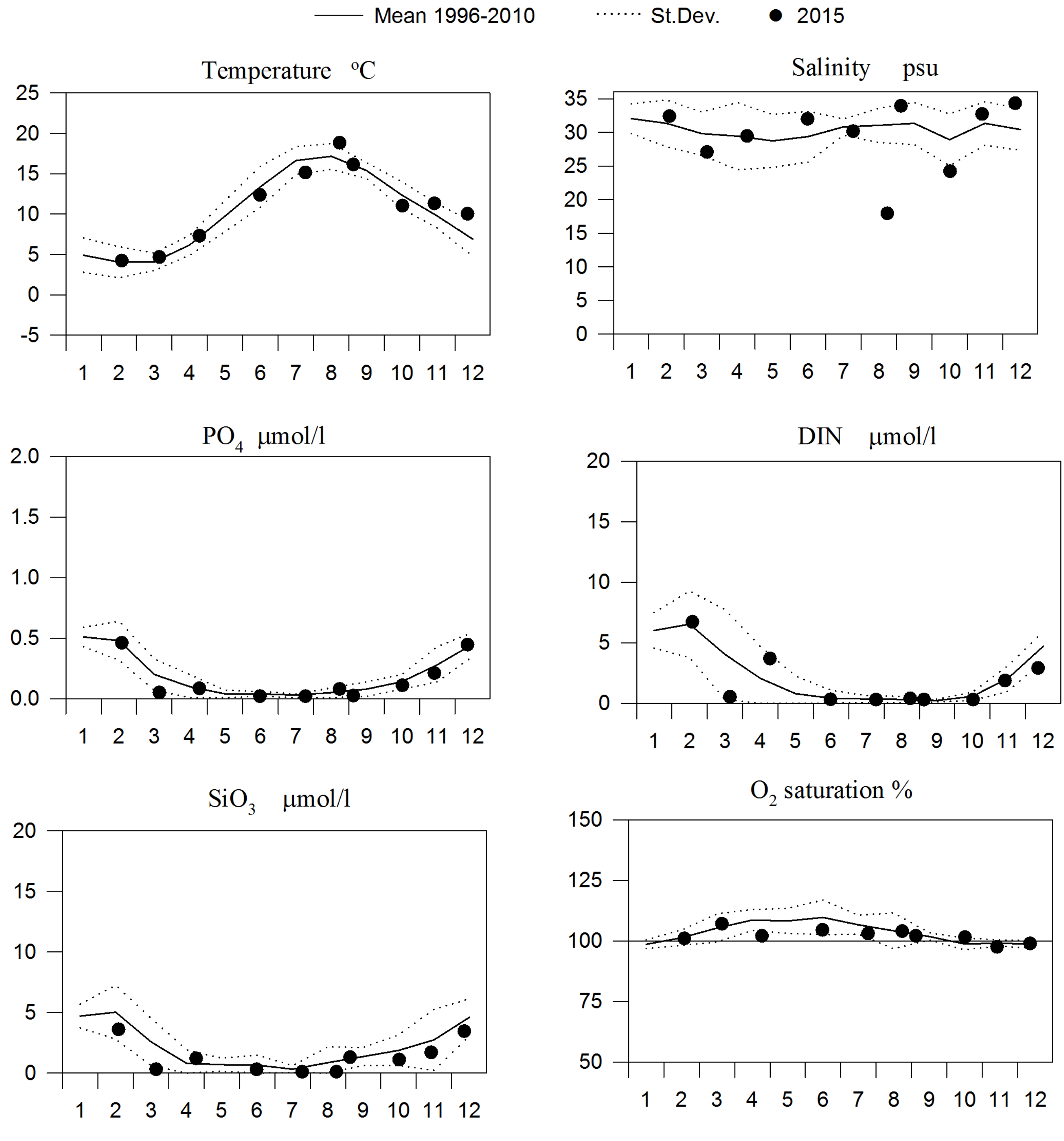


STATION Å13 DEEP WATER (75m)



STATION Å15 SURFACE WATER

Annual Cycles



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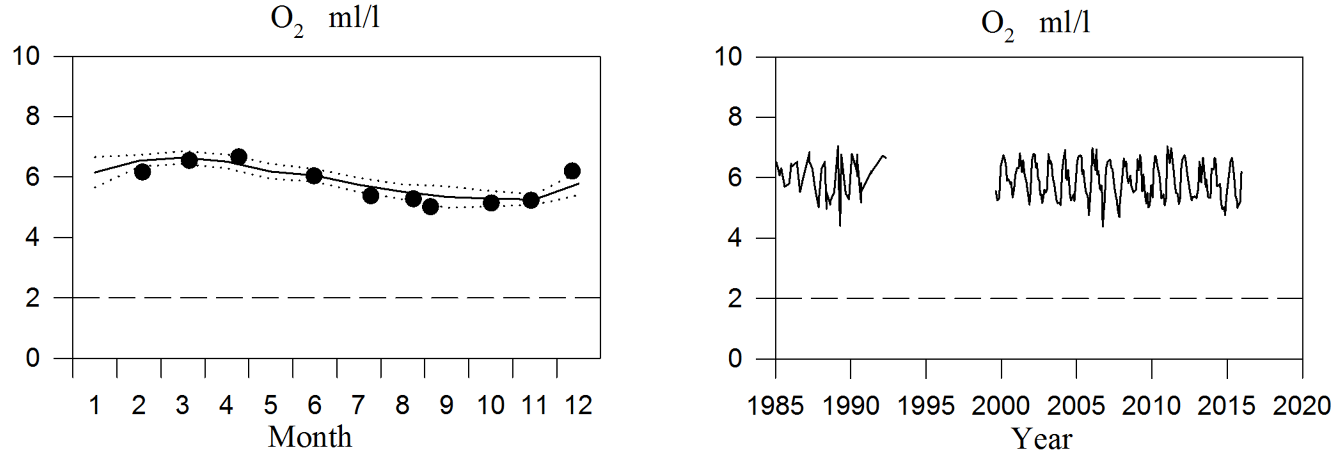

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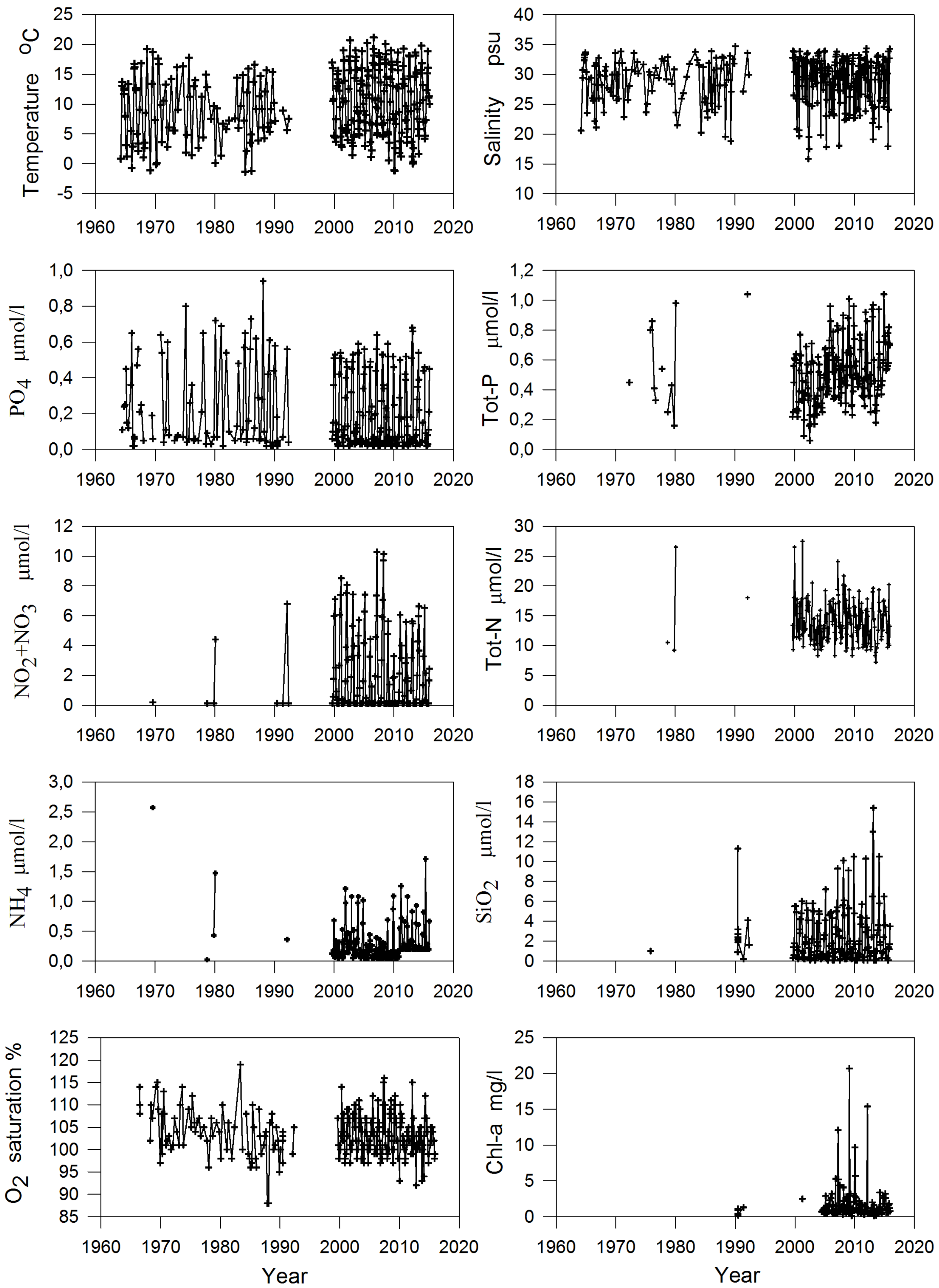
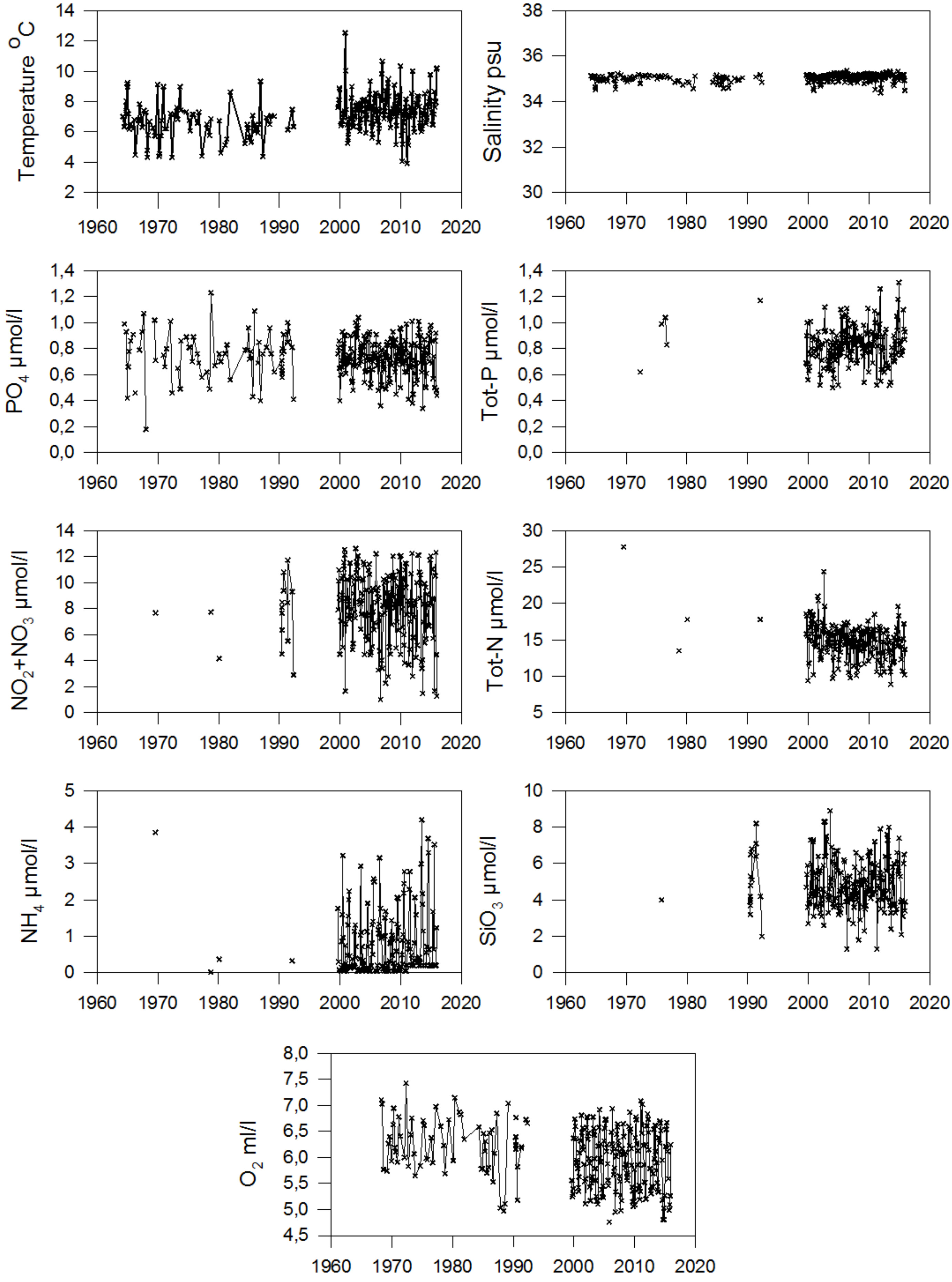


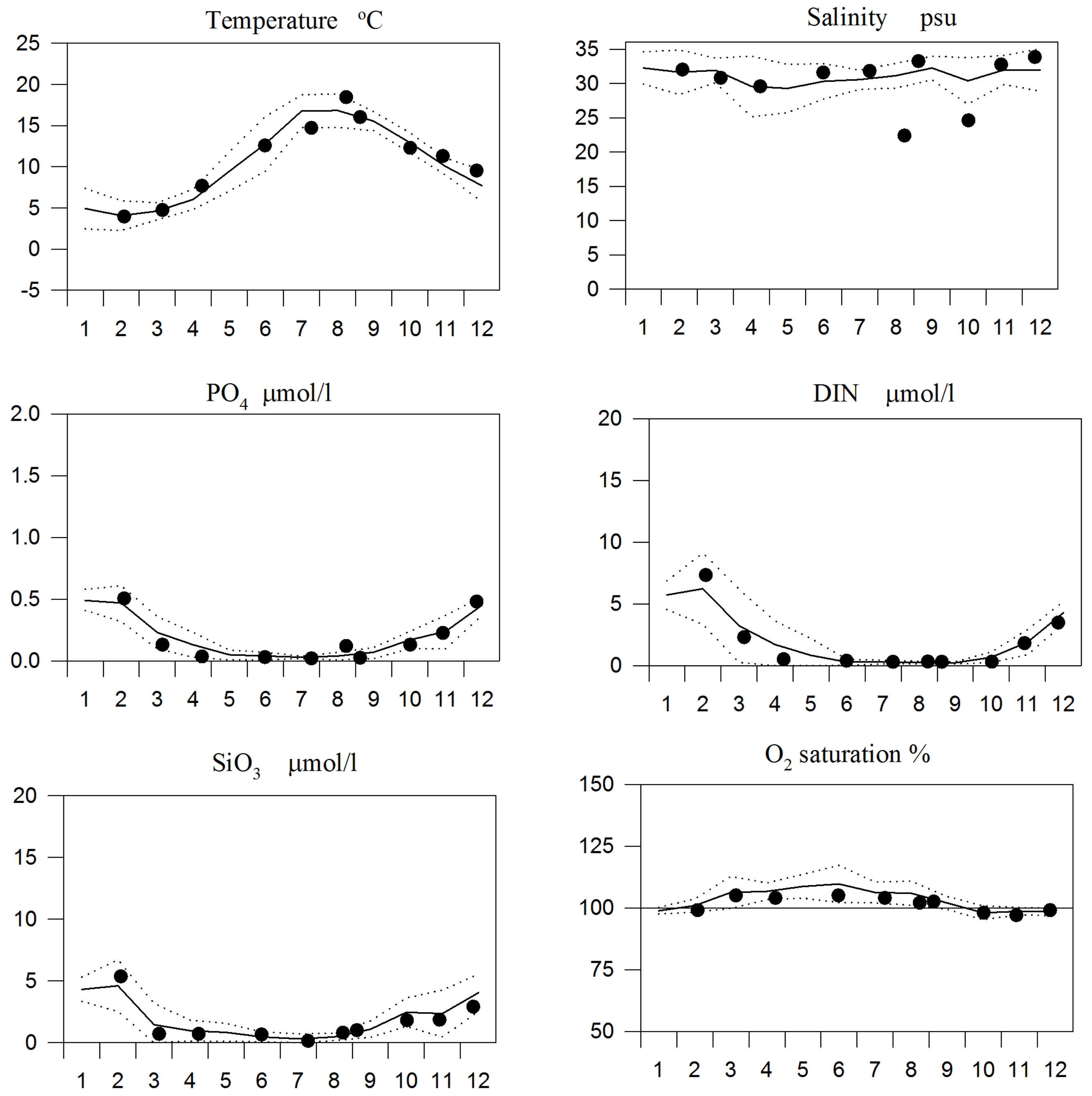
STATION Å15 DEEP WATER (125m)



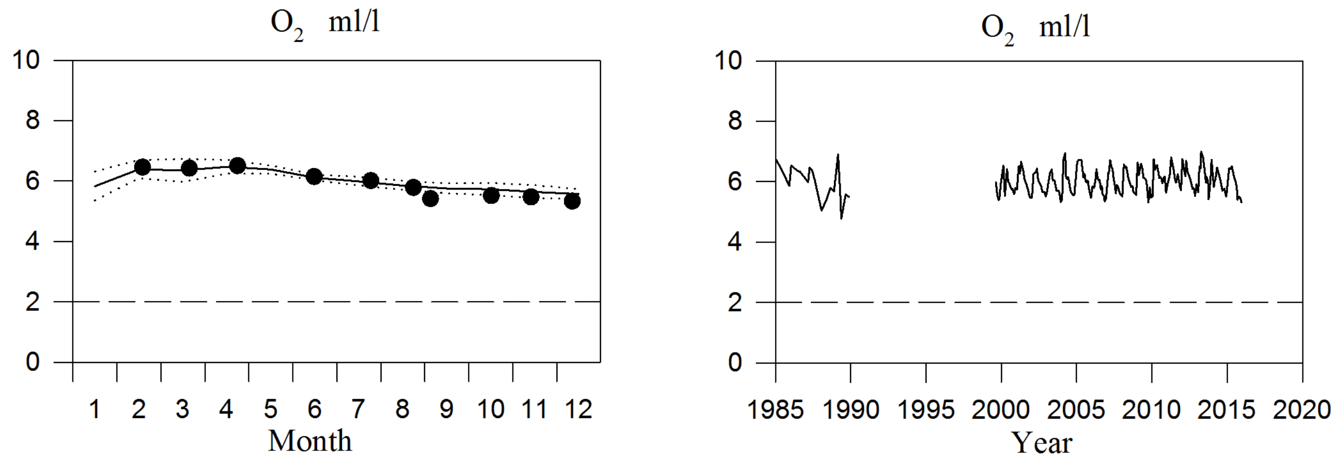
STATION Å17 SURFACE WATER

Annual Cycles

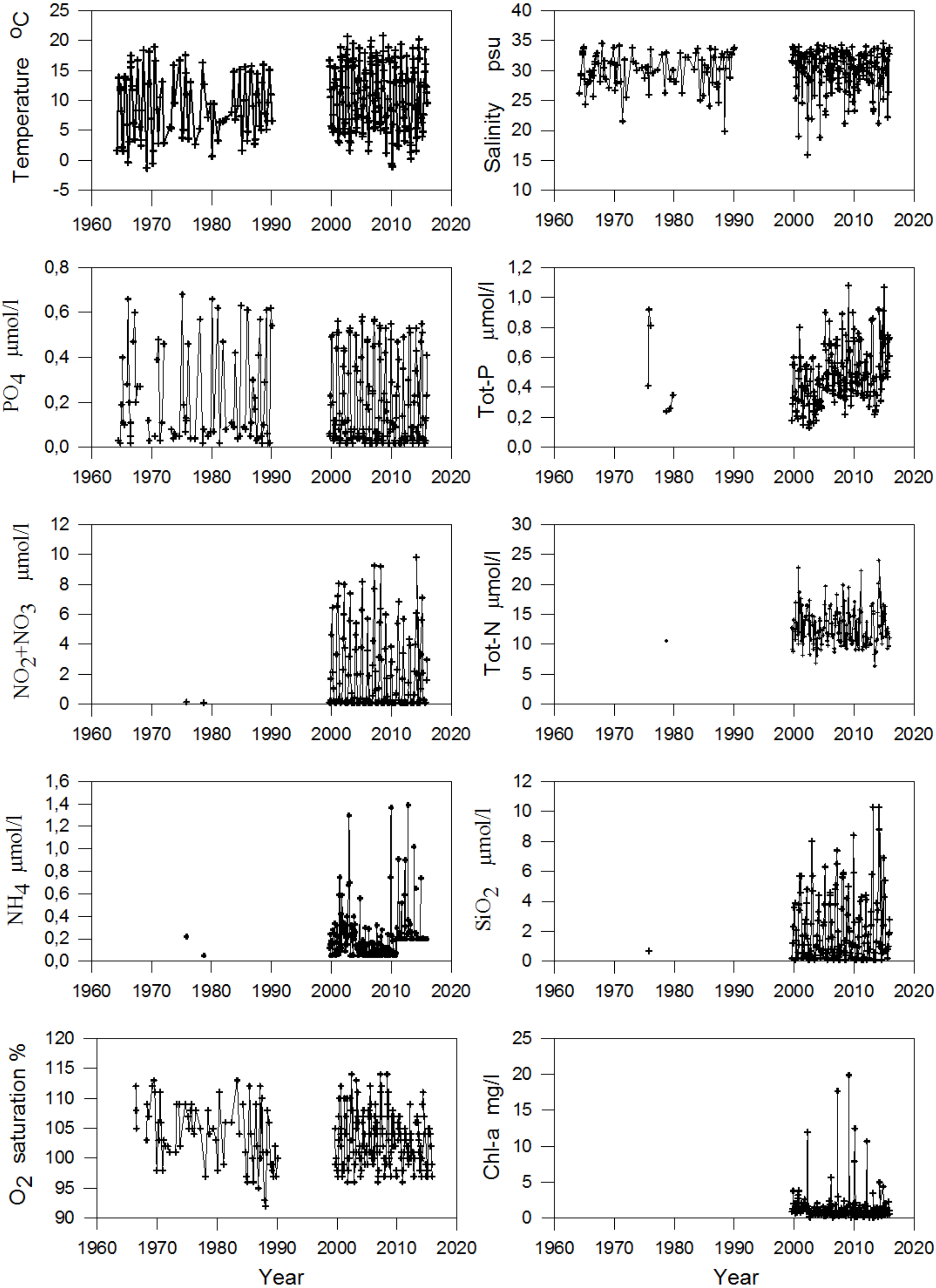
Mean 1996-2010 · St.Dev. · 2015



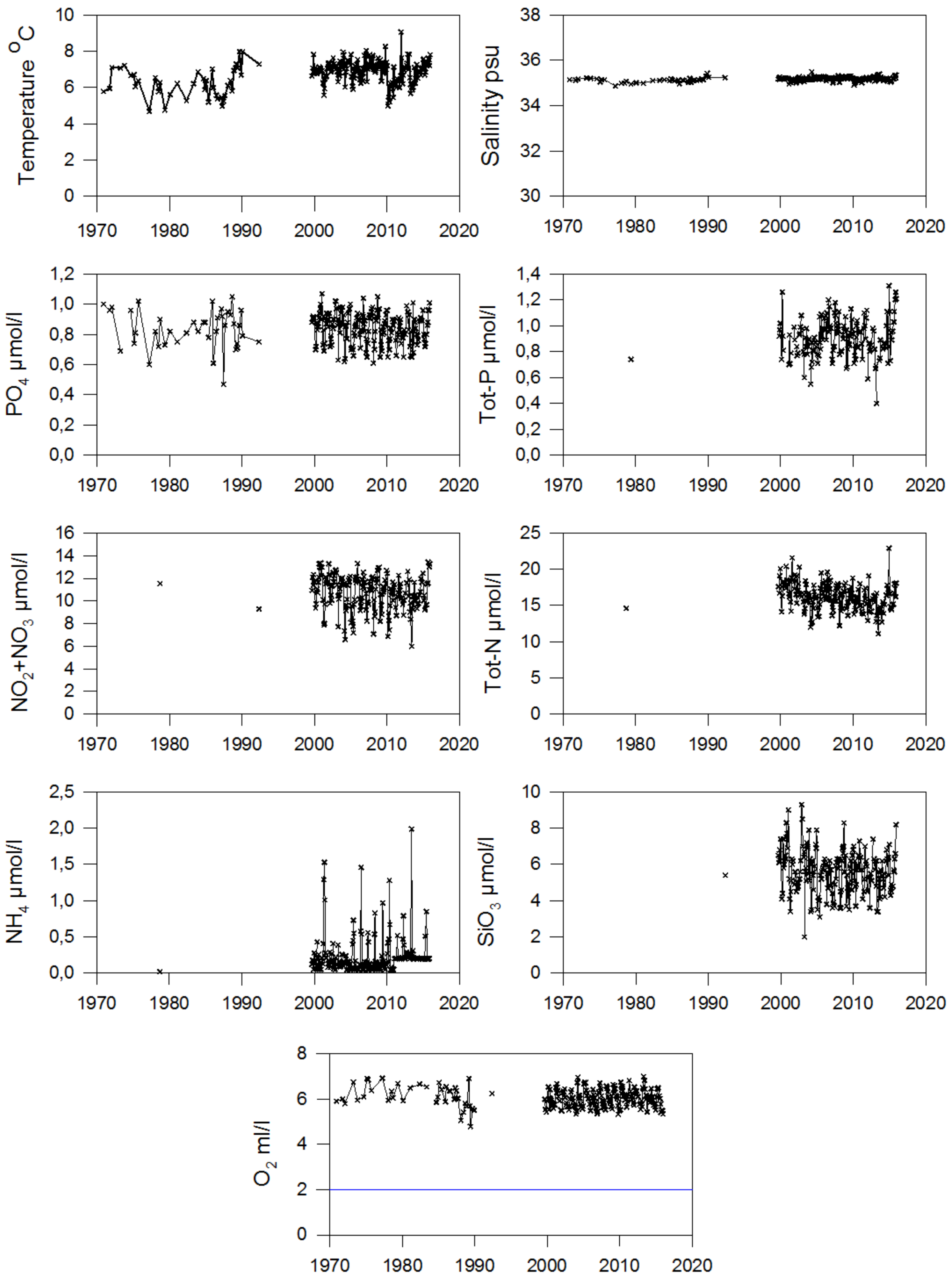
OXYGEN IN BOTTOM WATER (depth = 300m)



STATION Å17 SURFACE WATER

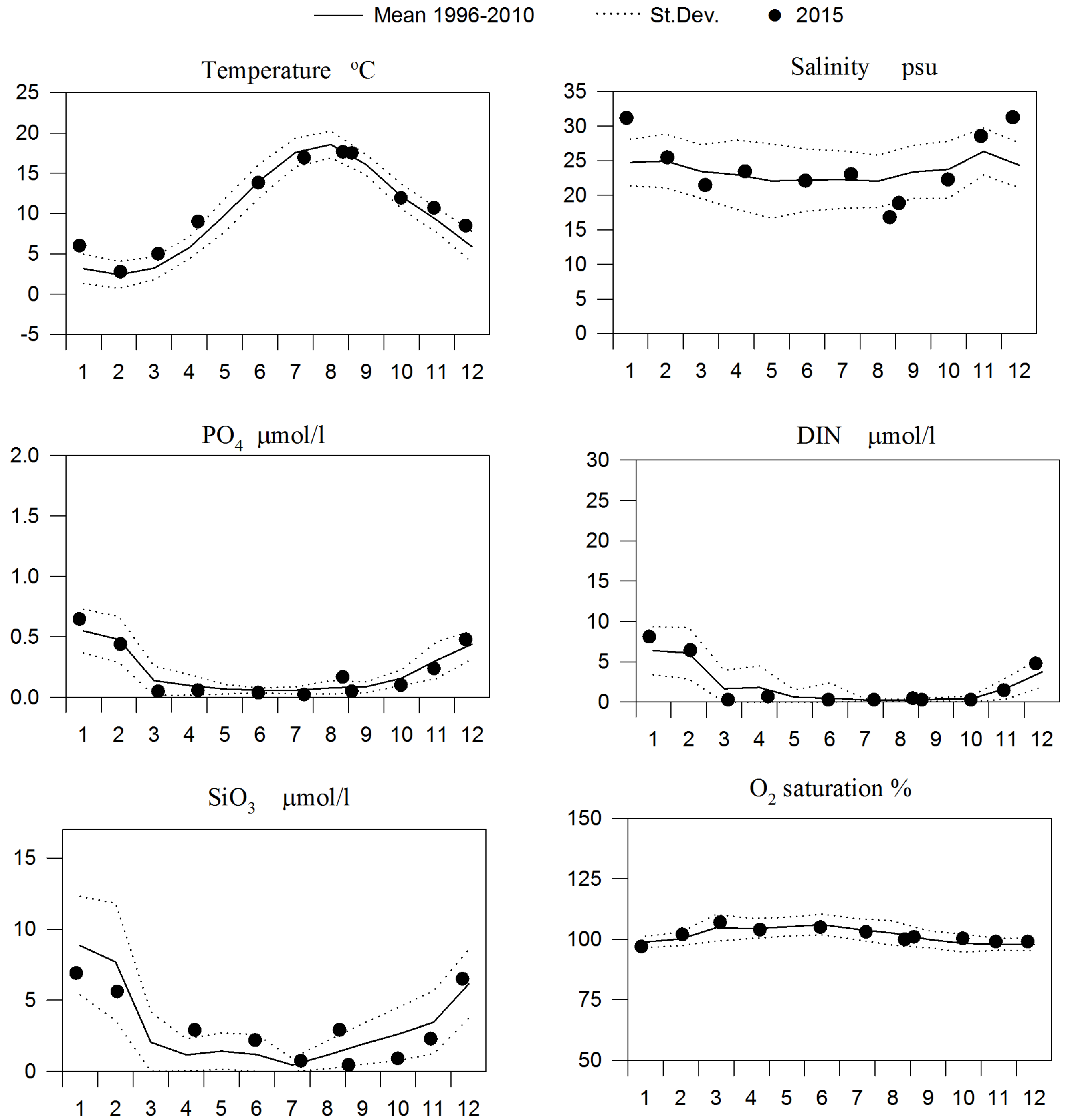


STATION Å17 DEEP WATER (300m)

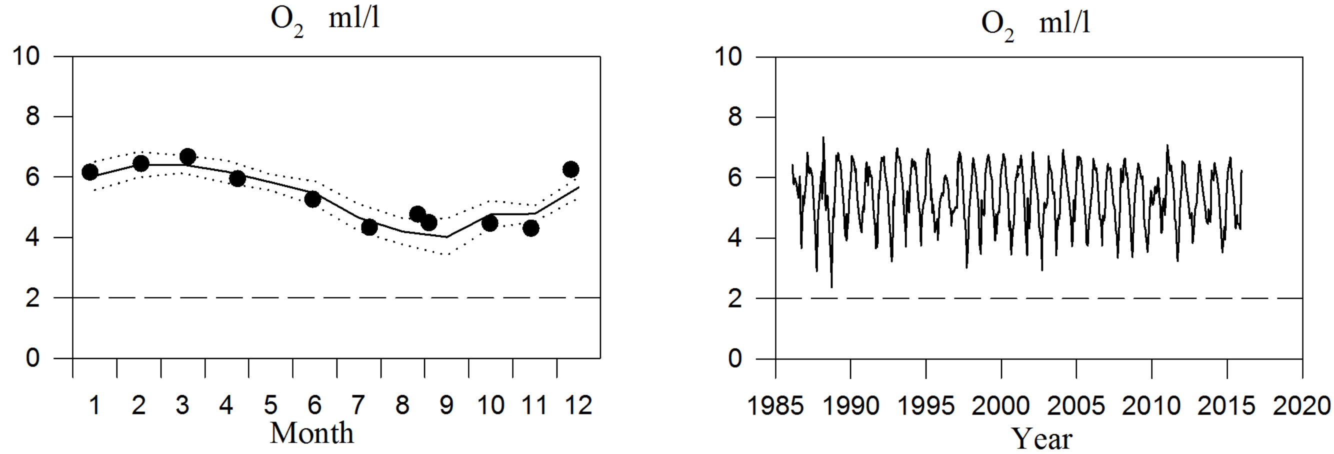


STATION FLADEN SURFACE WATER

Annual Cycles



OXYGEN IN BOTTOM WATER (depth > 70m)



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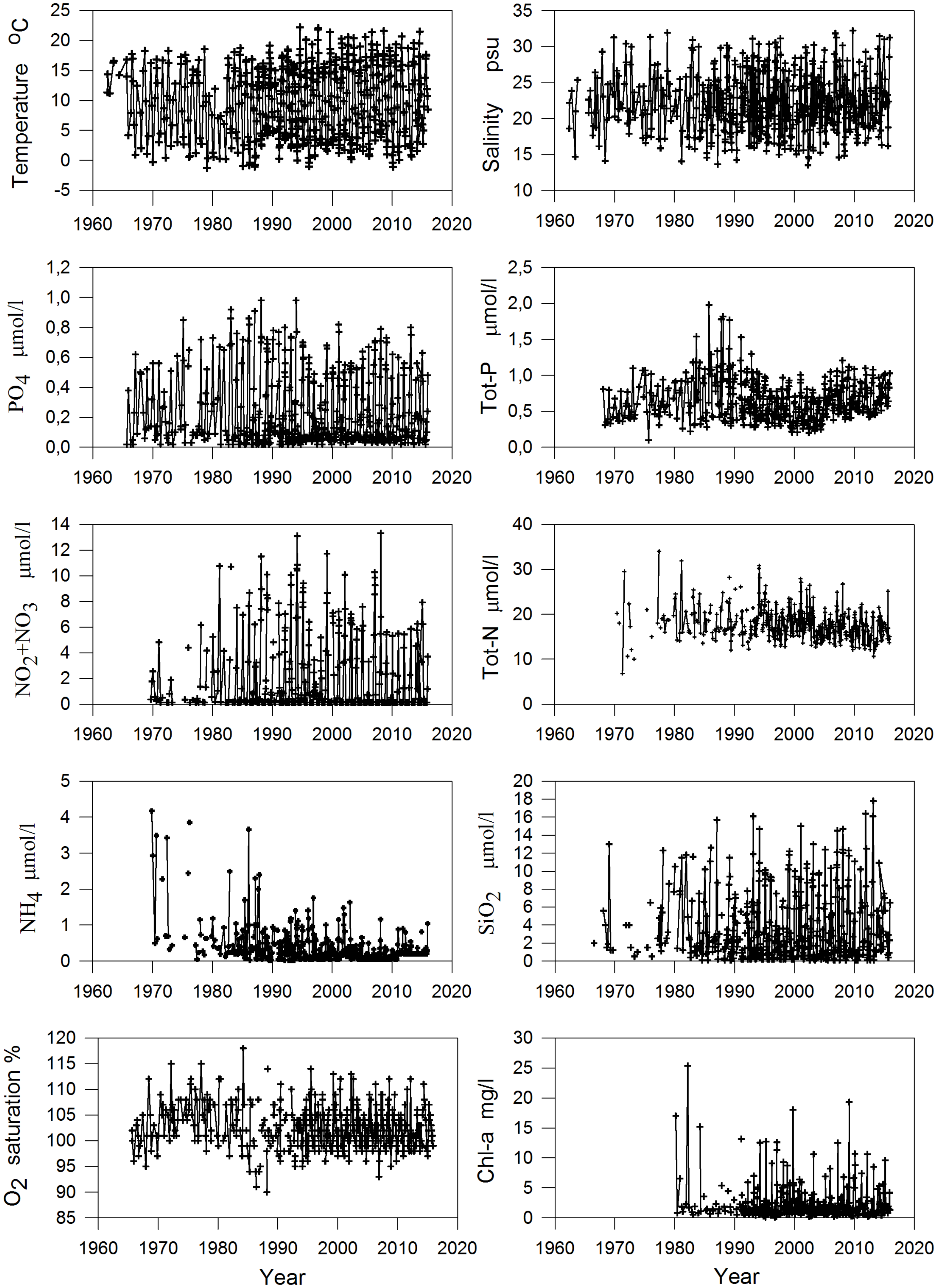
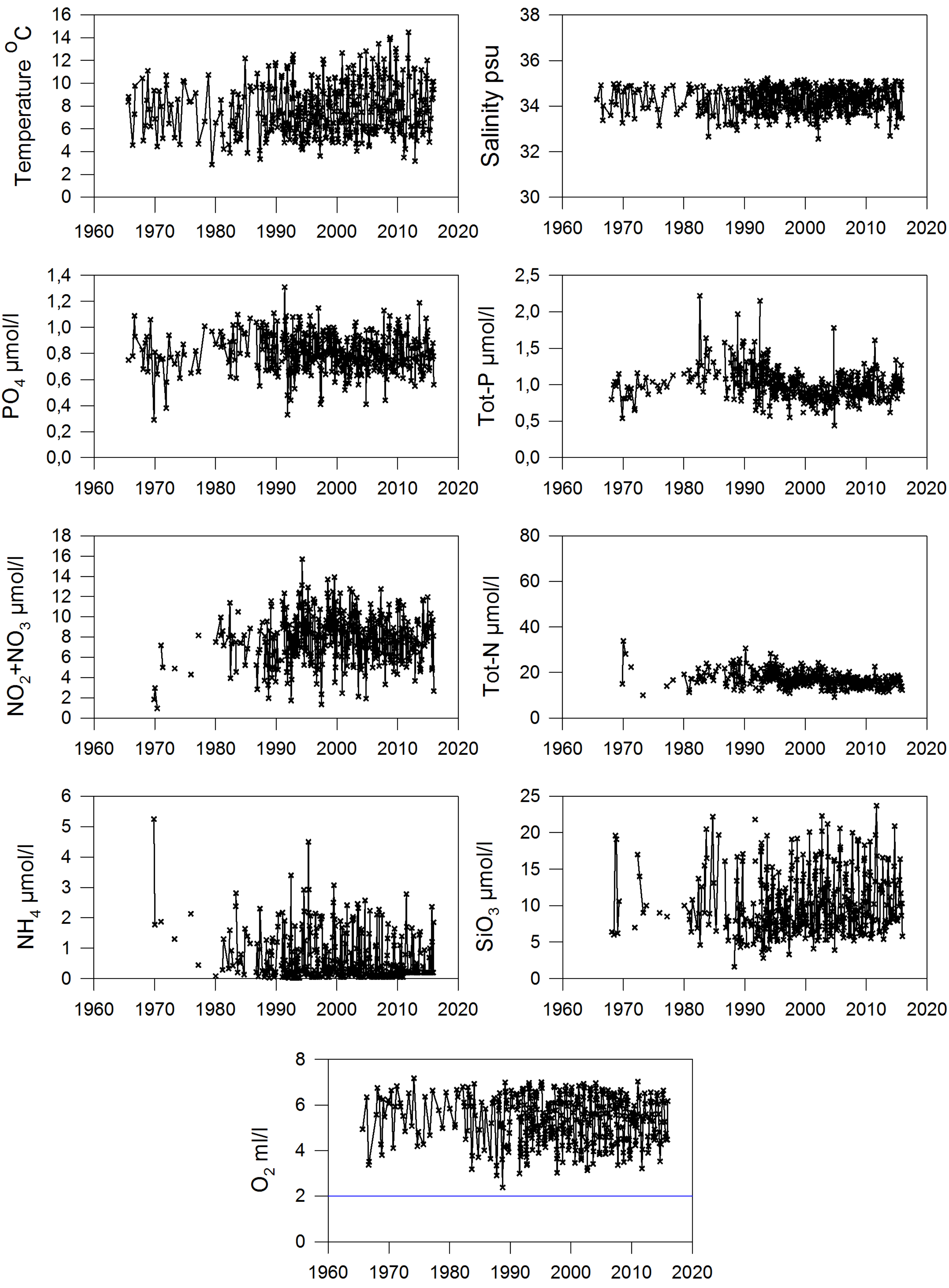
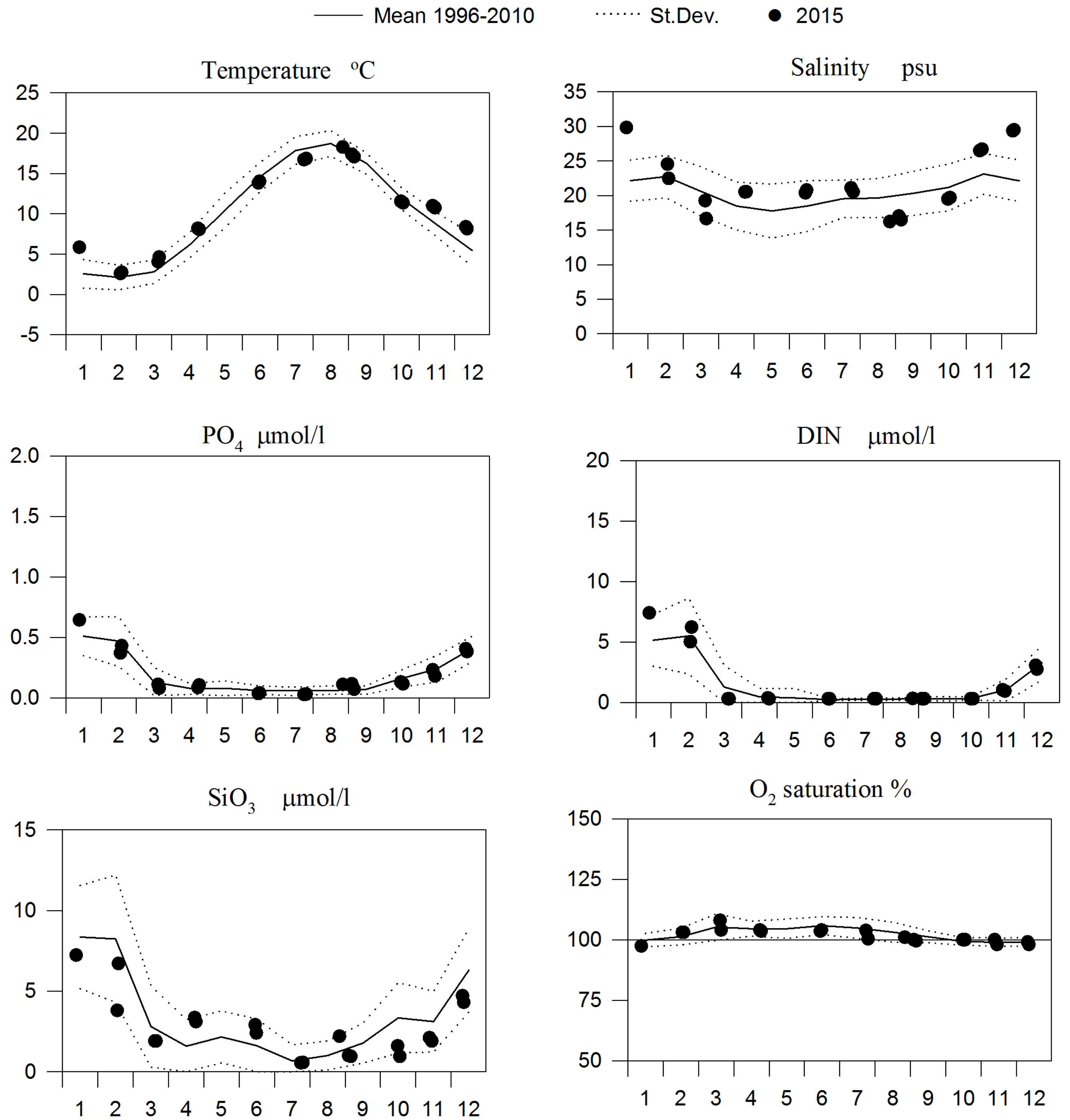


STATION FLADEN DEEP WATER (70m)

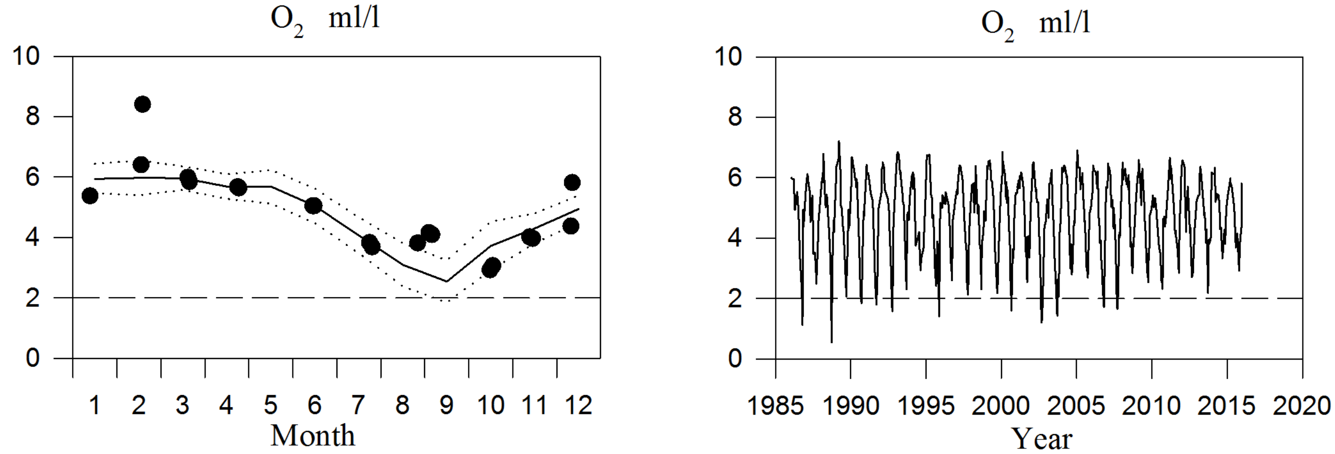


STATION ANHOLT E SURFACE WATER

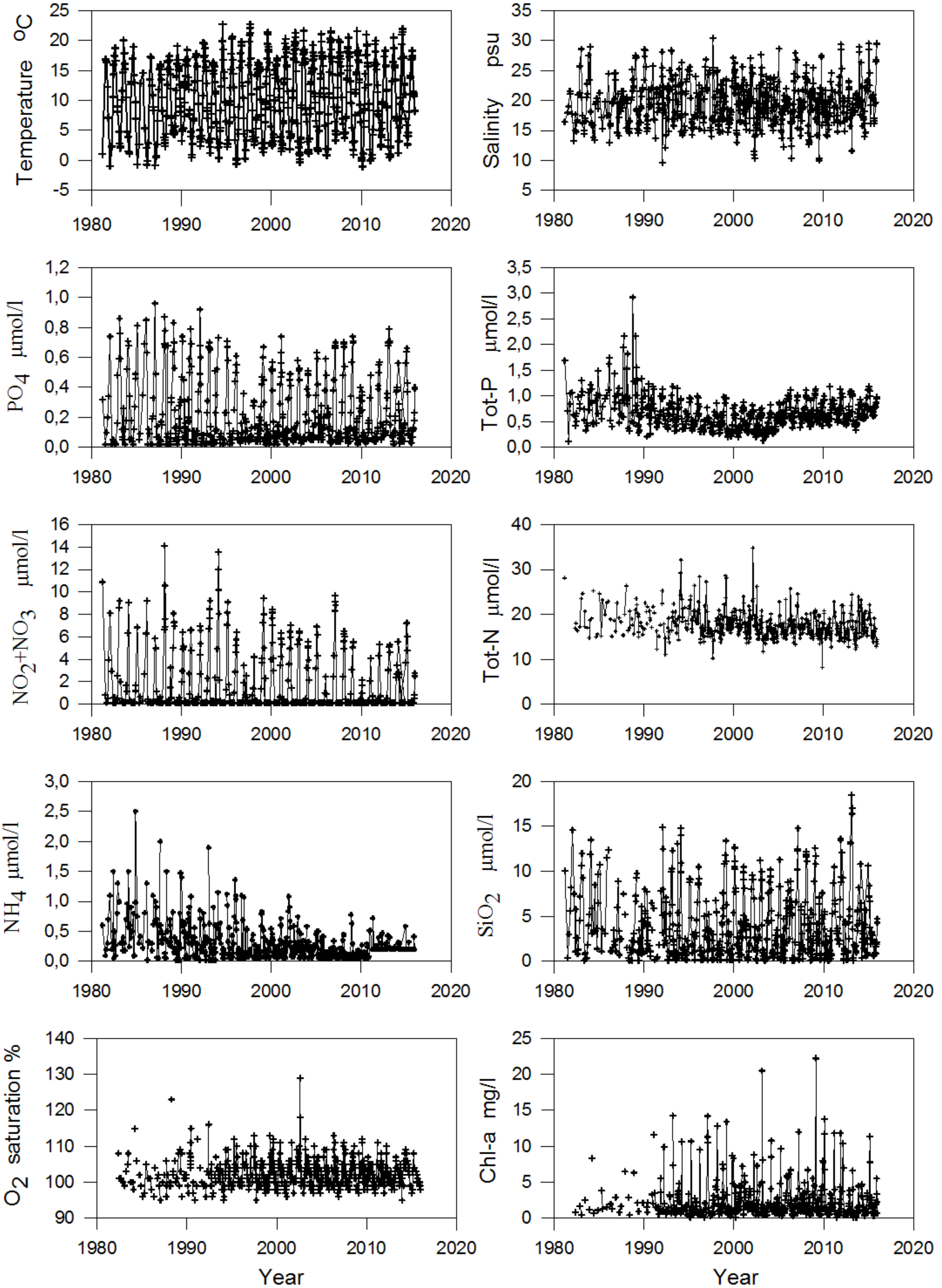
Annual Cycles



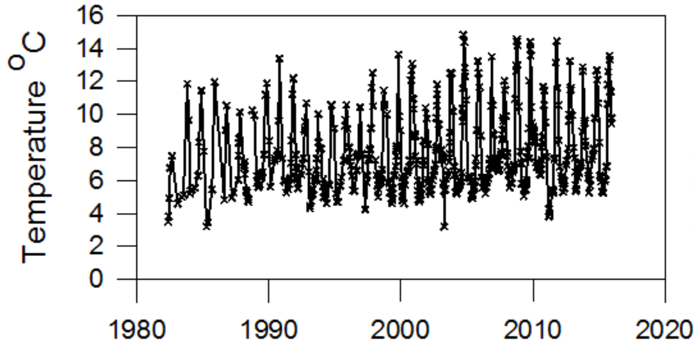
OXYGEN IN BOTTOM WATER (depth > 50m)

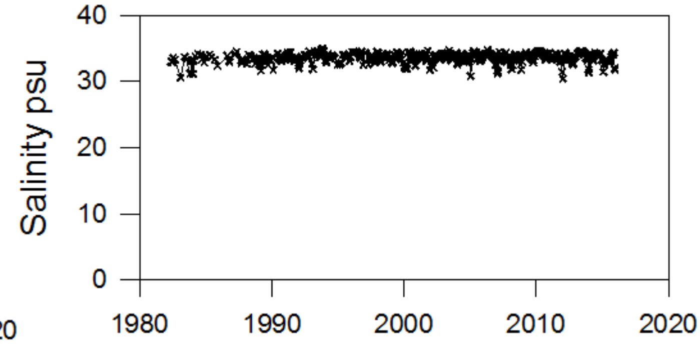


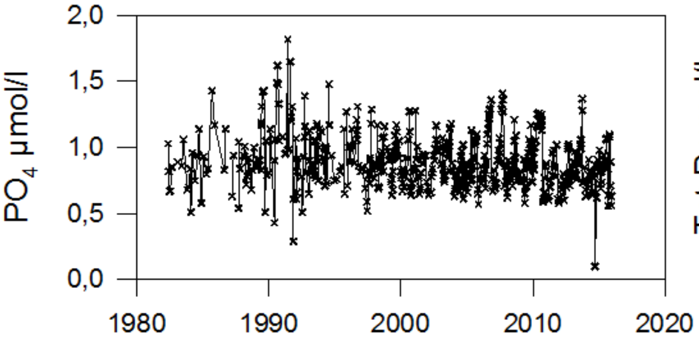
STATION ANHOLT E SURFACE WATER

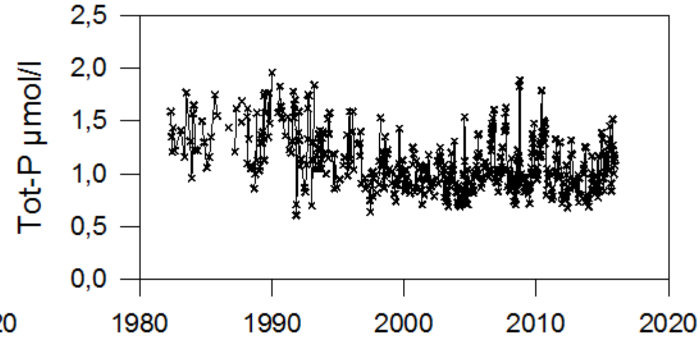


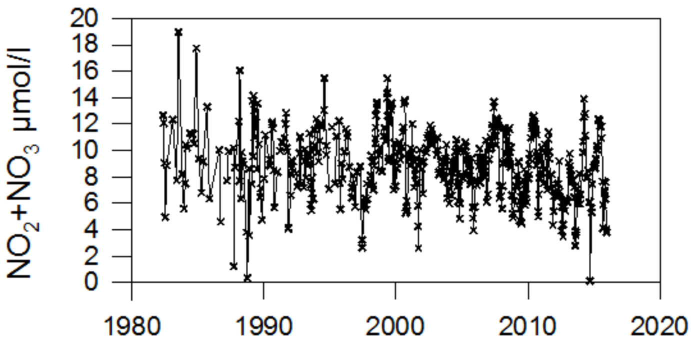
STATION ANHOLT-E DEEP WATER (50m)

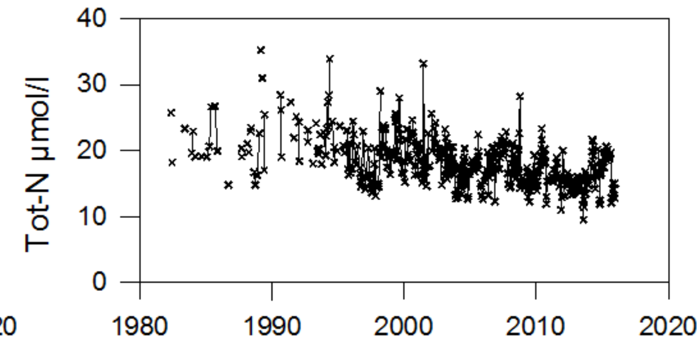


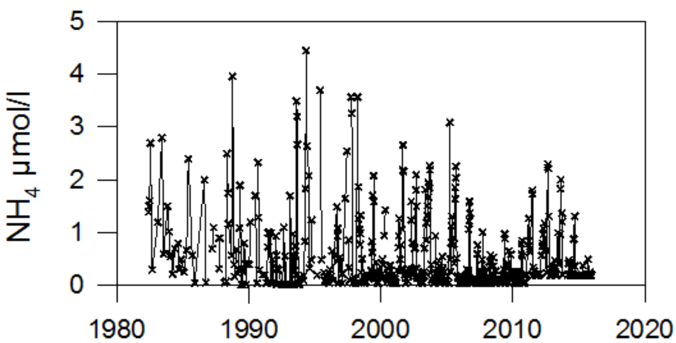


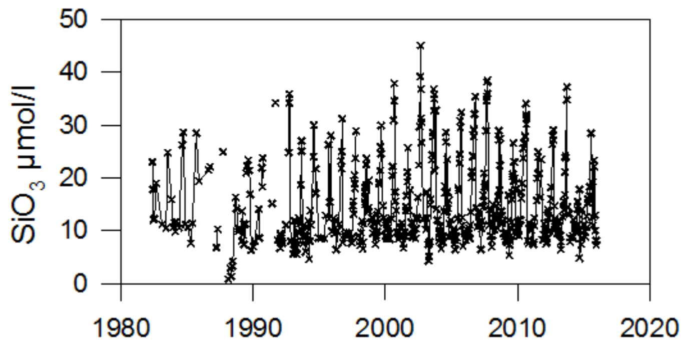


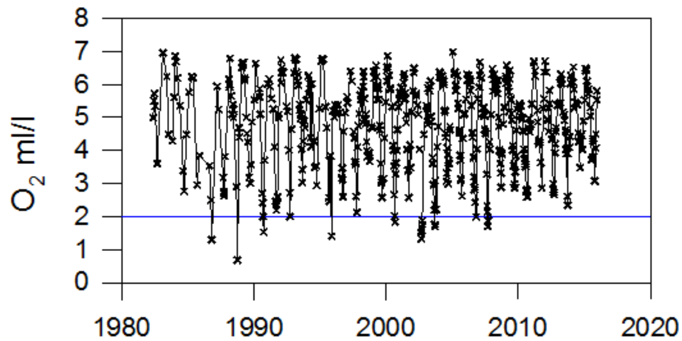






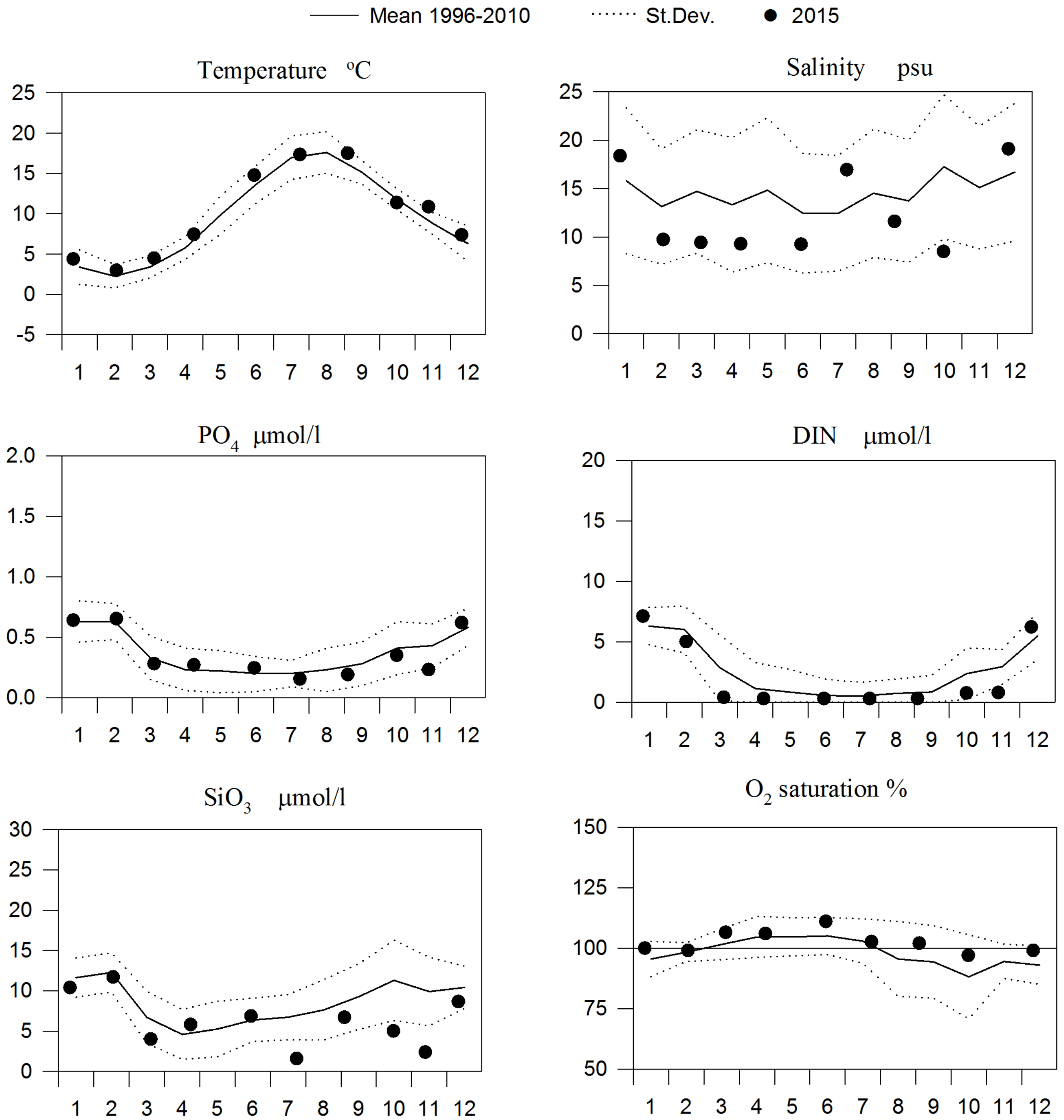




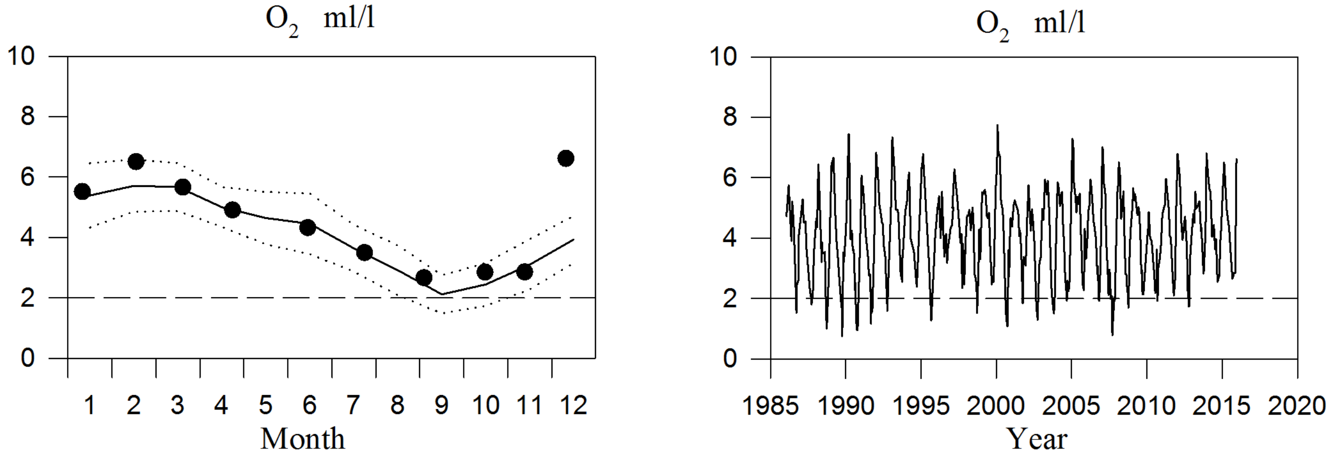


STATION W LANDSKRONA SURFACE WATER

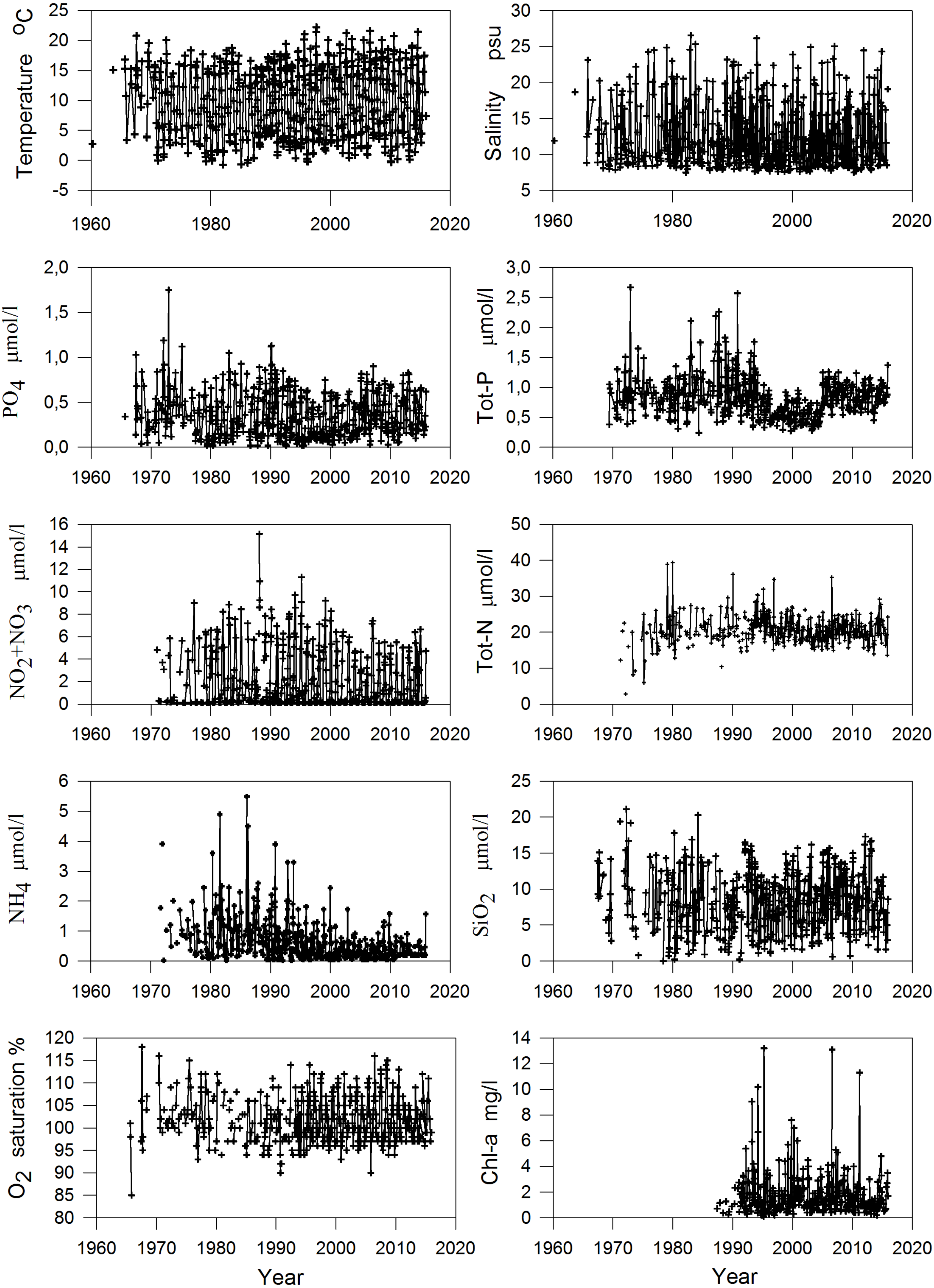
Annual Cycles



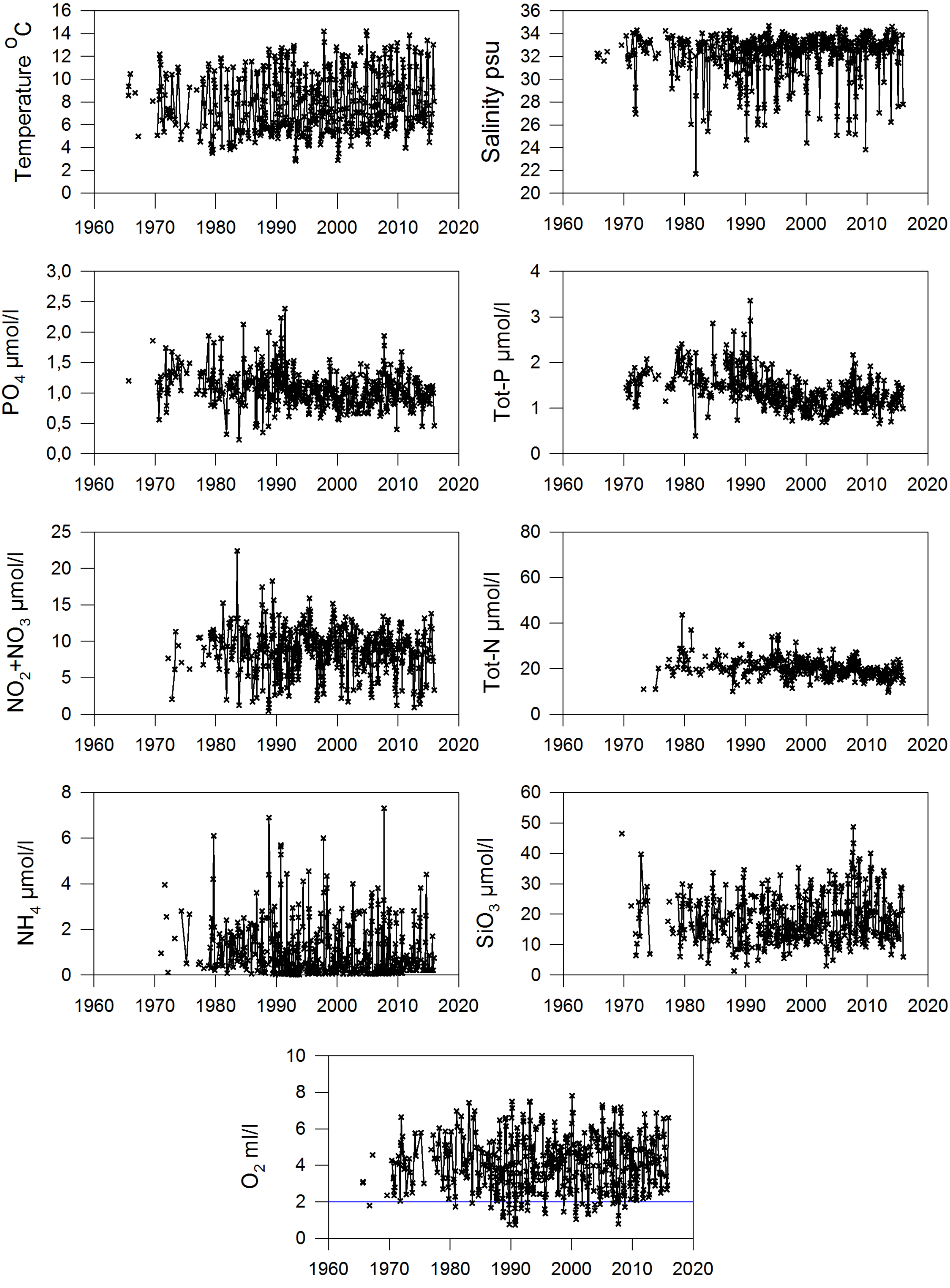
OXYGEN IN BOTTOM WATER (depth >40m)



STATION W LANDSKRONA SURFACE WATER

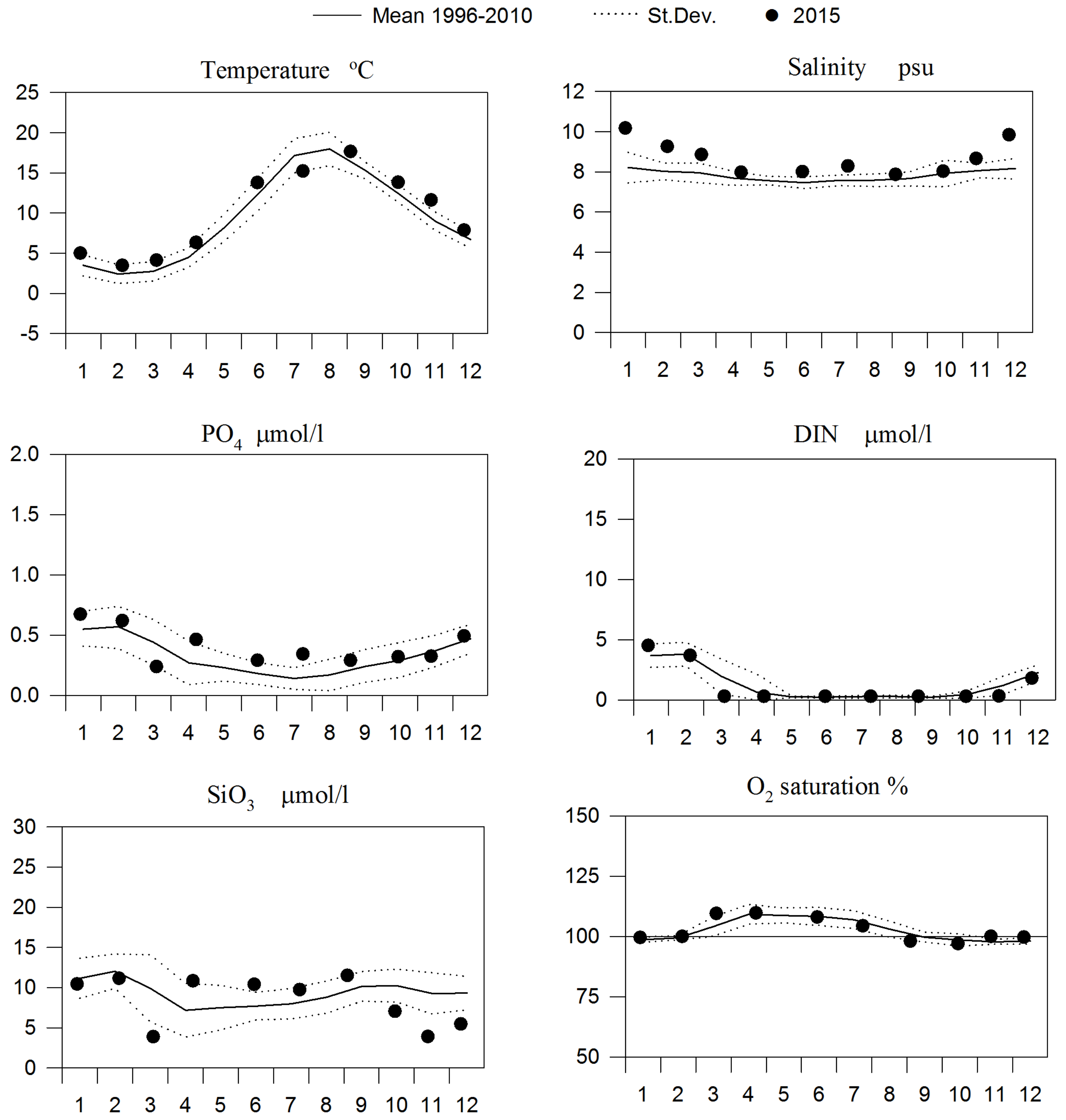


STATION W LANDSKRONA DEEP WATER (40m)

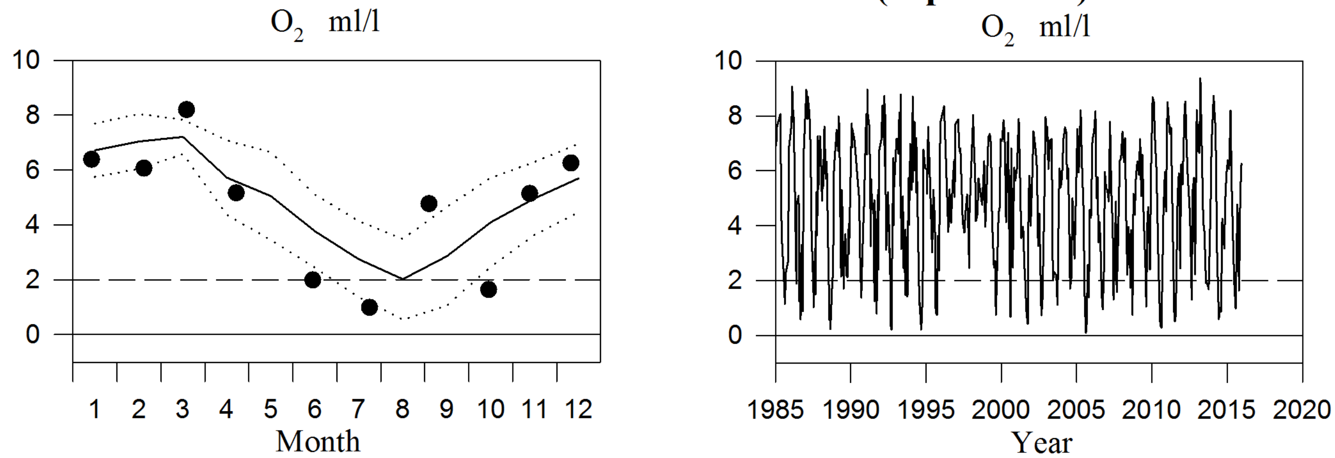


STATION BY1 SURFACE WATER

Annual Cycles



OXYGEN IN BOTTOM WATER (depth >40m)



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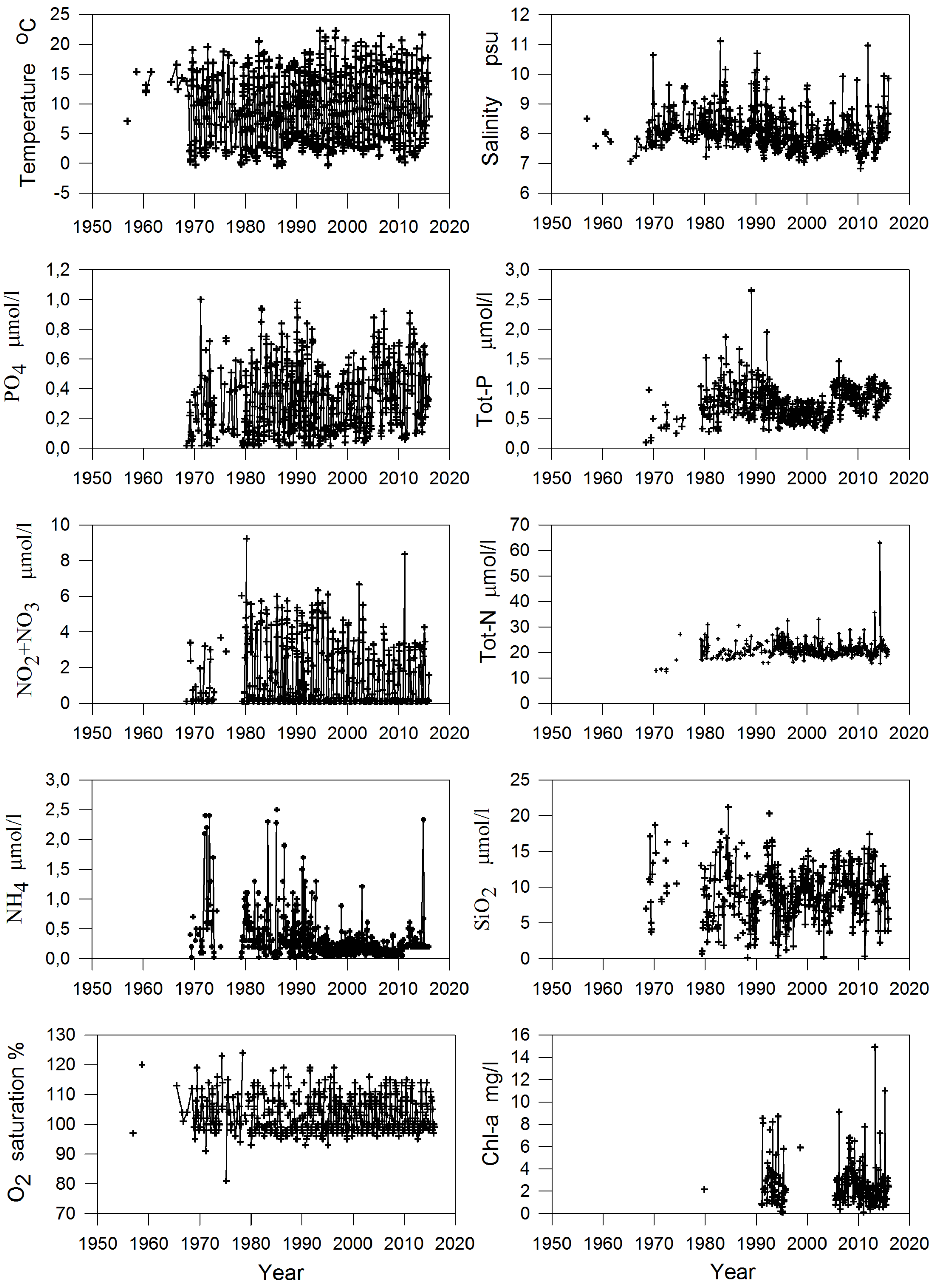

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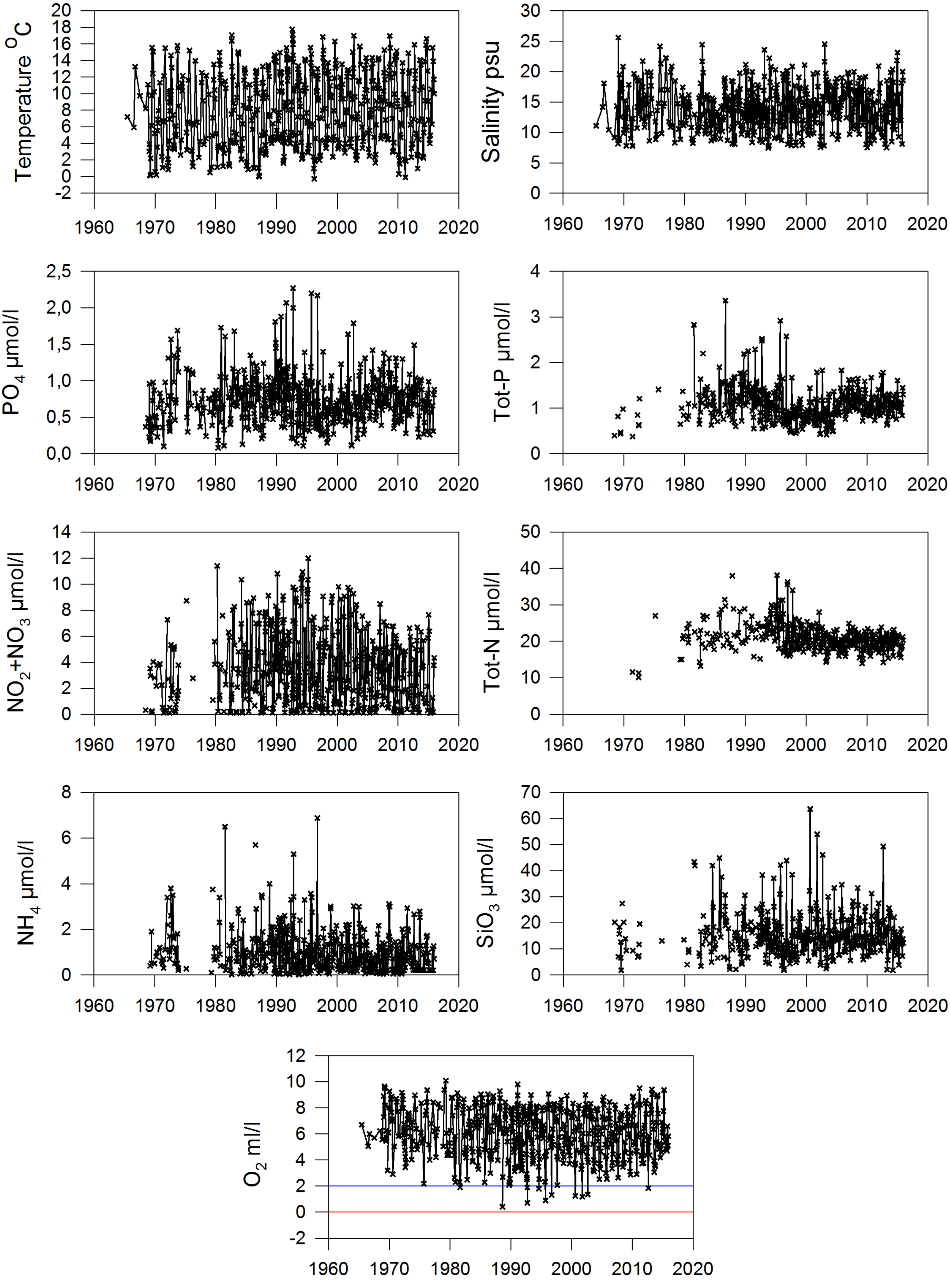
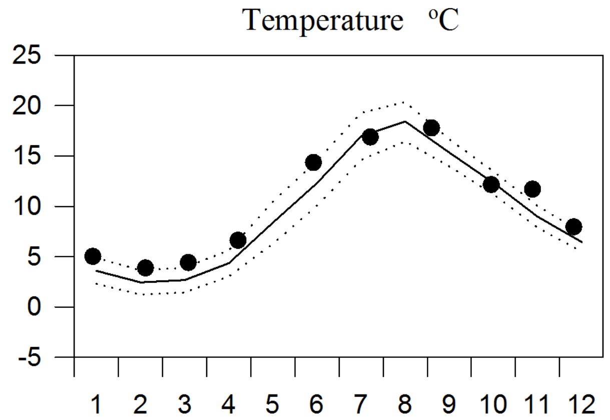
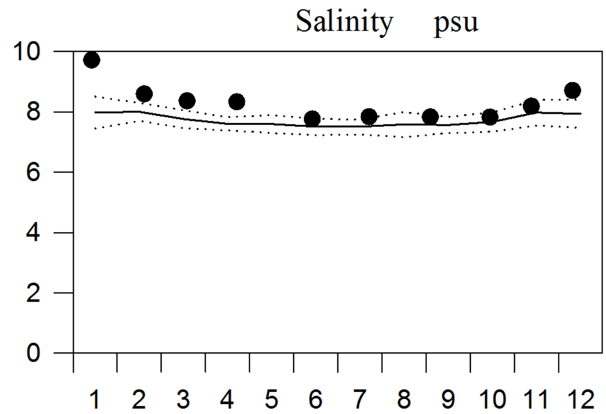


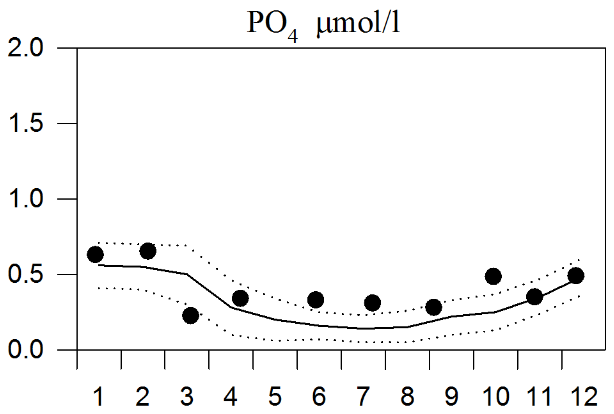
STATION BY2 SURFACE WATER

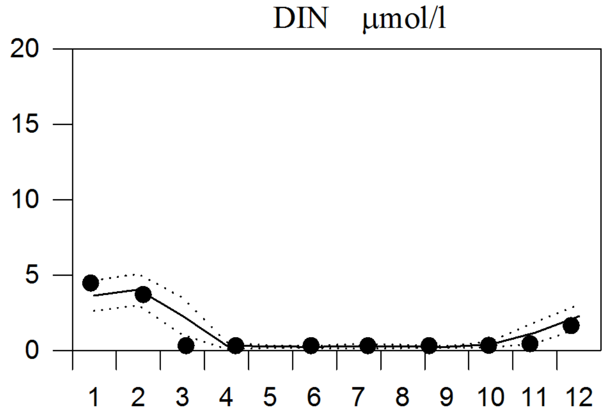
Annual Cycles

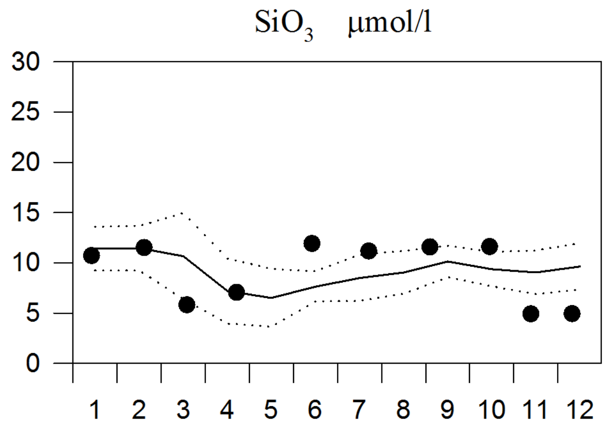
Mean 1996-2010 St.Dev. 2015

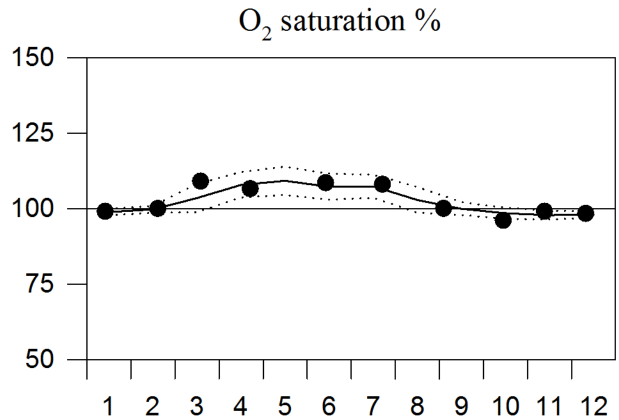




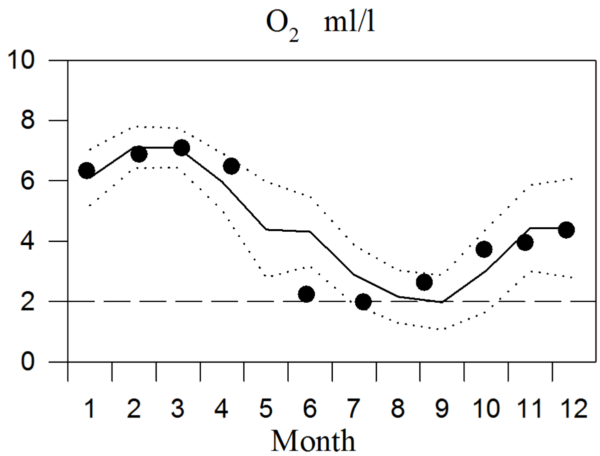


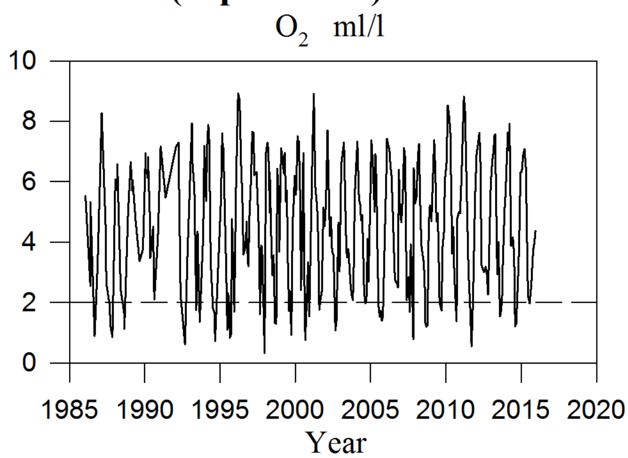




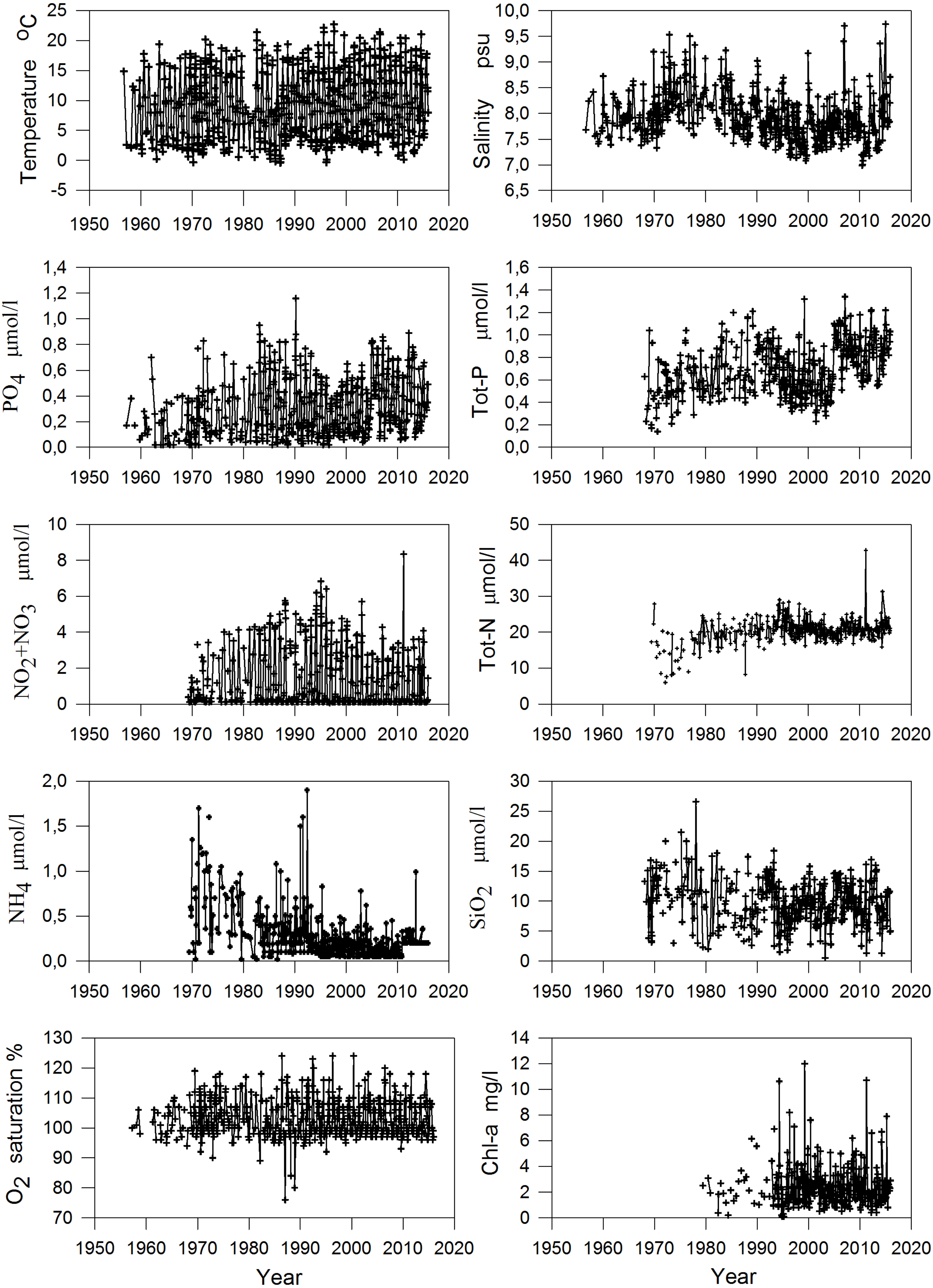


OXYGEN IN BOTTOM WATER (depth >40m)

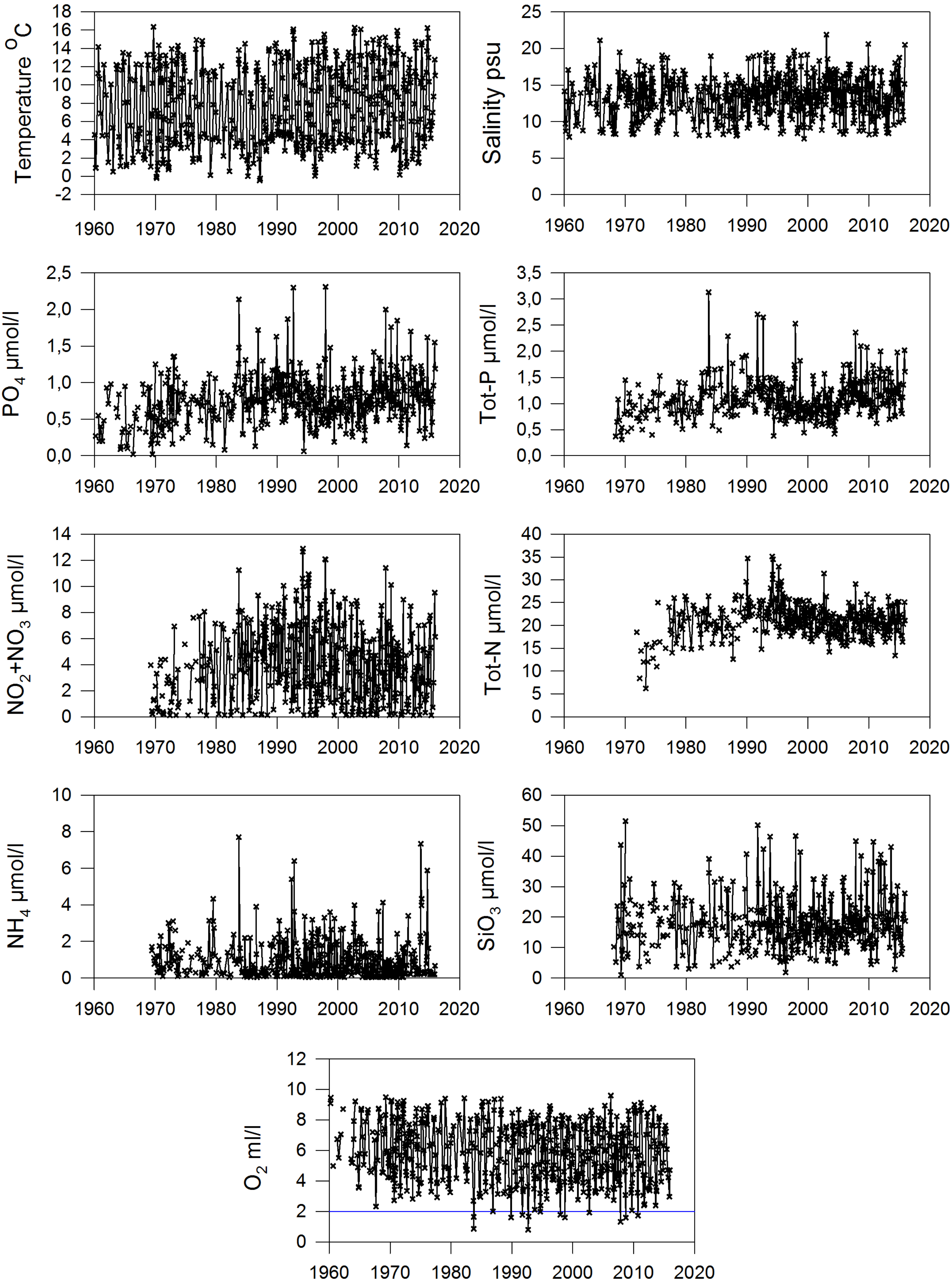




STATION BY2 SURFACE WATER



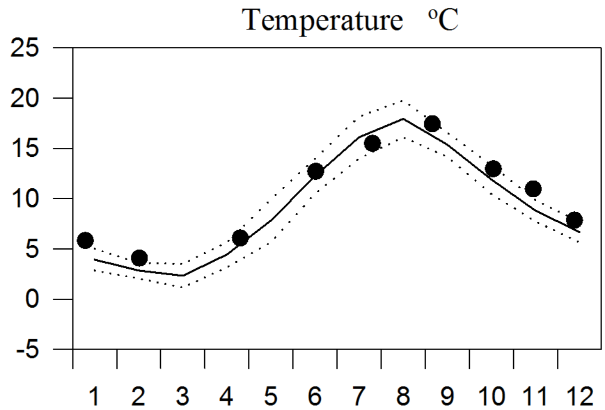
STATION BY2 DEEP WATER (40m)

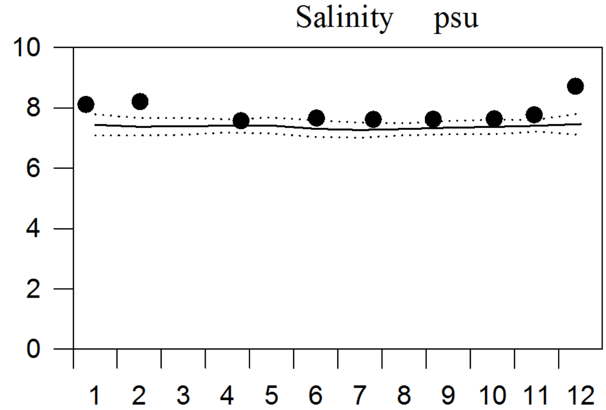


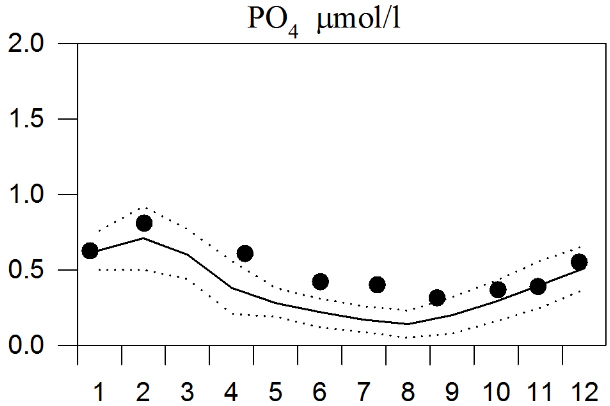
STATION HANÖBUKTEN SURFACE WATER

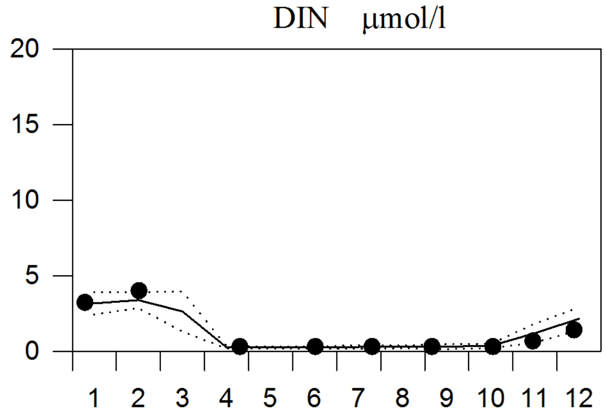
Annual Cycles

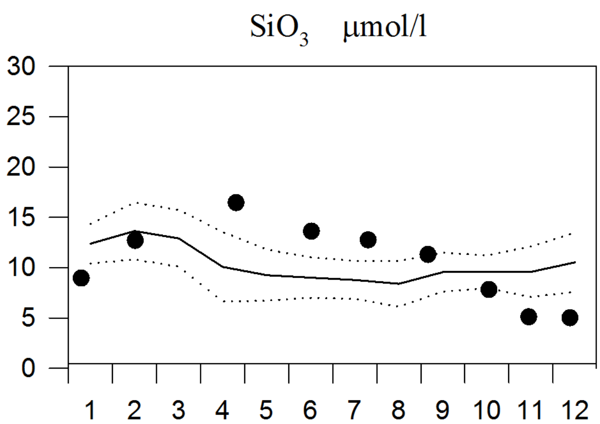
Mean 1996-2010 ······ St.Dev. ● 2015

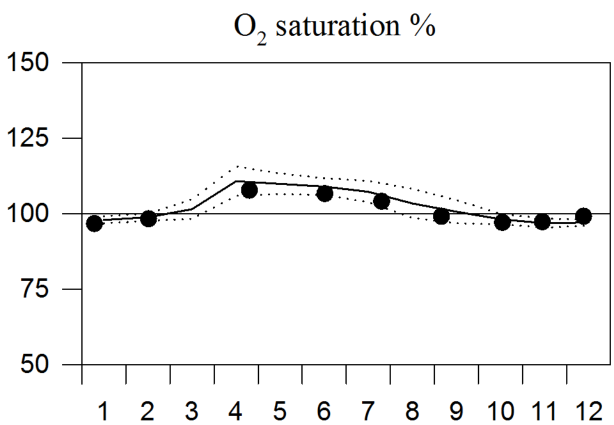




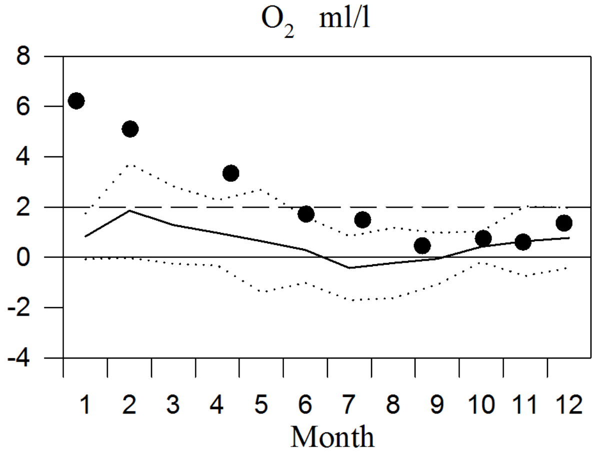


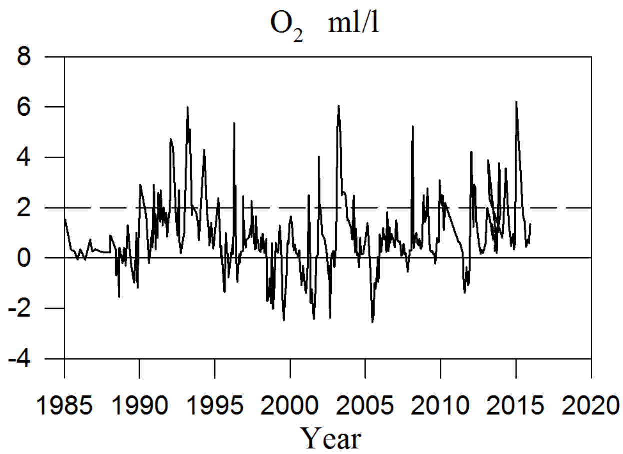




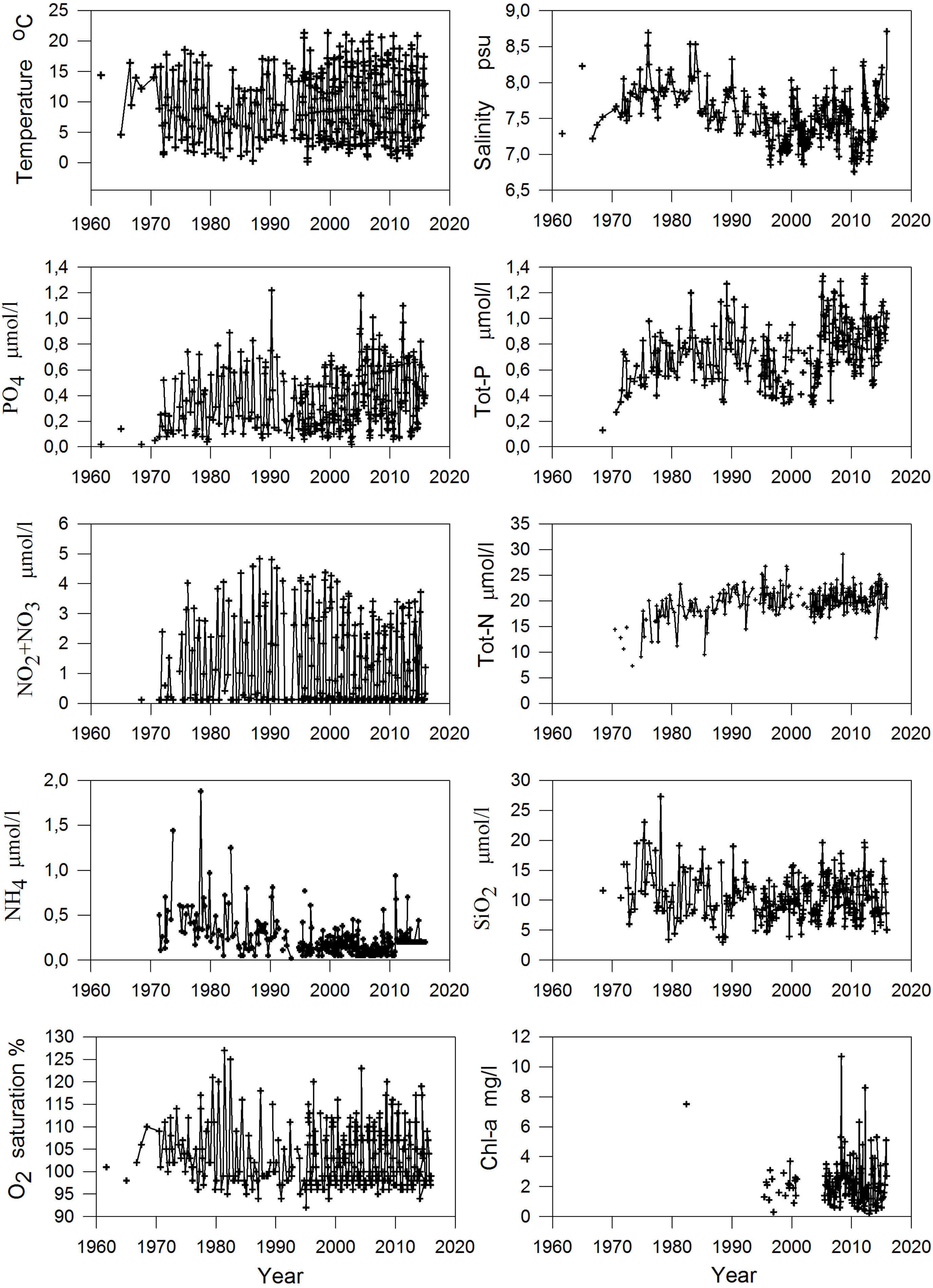


OXYGEN IN BOTTOM WATER (depth > 70m)

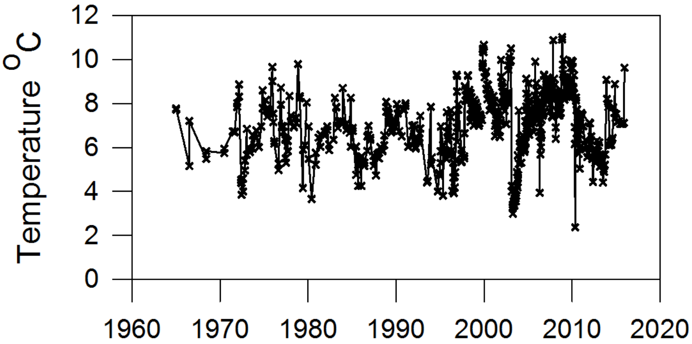


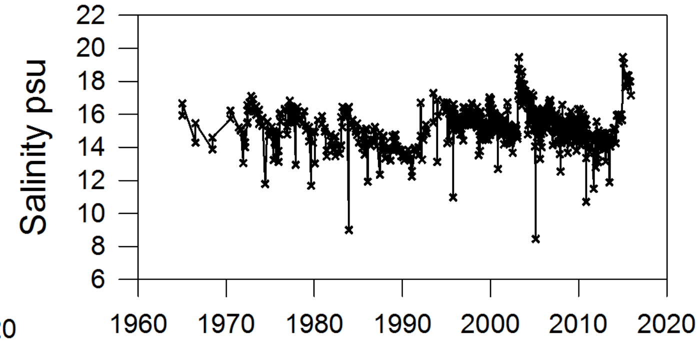


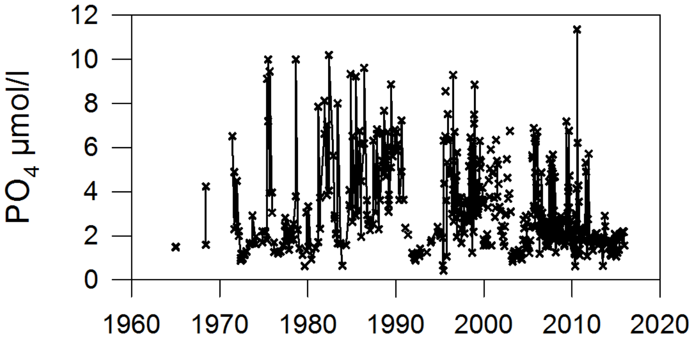
STATION HANÖBUKTEN SURFACE WATER

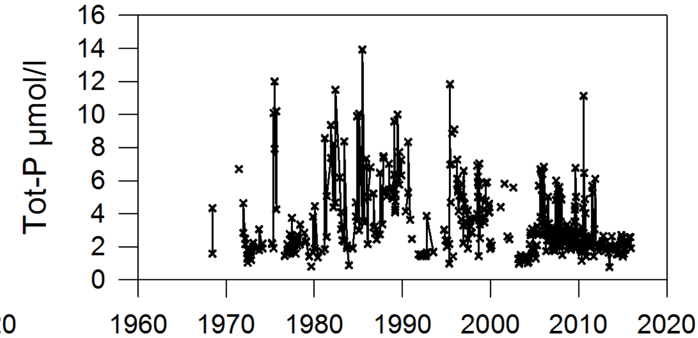


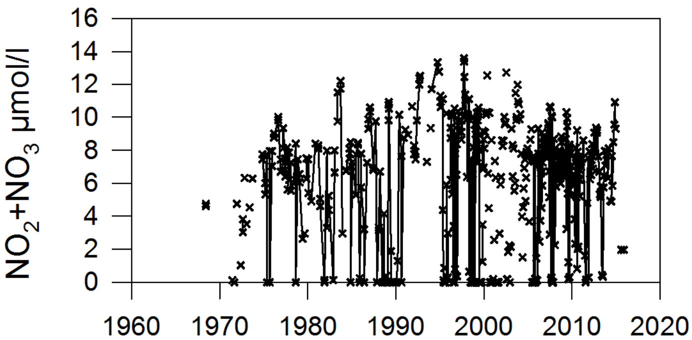
STATION HANÖBUKTEN DEEP WATER (70m)

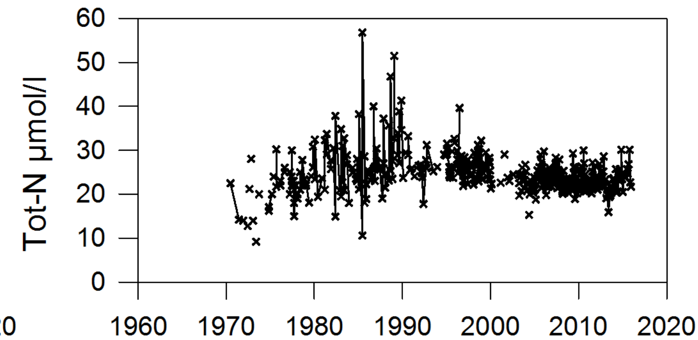


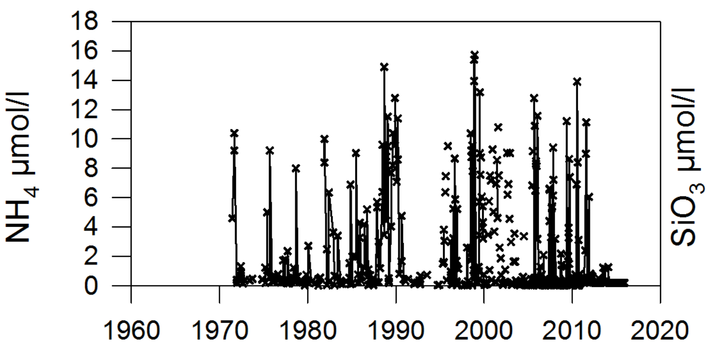


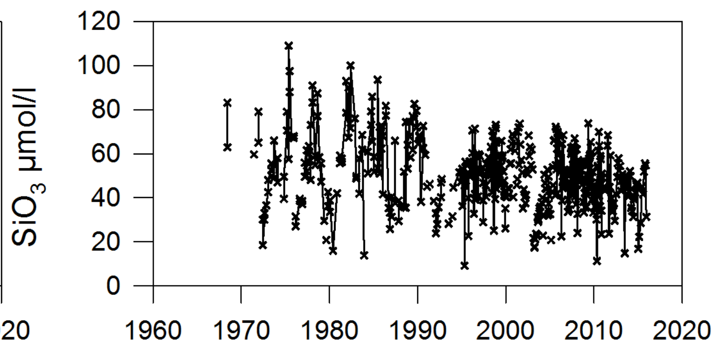


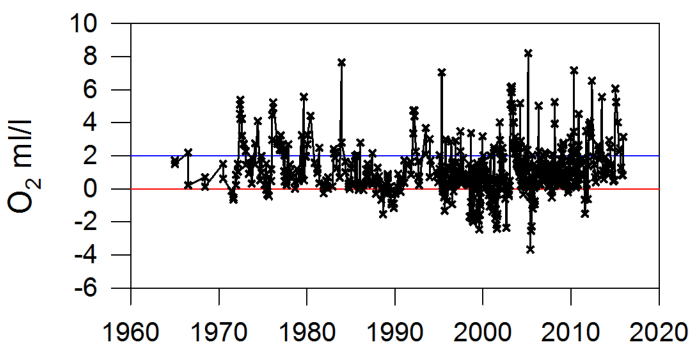






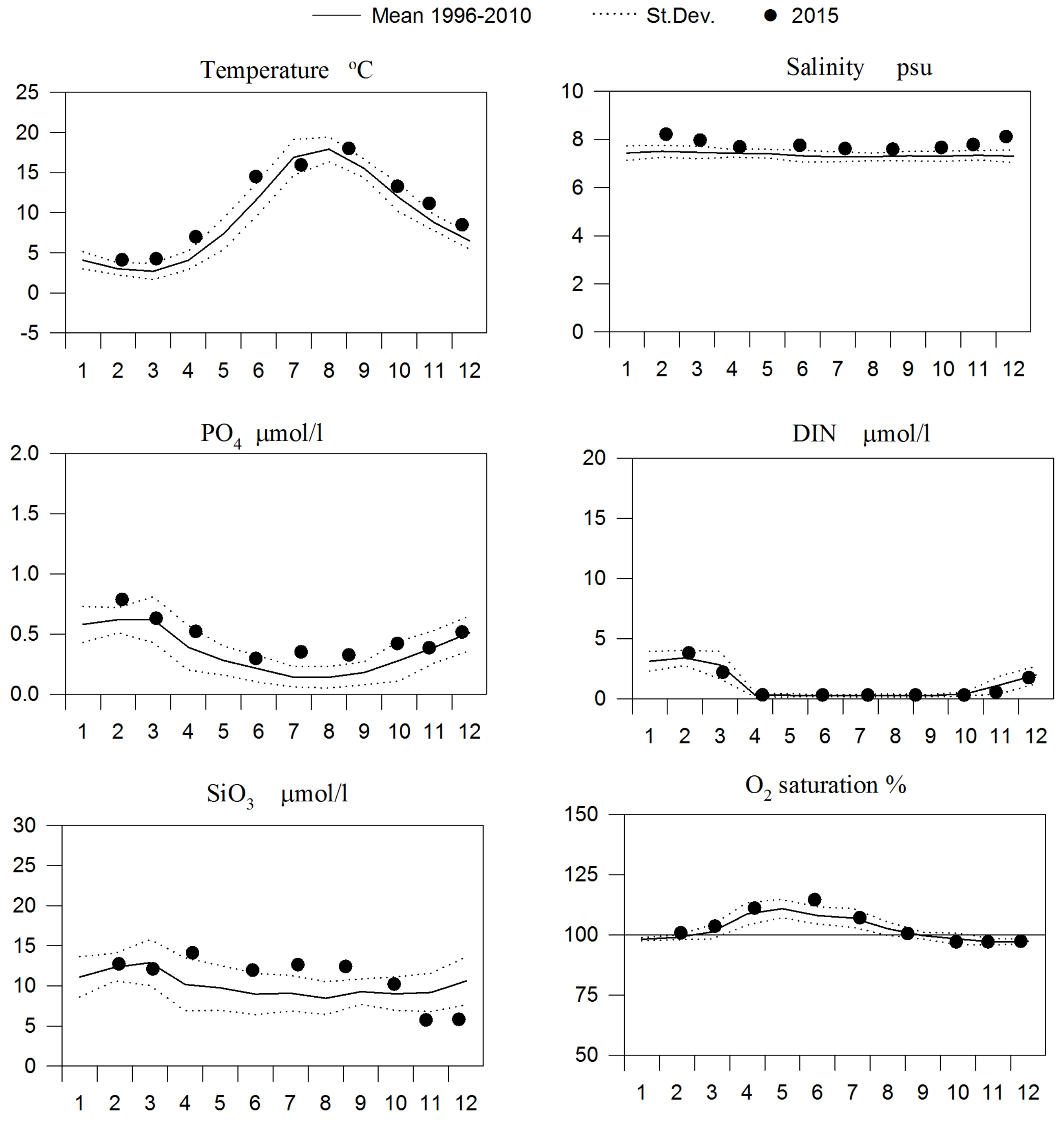




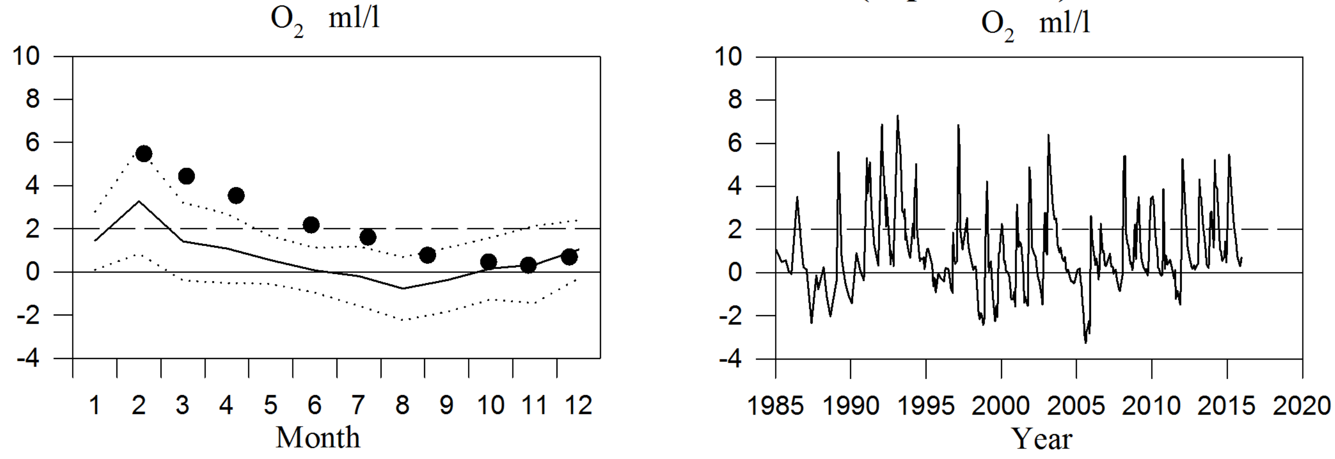


STATION BY4 SURFACE WATER

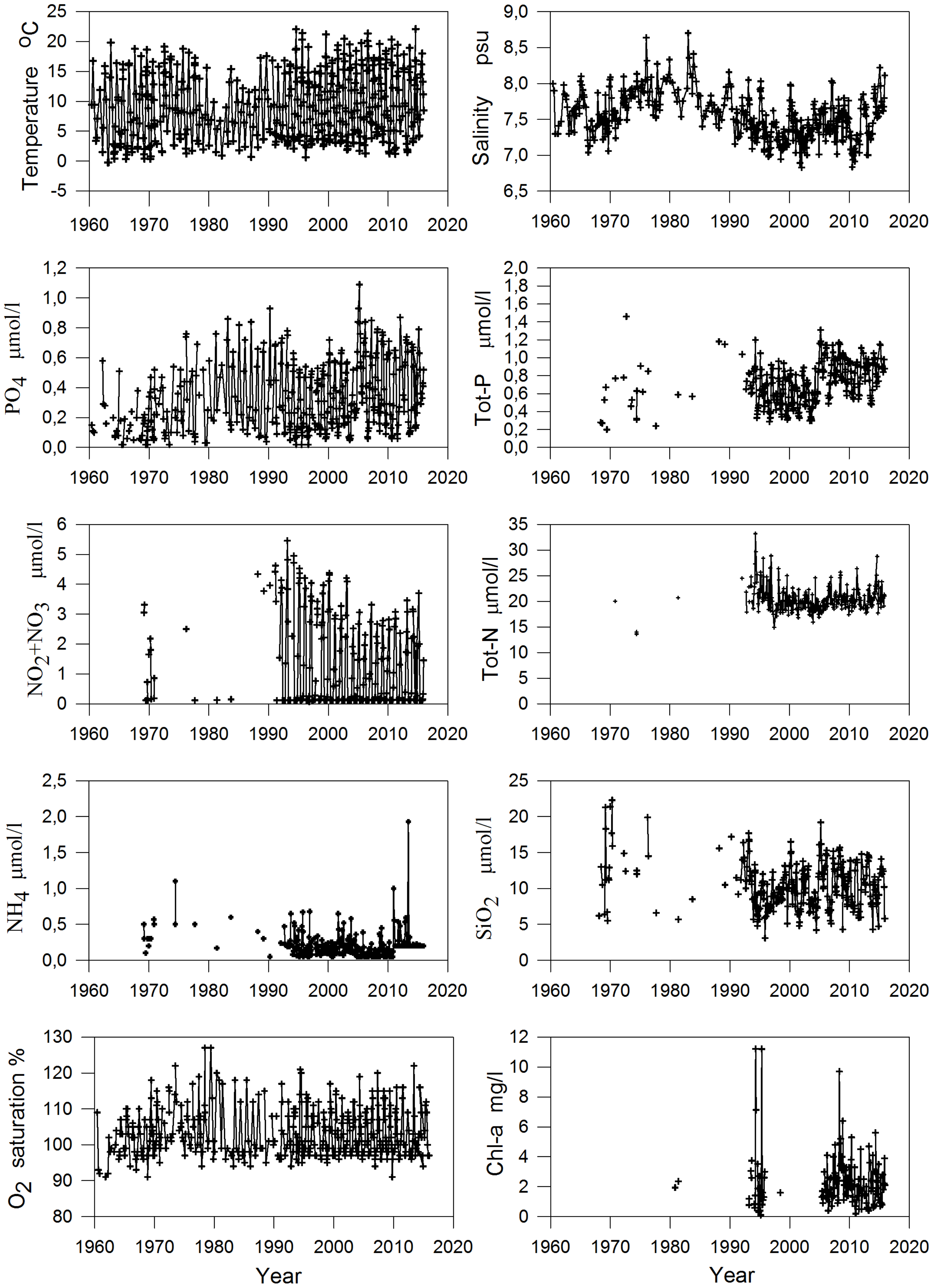
Annual Cycles



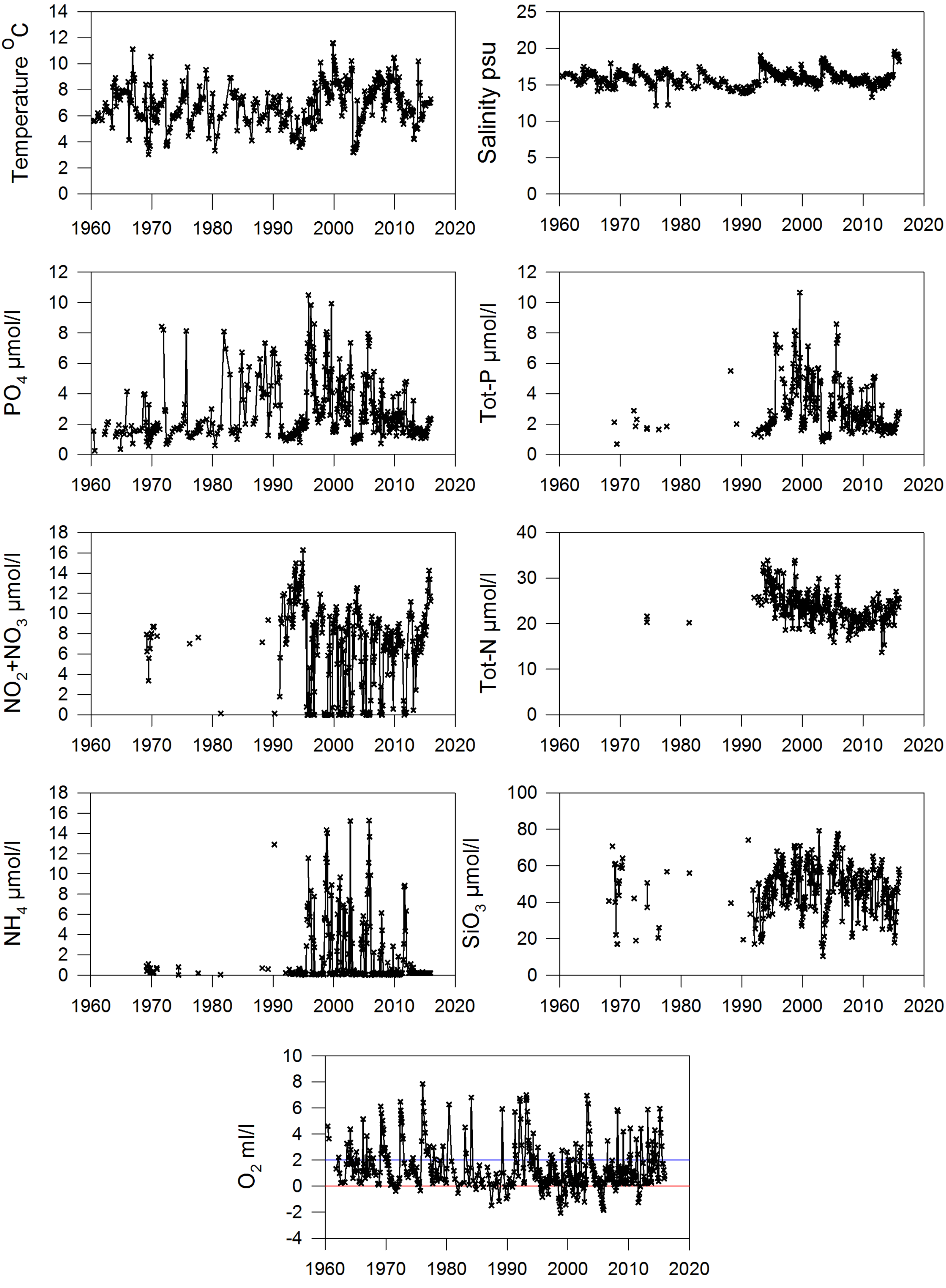
OXYGEN IN BOTTOM WATER (depth >80m)



STATION BY4 SURFACE WATER

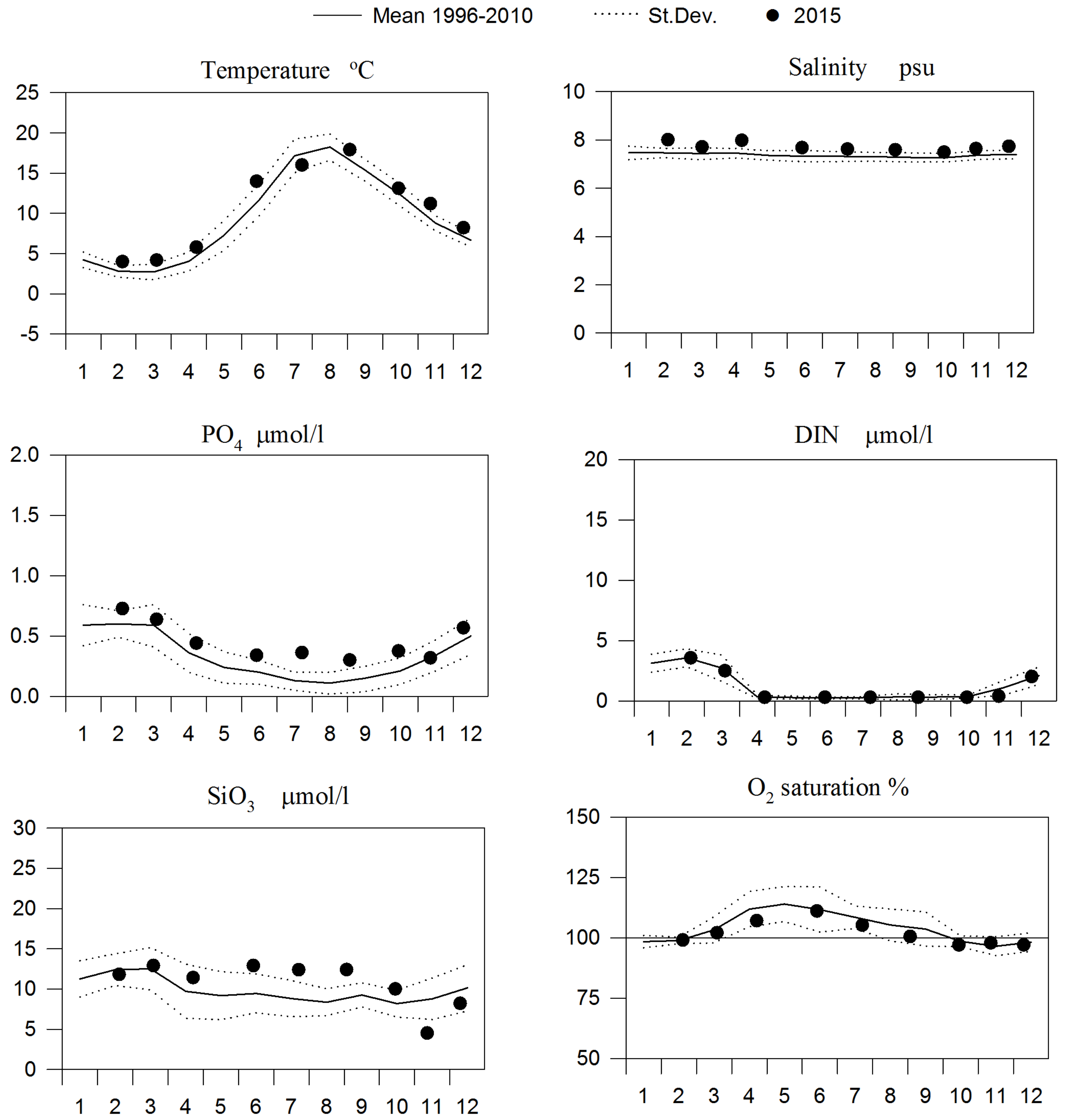


STATION BY4 DEEP WATER (80m)

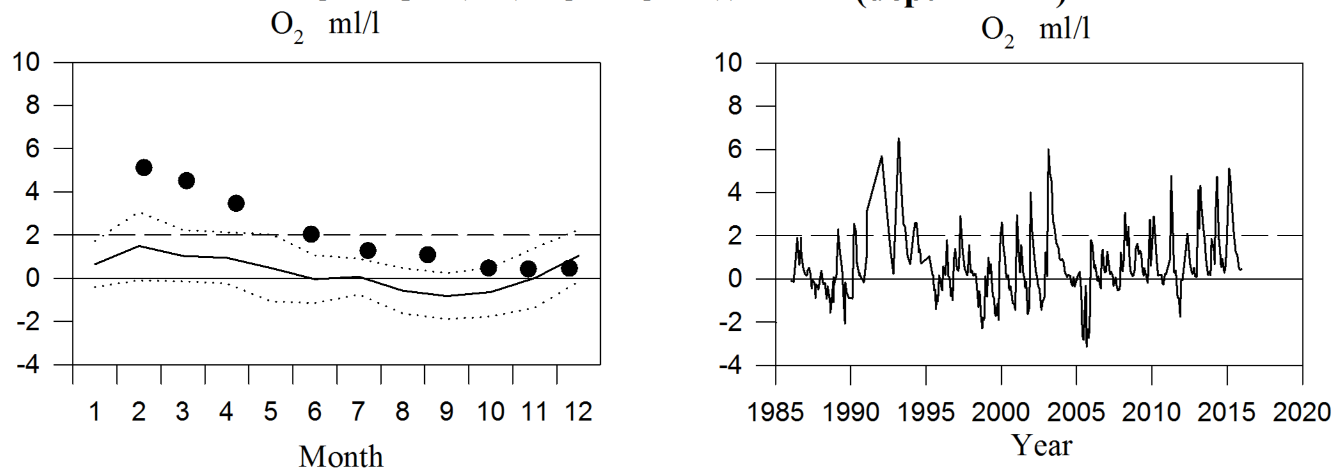


STATION BY5 SURFACE WATER

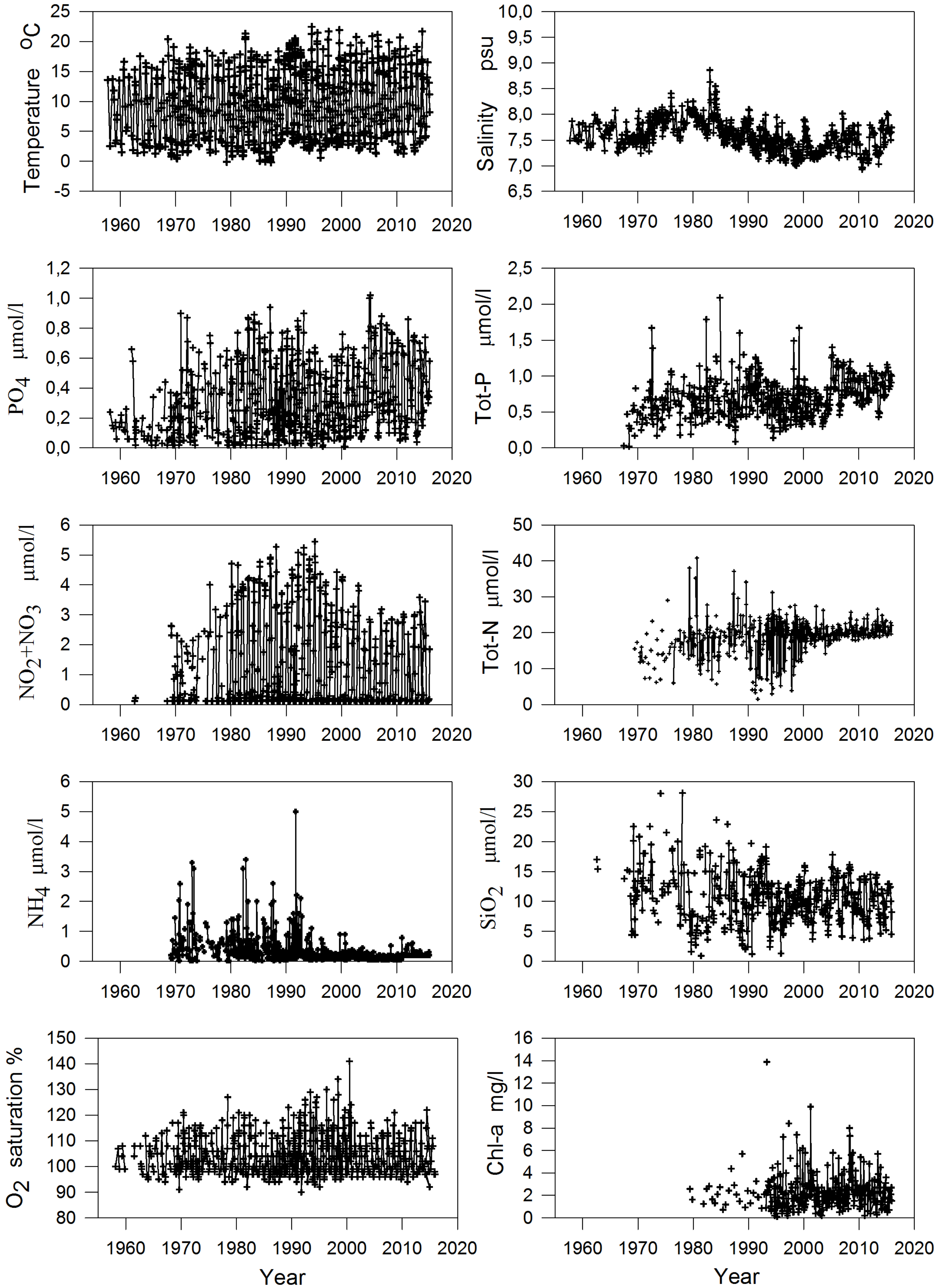
Annual Cycles



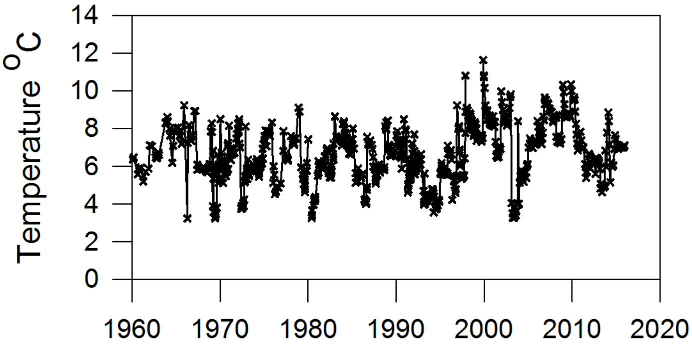
OXYGEN IN BOTTOM WATER (depth >80m)

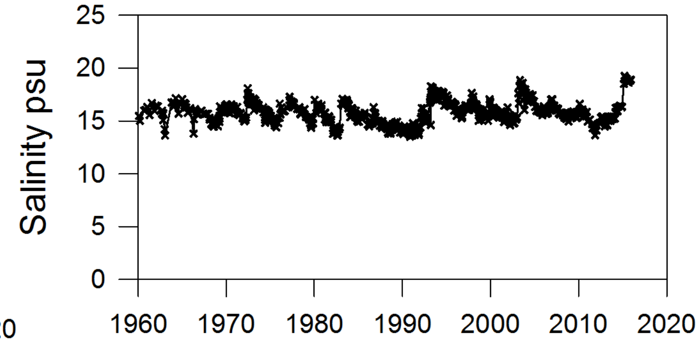


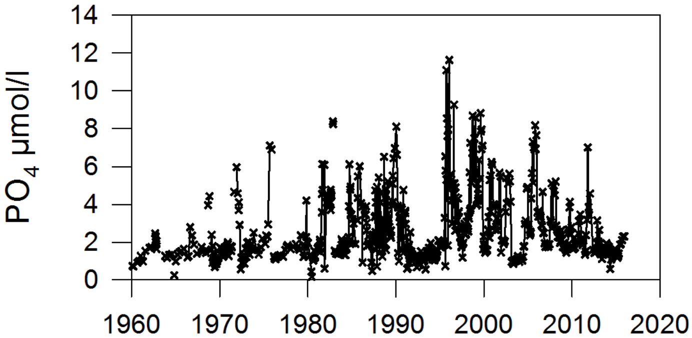
STATION BY5 SURFACE WATER

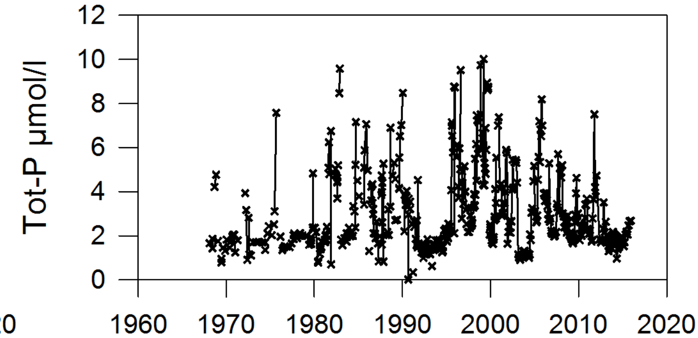


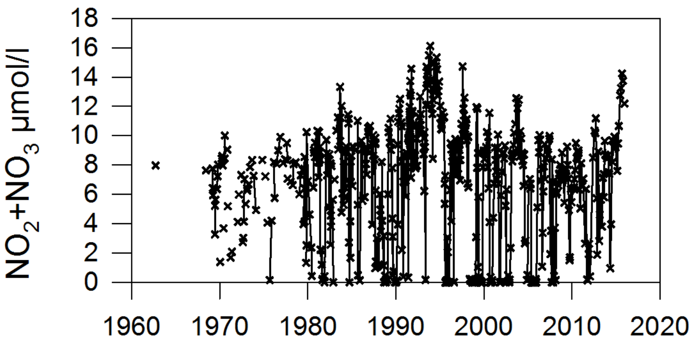
STATION BY5 DEEP WATER (80m)

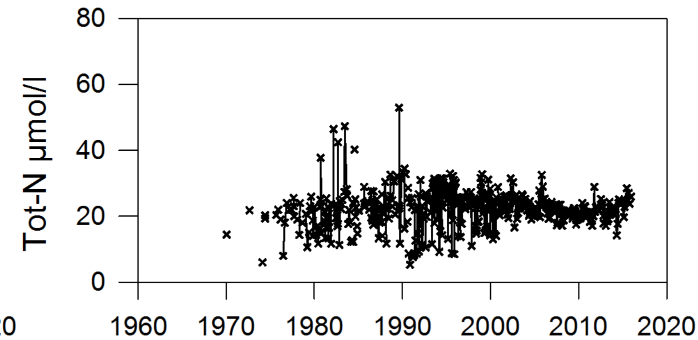


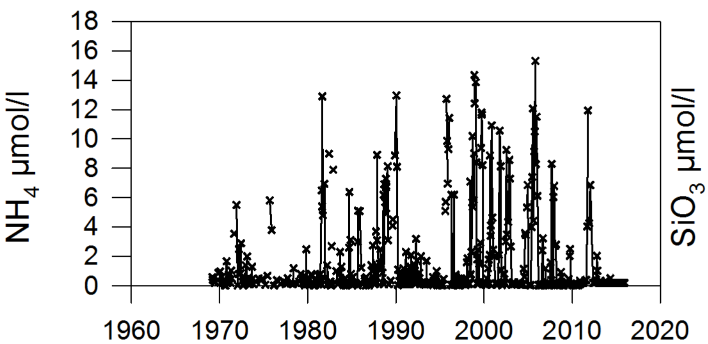


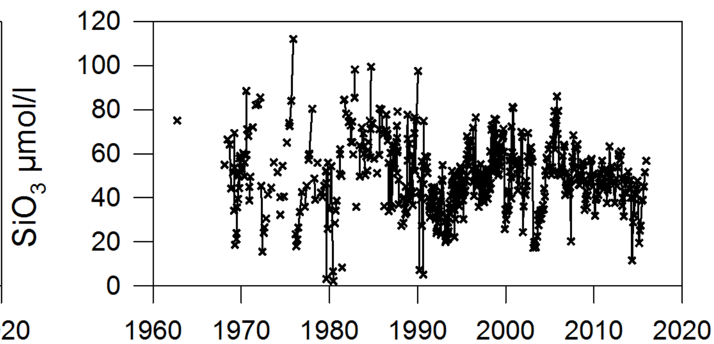


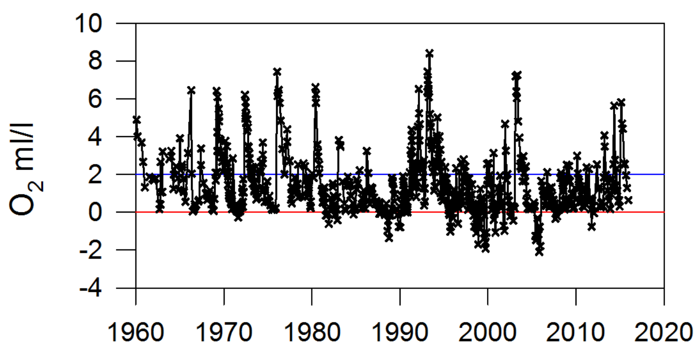






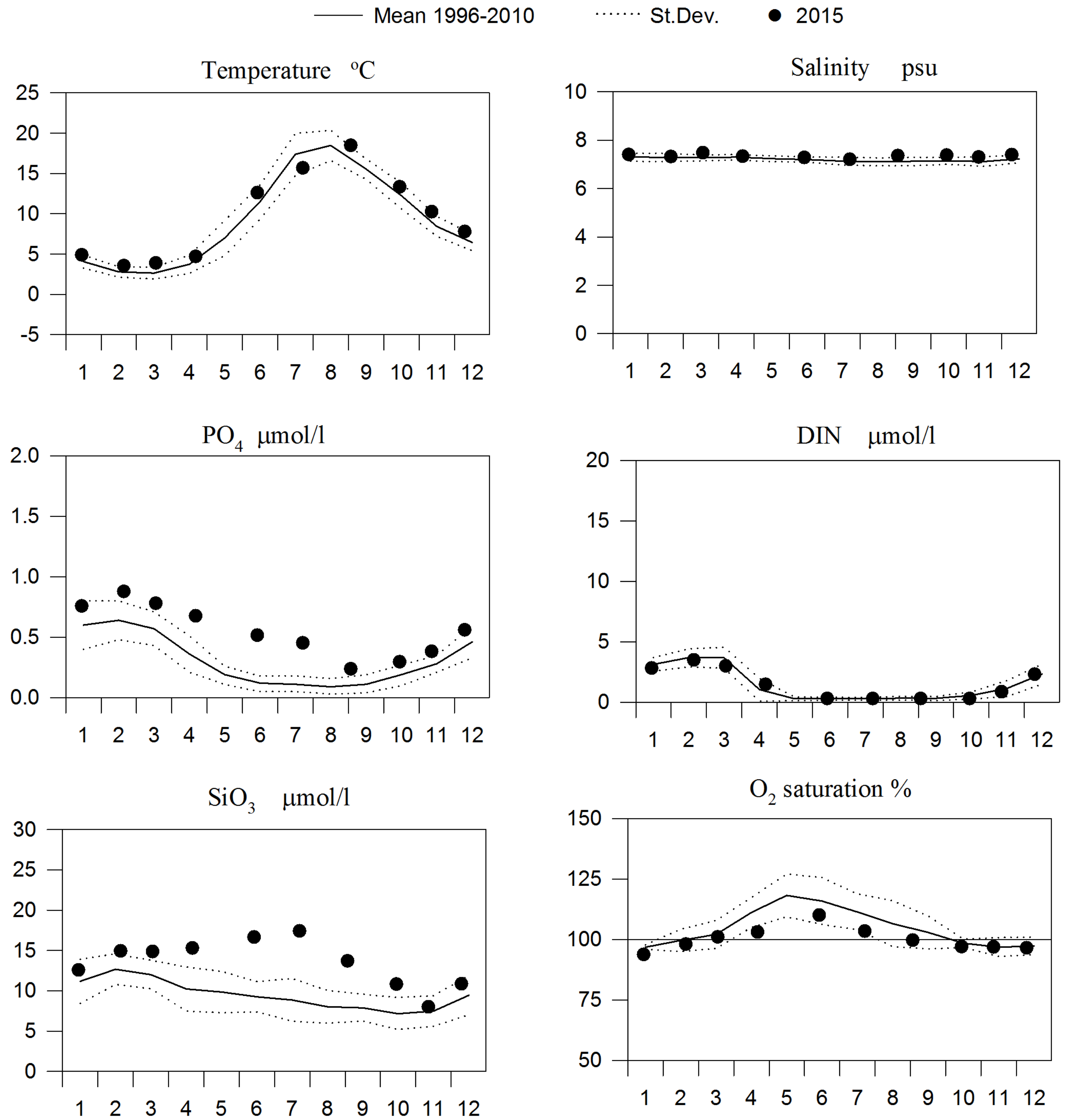




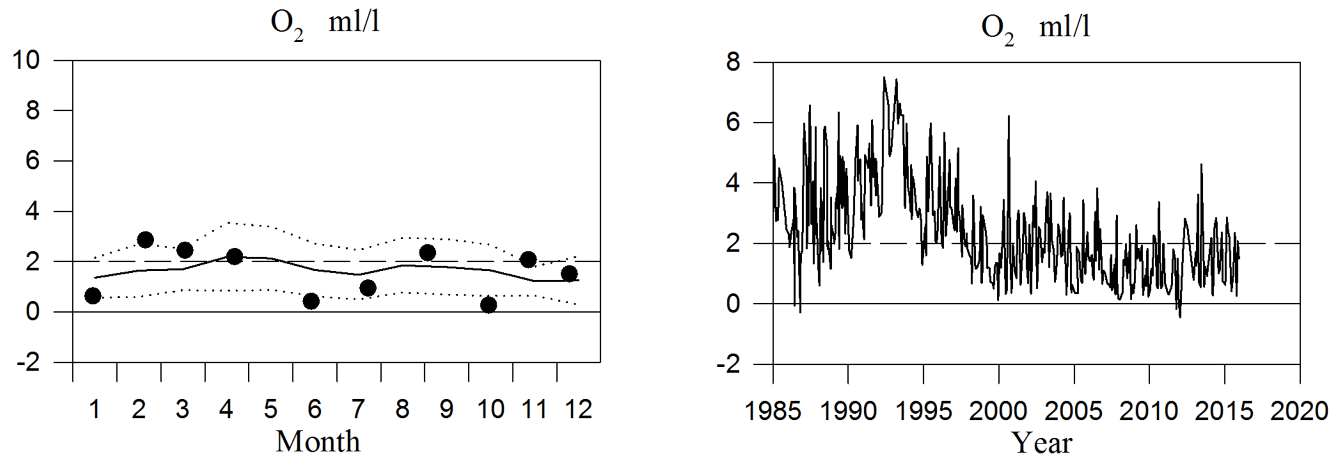


STATION BCS III-10 SURFACE WATER

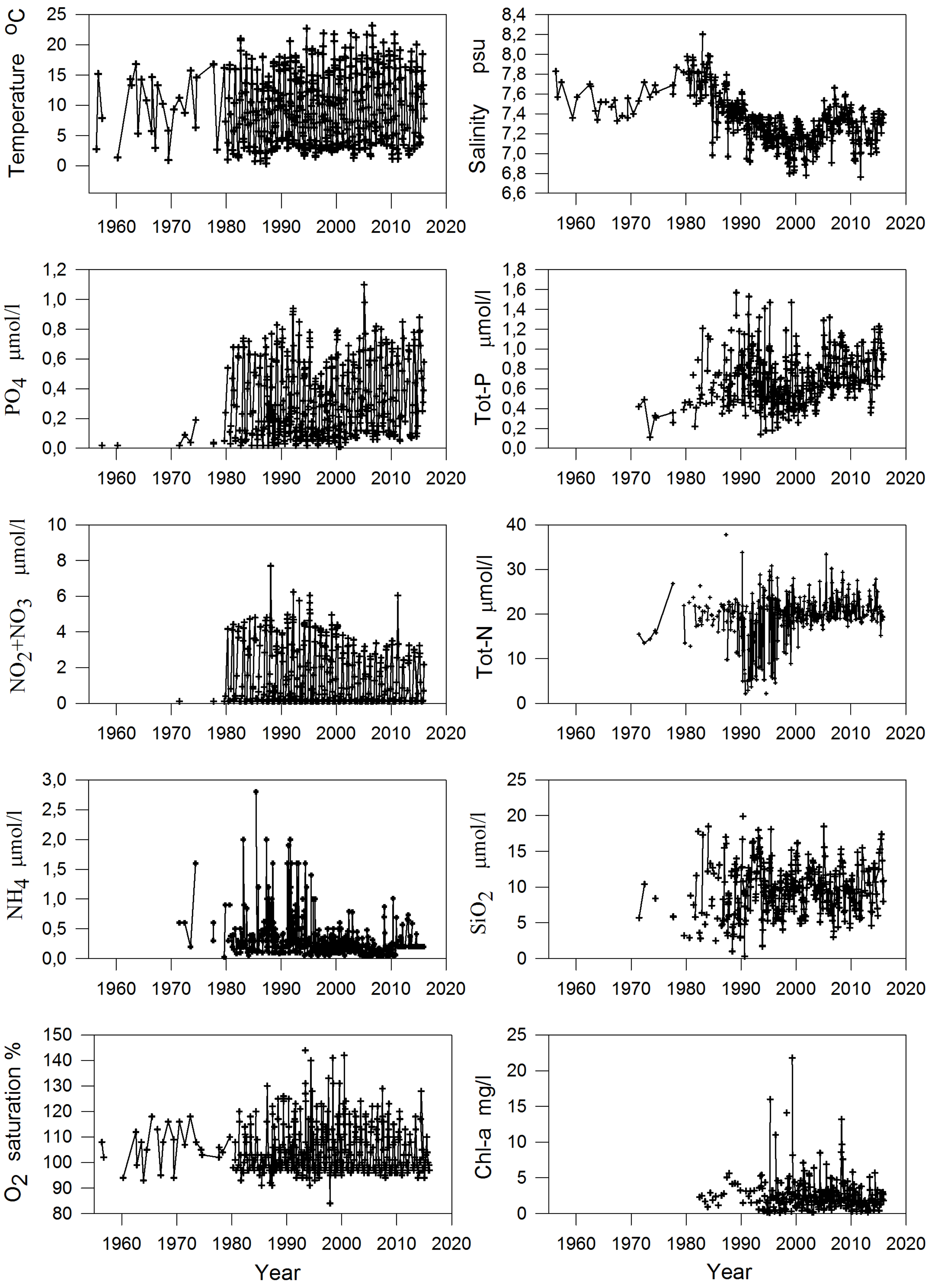
Annual Cycles



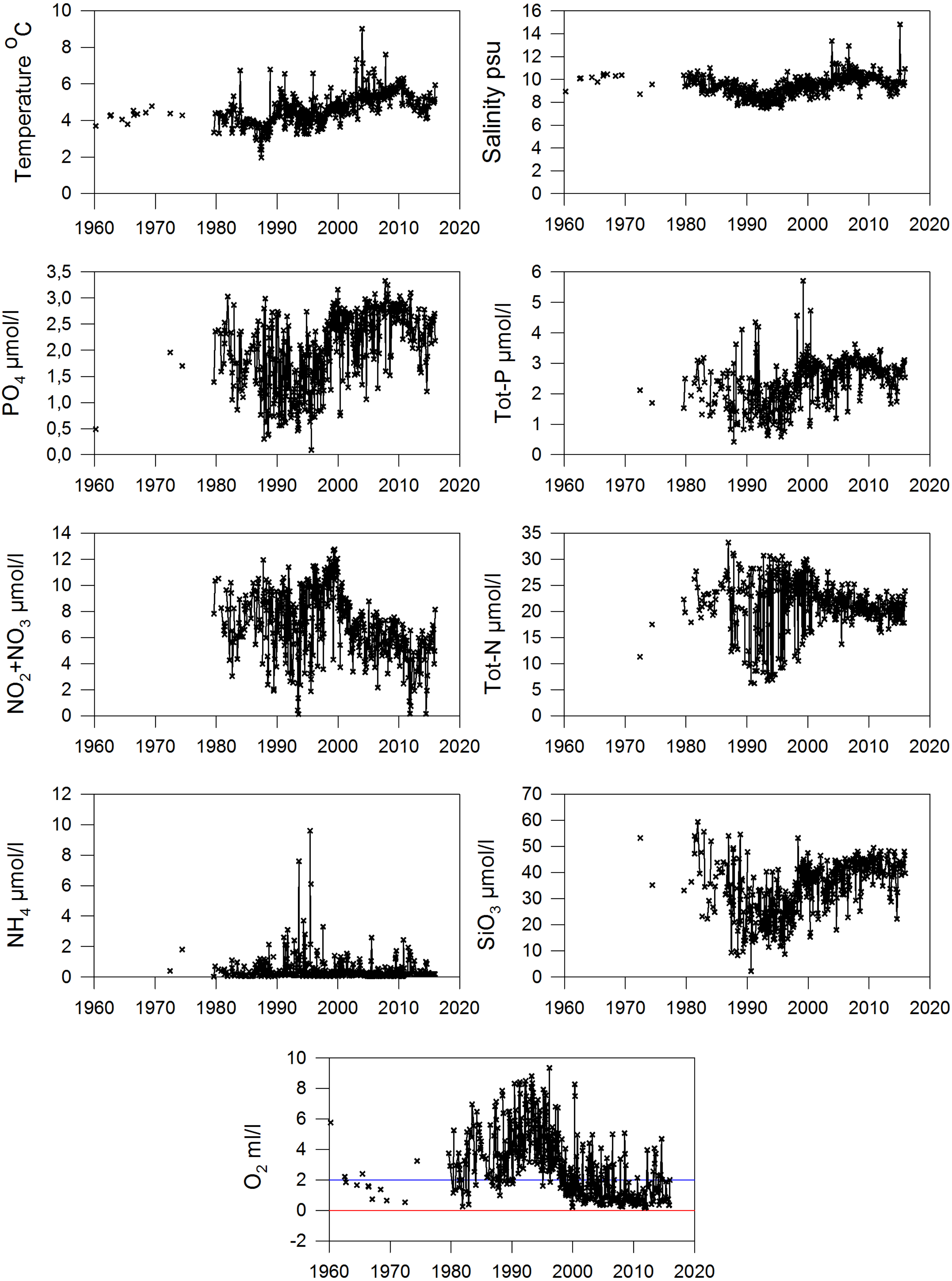
OXYGEN IN BOTTOM WATER (depth > 80m)



STATION BCS III-10 SURFACE WATER

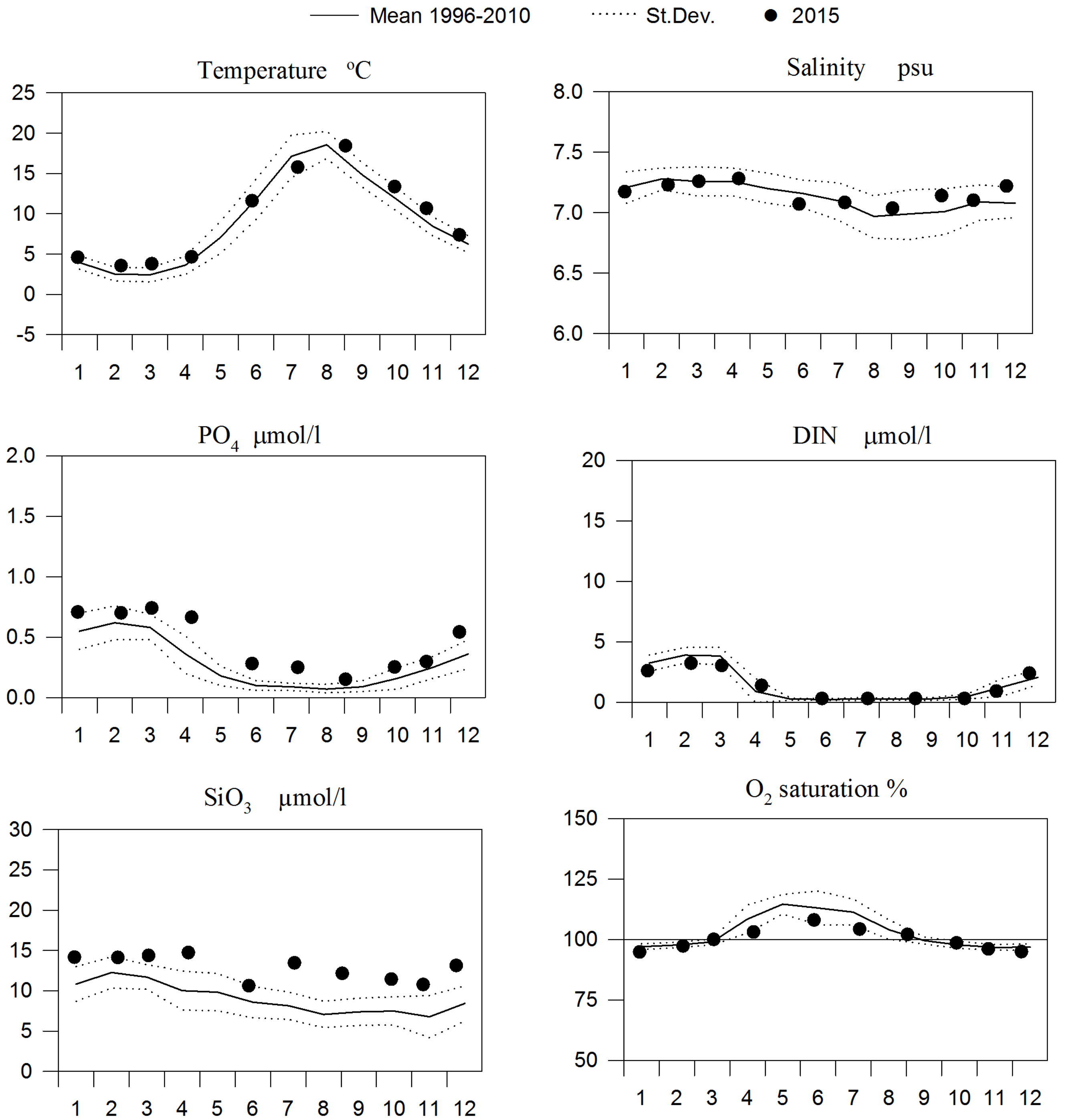


STATION BCS III-10 DEEP WATER (80m)

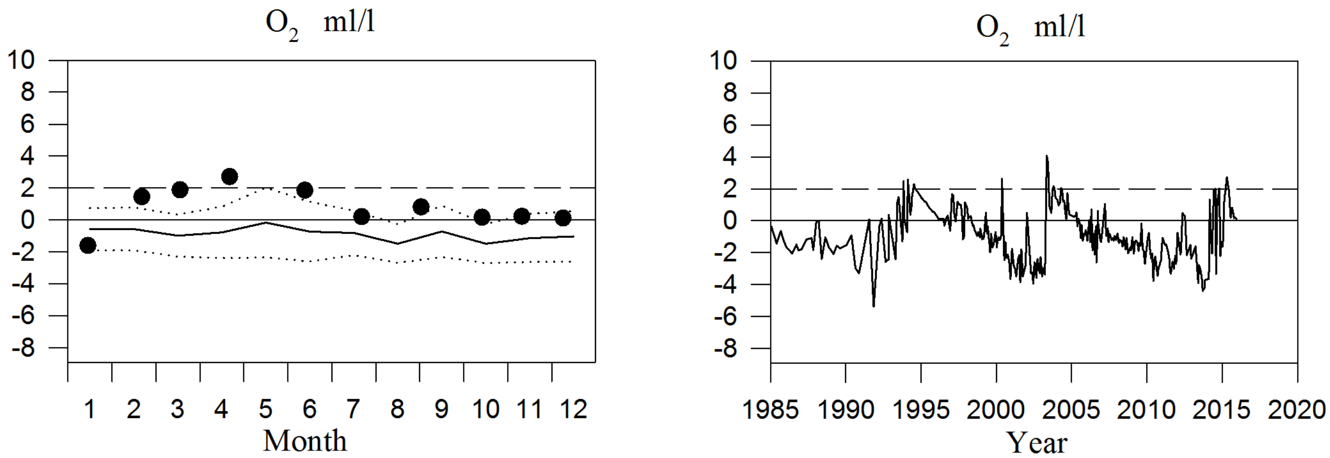


STATION BY10 SURFACE WATER

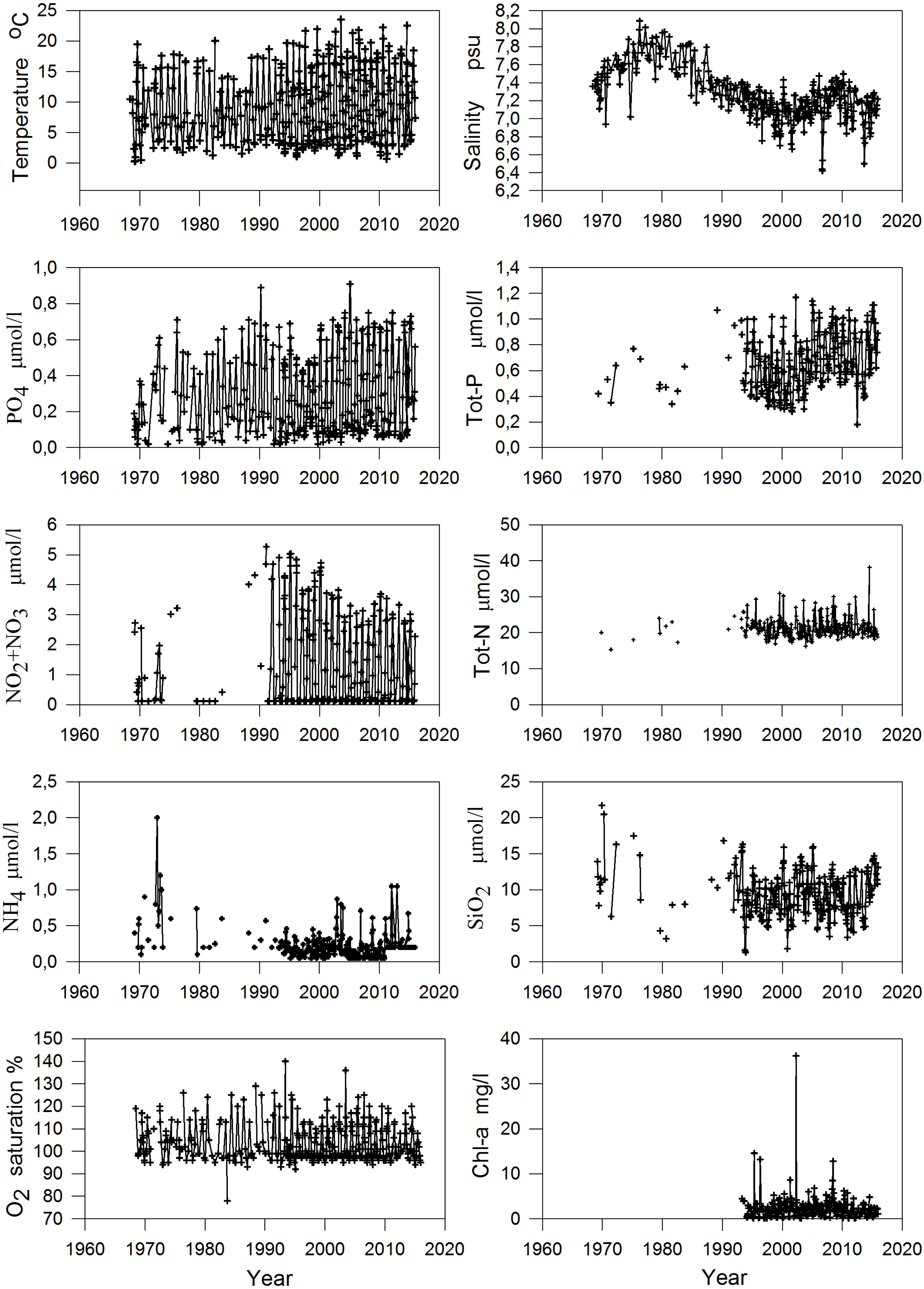
Annual Cycles



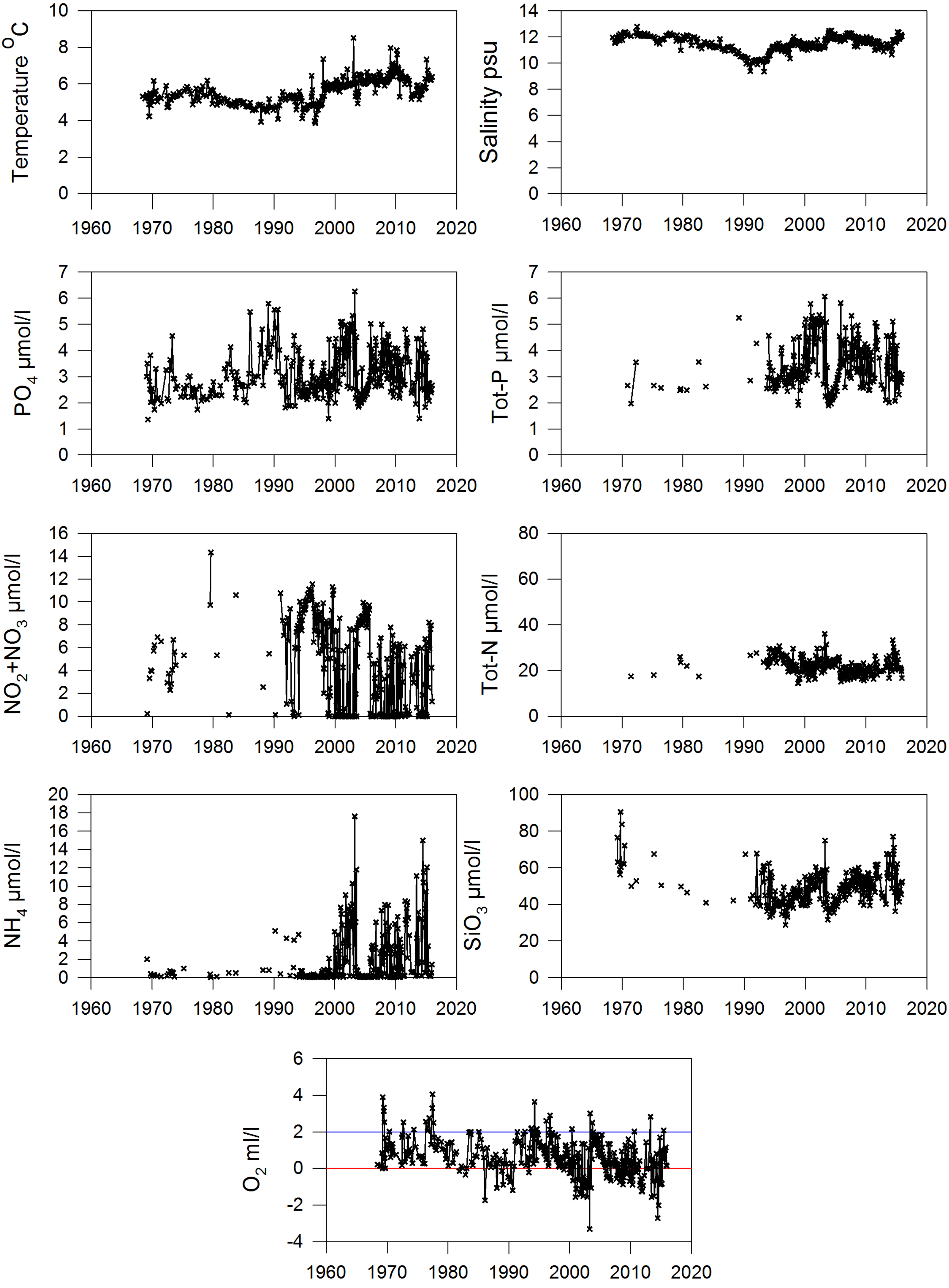
OXYGEN IN BOTTOM WATER (depth >125m)



STATION BY10 SURFACE WATER



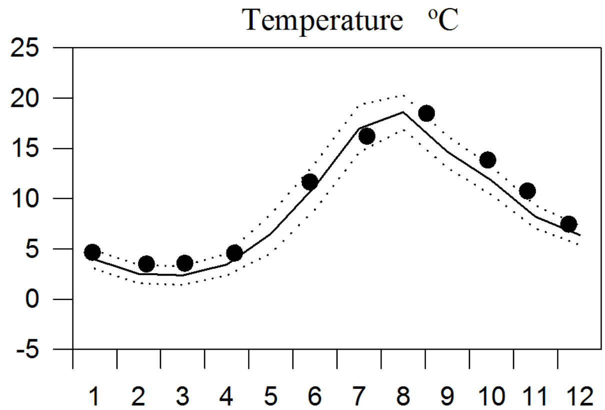
STATION BY10 DEEP WATER (125m)

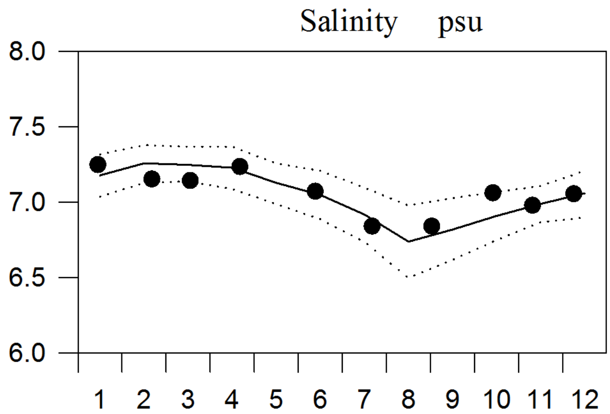


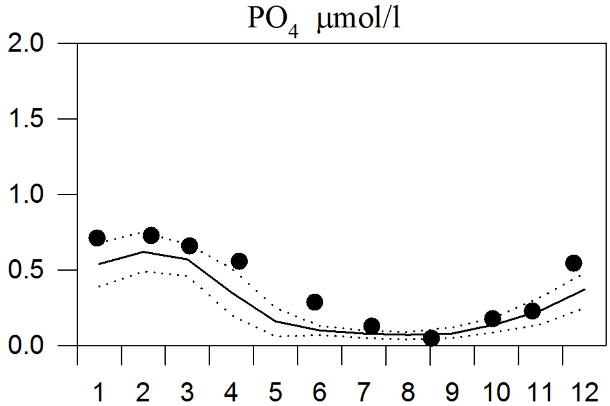
STATION BY15 SURFACE WATER

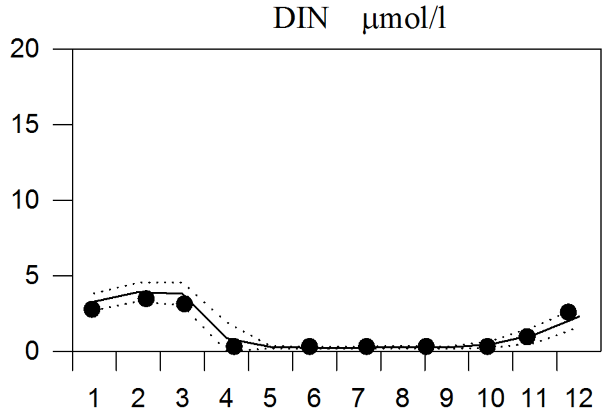
Annual Cycles

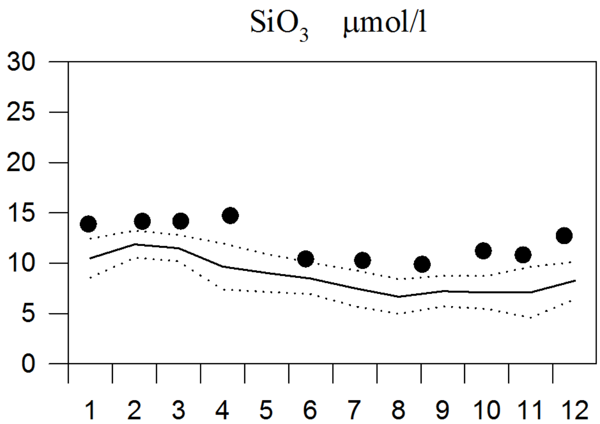
Mean 1996-2010 ······ St.Dev. ● 2015

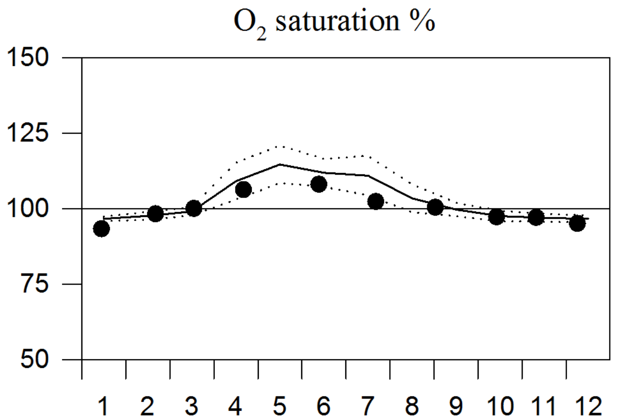




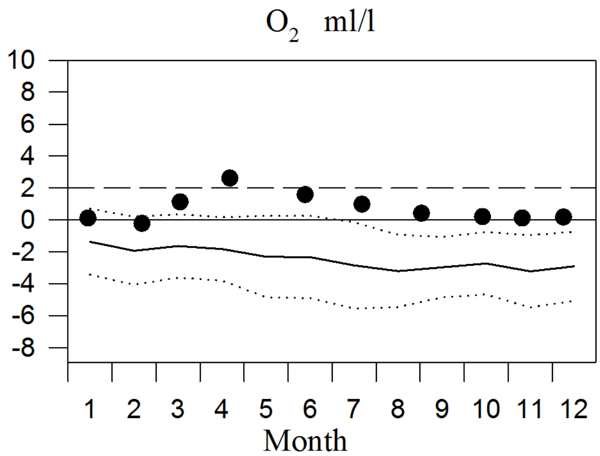


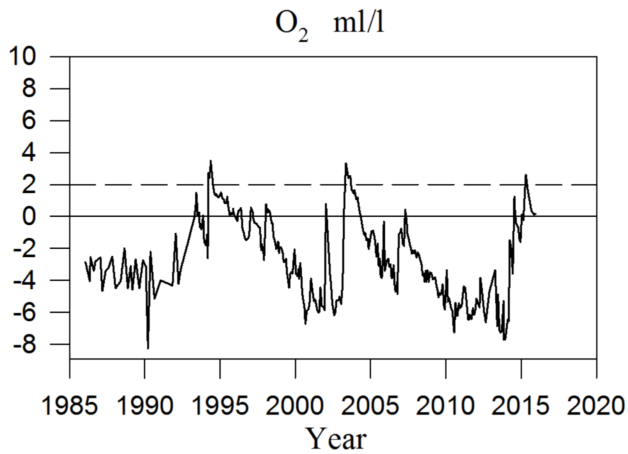




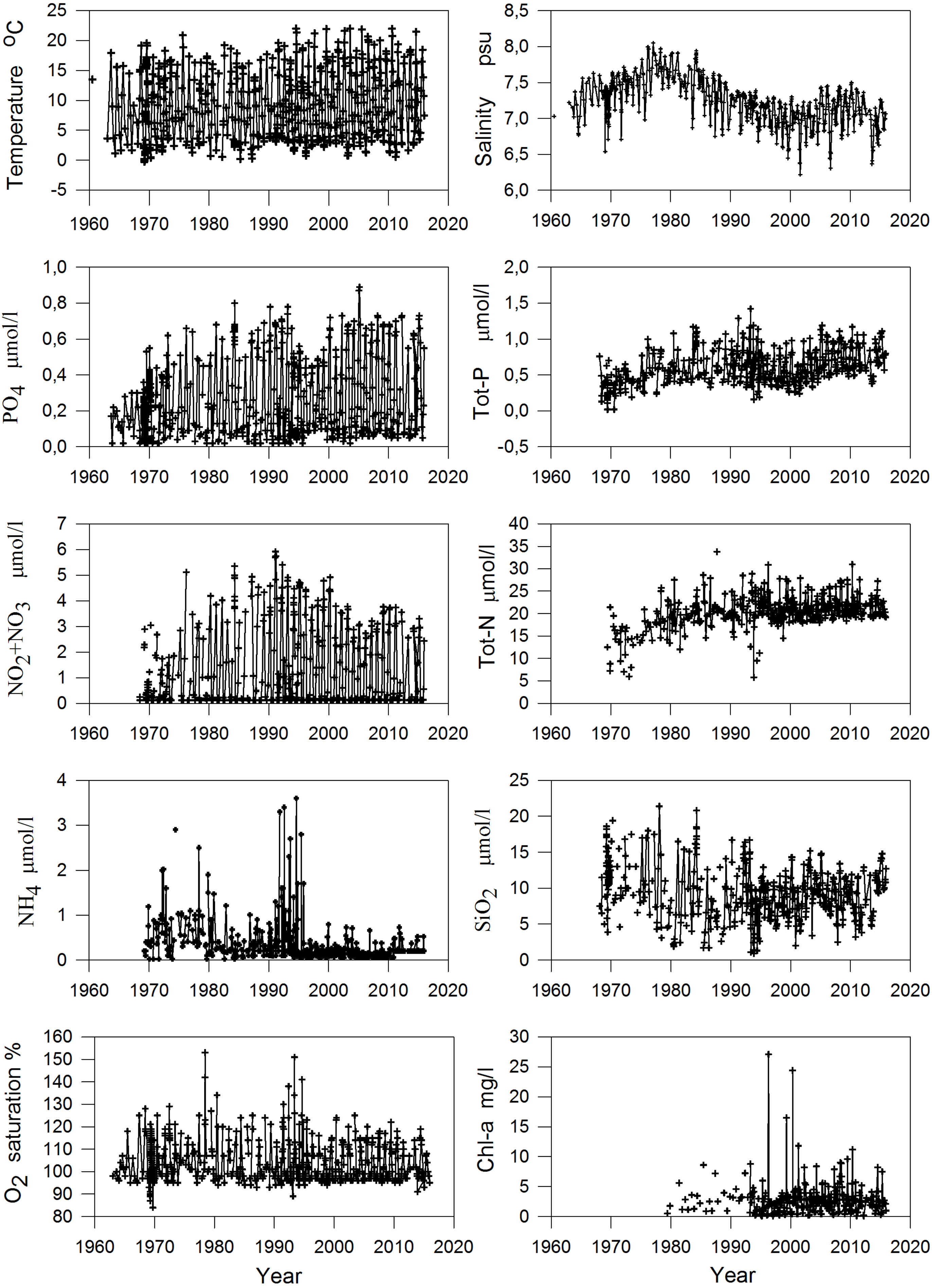


OXYGEN IN BOTTOM WATER (depth >225m)

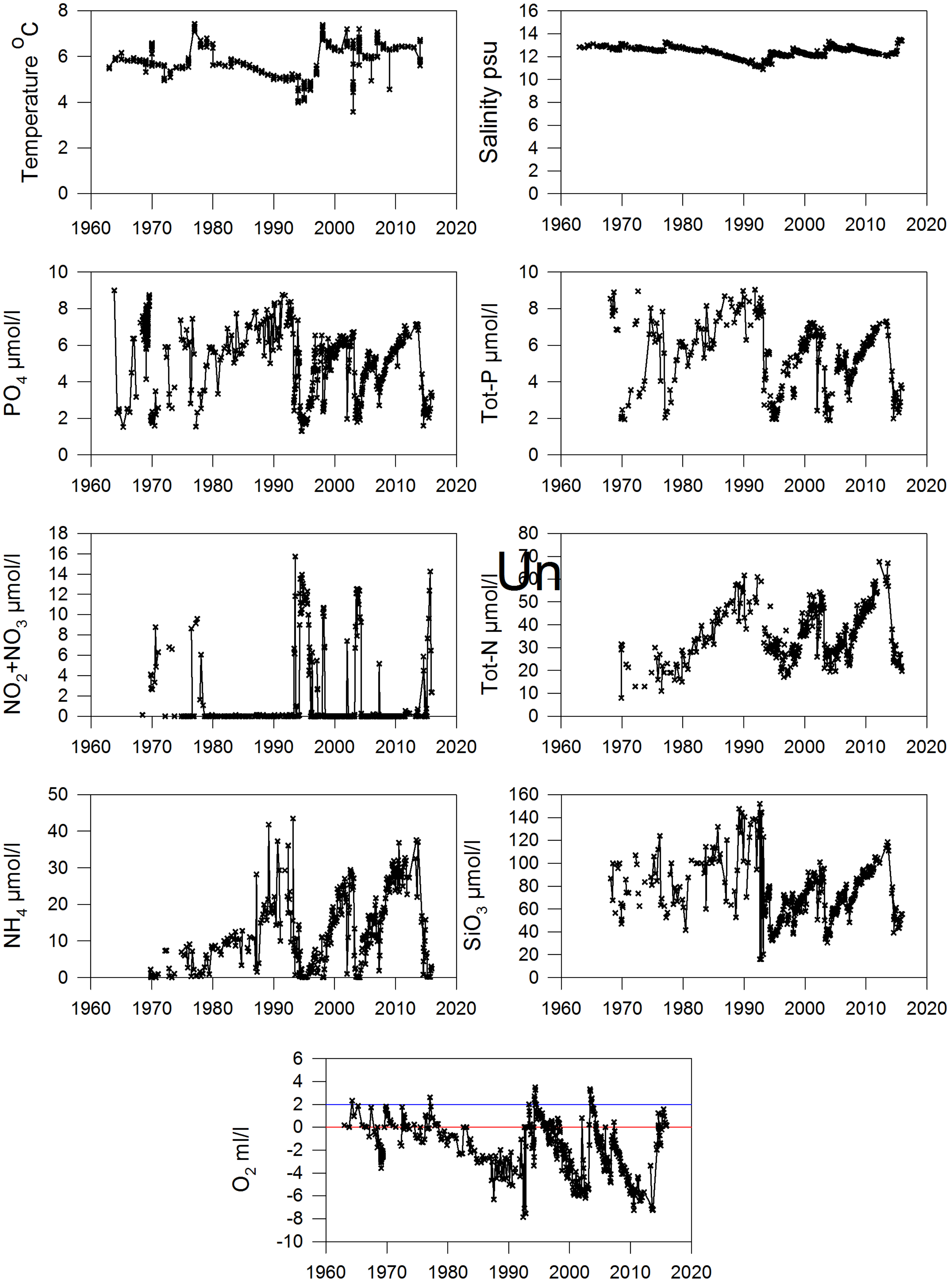




STATION BY15 SURFACE WATER



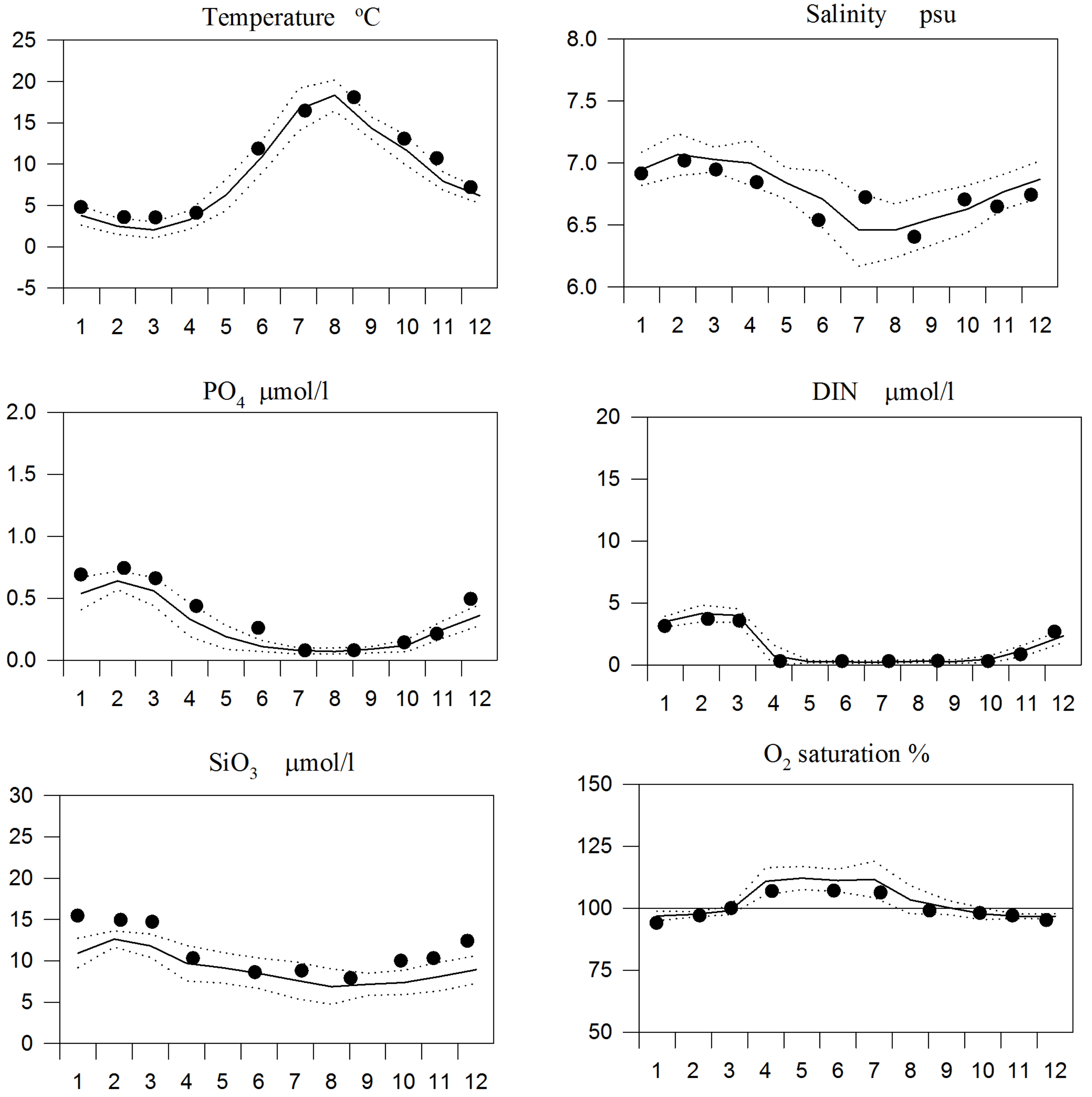
STATION BY15 DEEP WATER (240m)



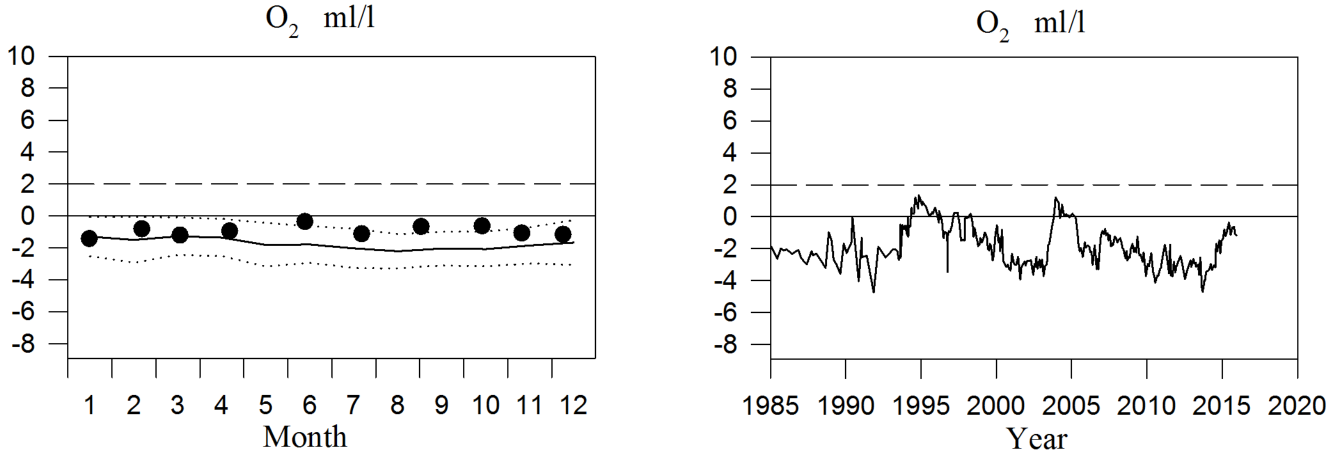
STATION BY20 SURFACE WATER

Annual Cycles

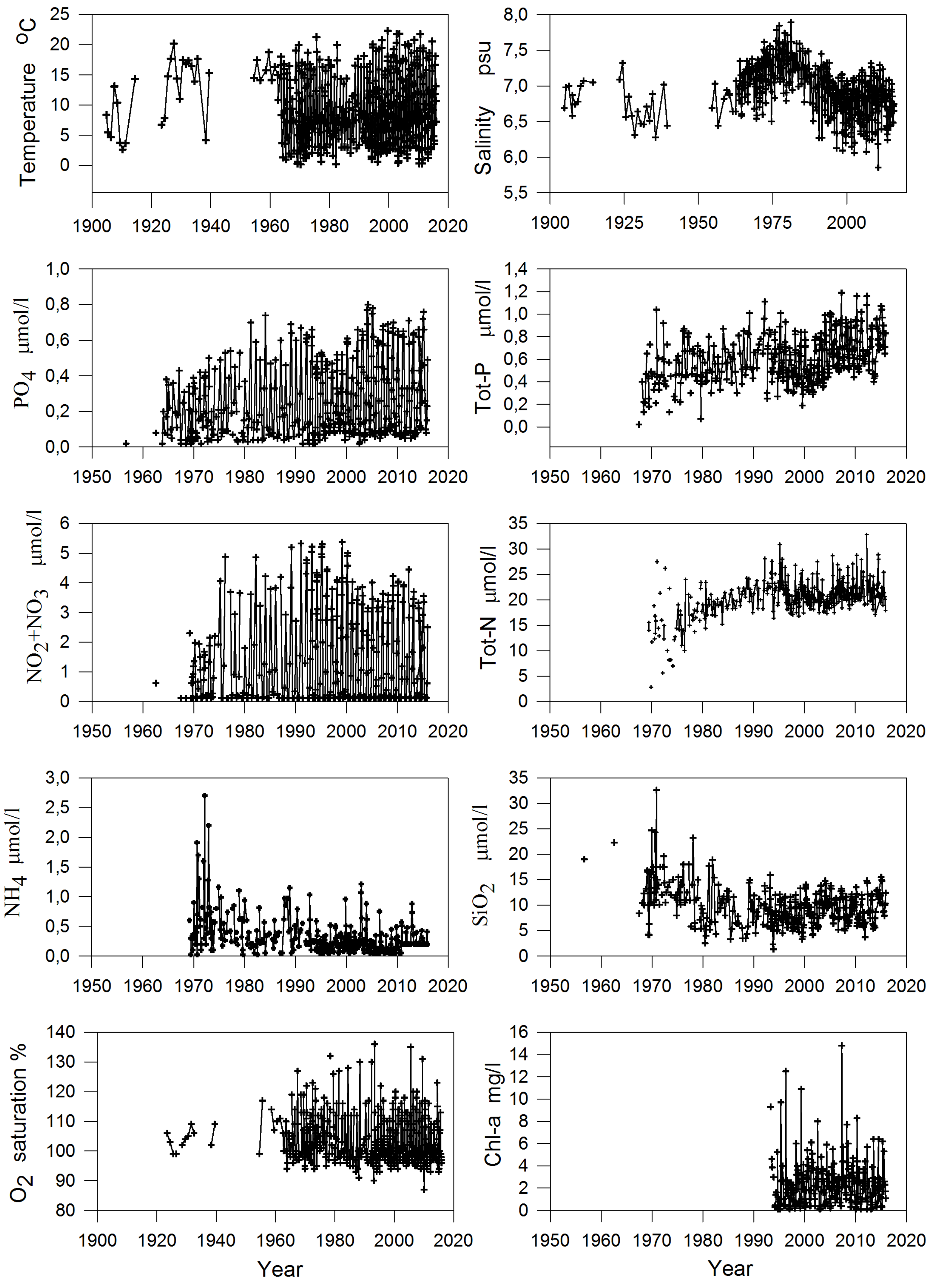
Mean 1996-2010 ····· St.Dev. ● 2015



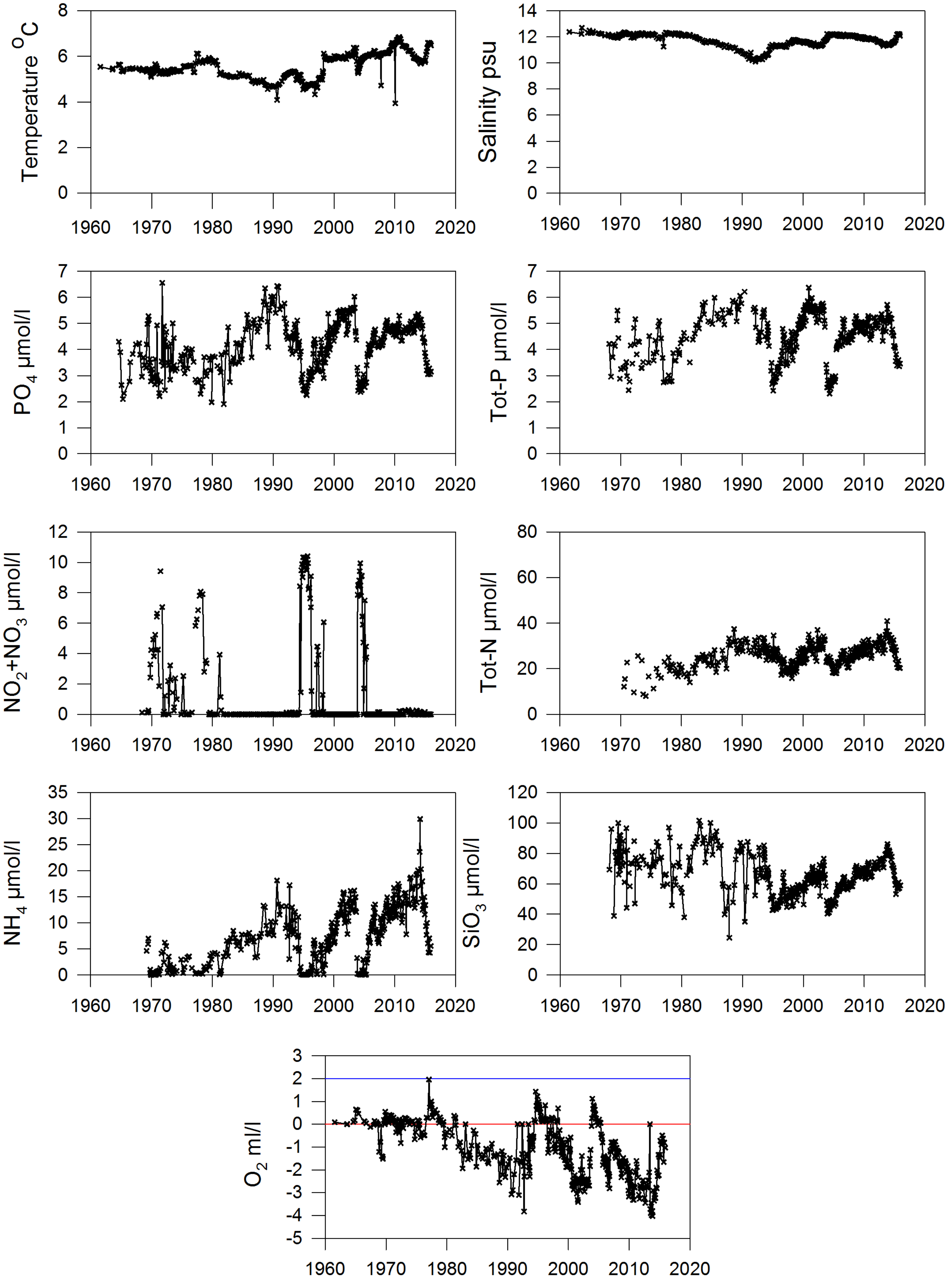
OXYGEN IN BOTTOM WATER (depth >175m)



STATION BY20 SURFACE WATER



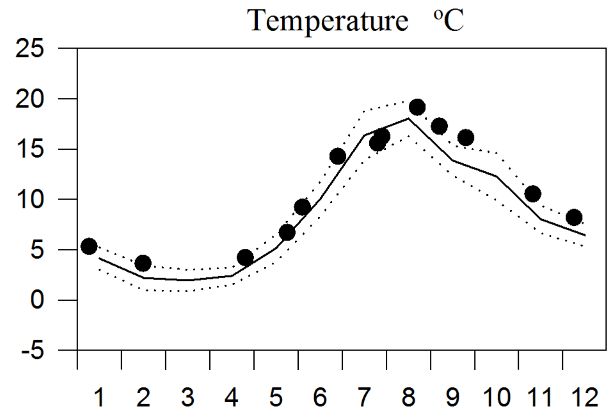
STATION BY20 DEEP WATER (175m)

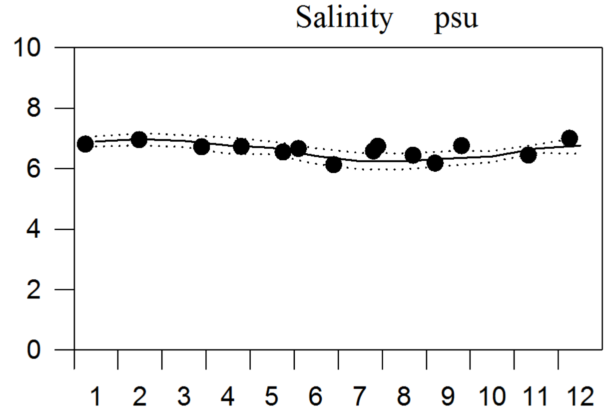


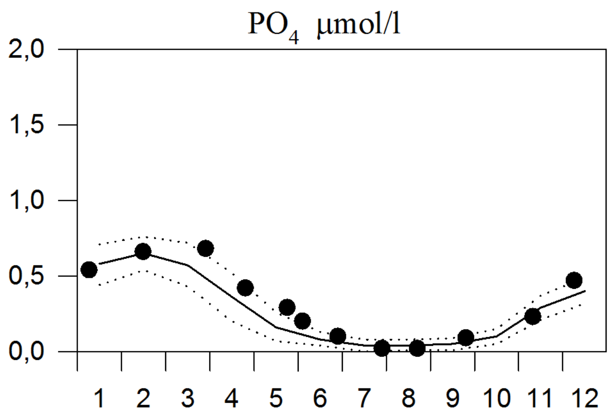
STATION BY29 SURFACE WATER

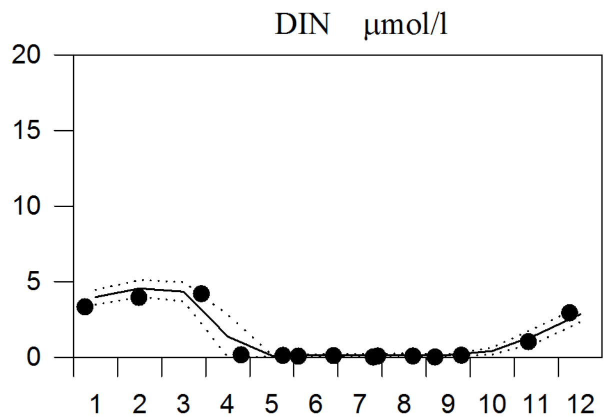
Annual Cycles

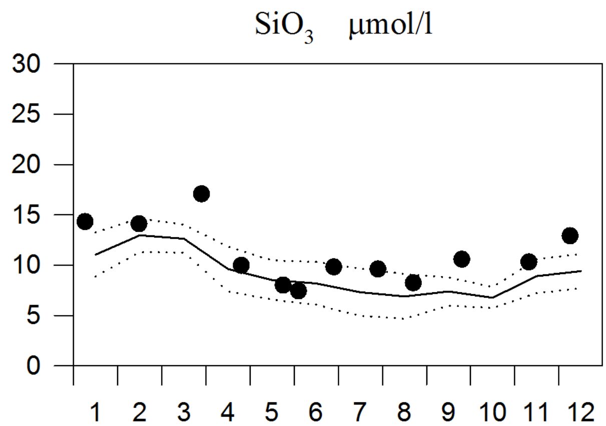
Mean 1996-2010 ······ St.Dev. ● 2015

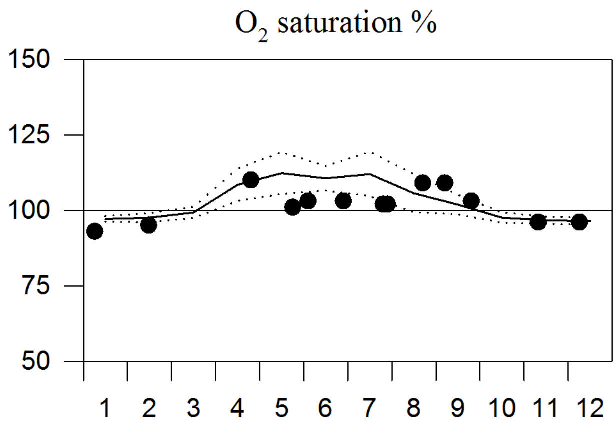




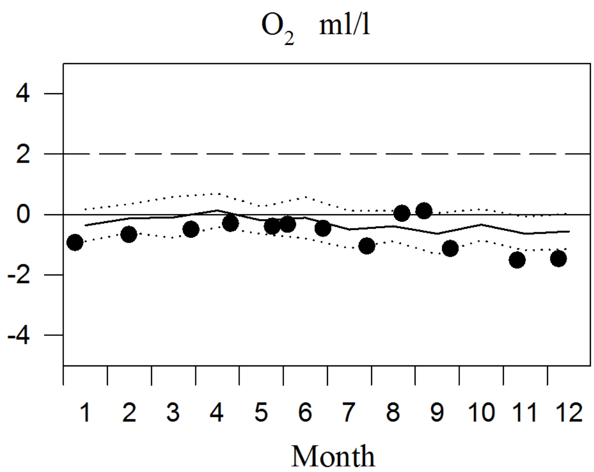


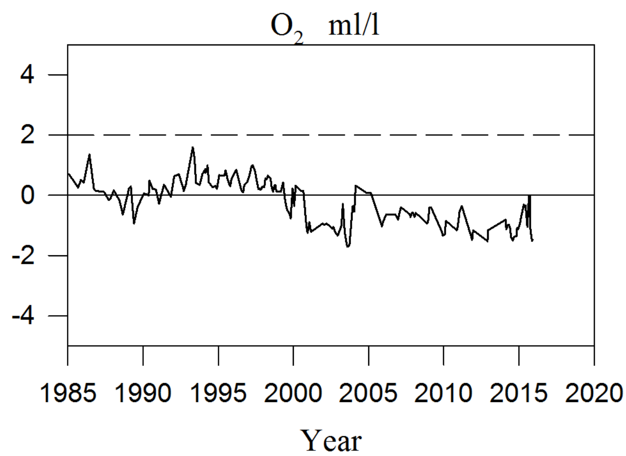




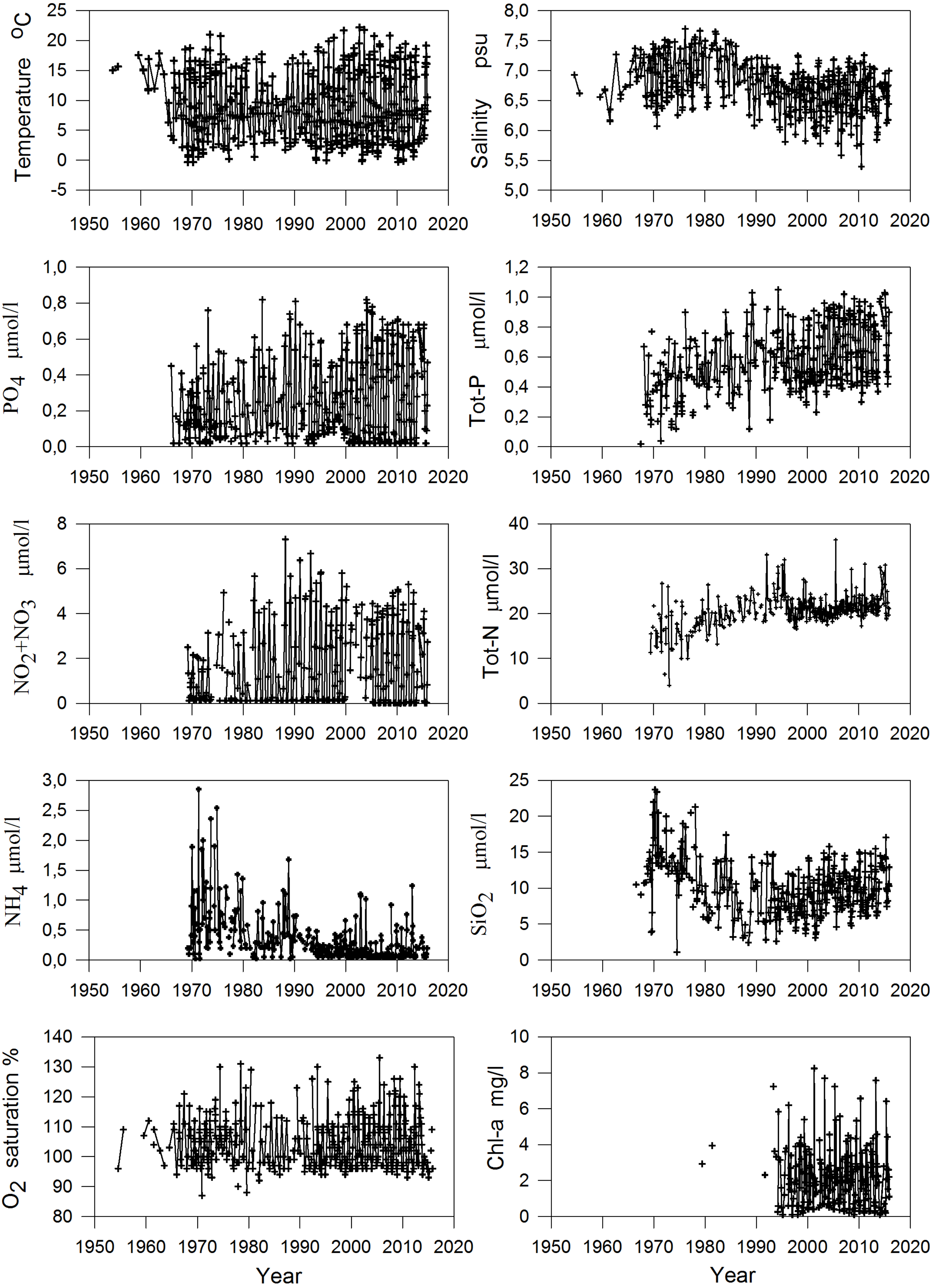


OXYGEN IN BOTTOM WATER (>=150m)

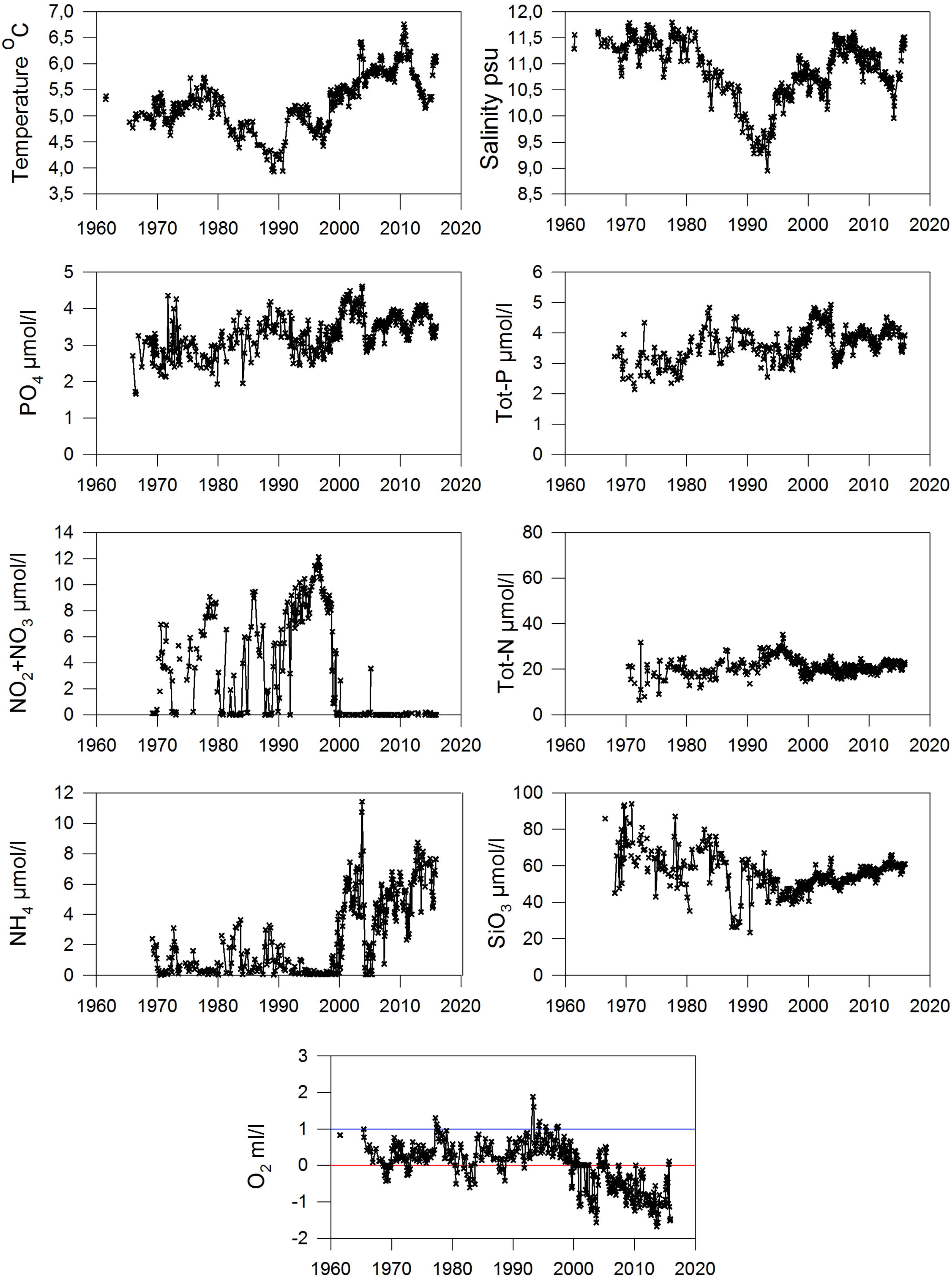




STATION BY29 SURFACE WATER

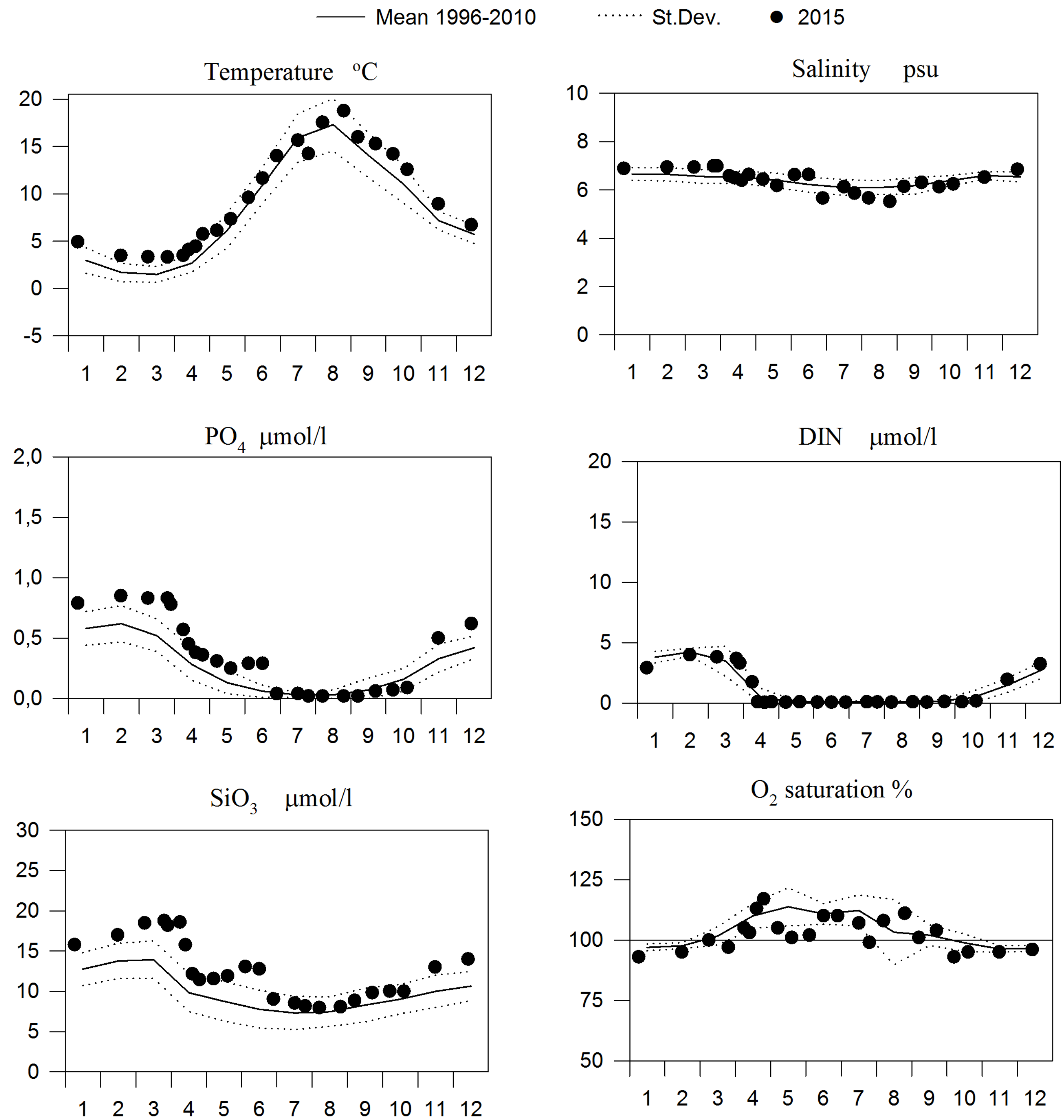


STATION BY29 DEEP WATER (150m)

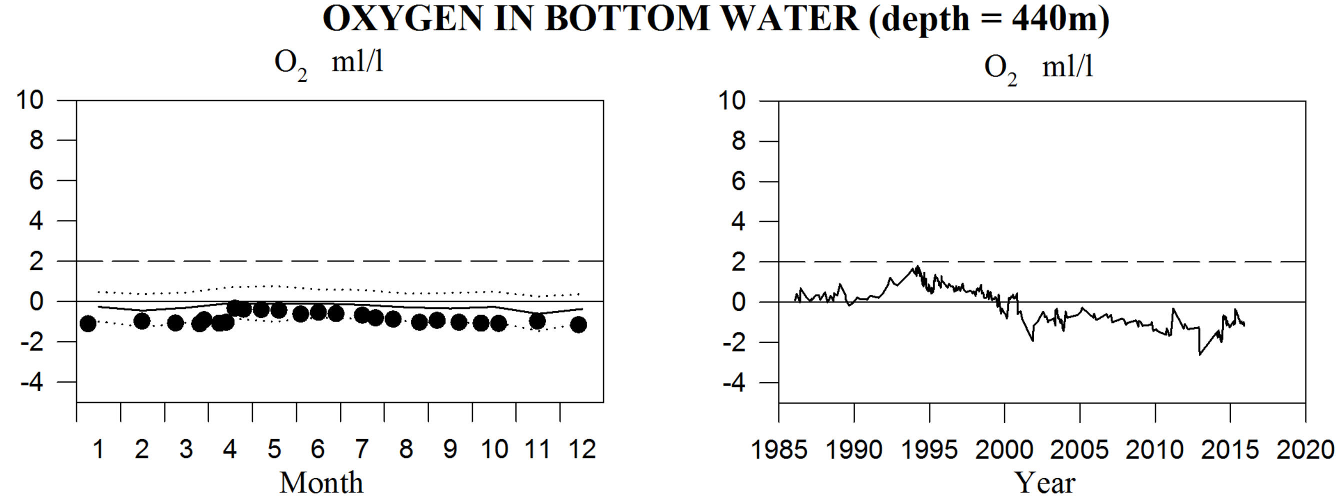


STATION BY31 SURFACE WATER

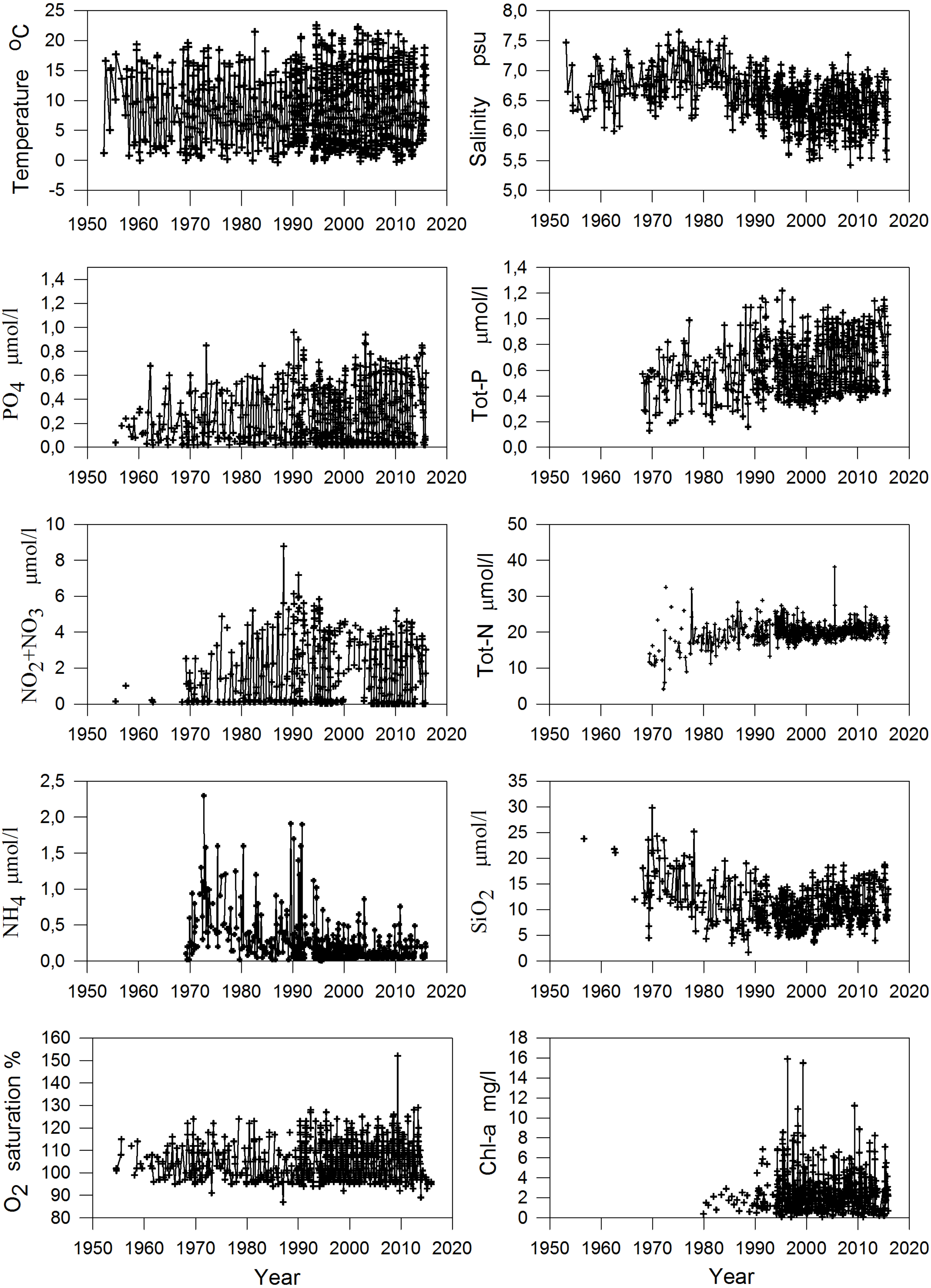
Annual Cycles



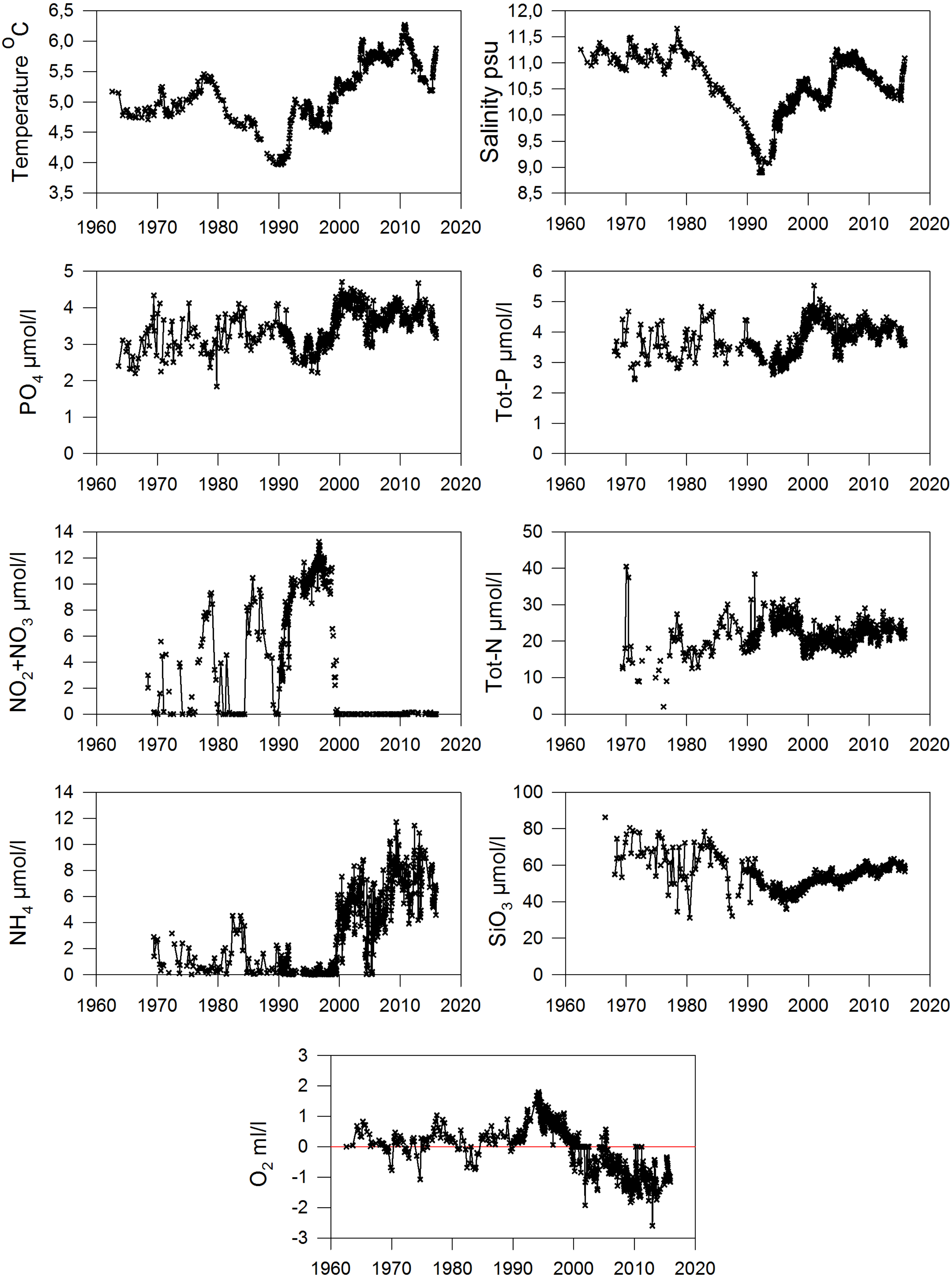
OXYGEN IN BOTTOM WATER (depth = 440m)



STATION BY31 SURFACE WATER

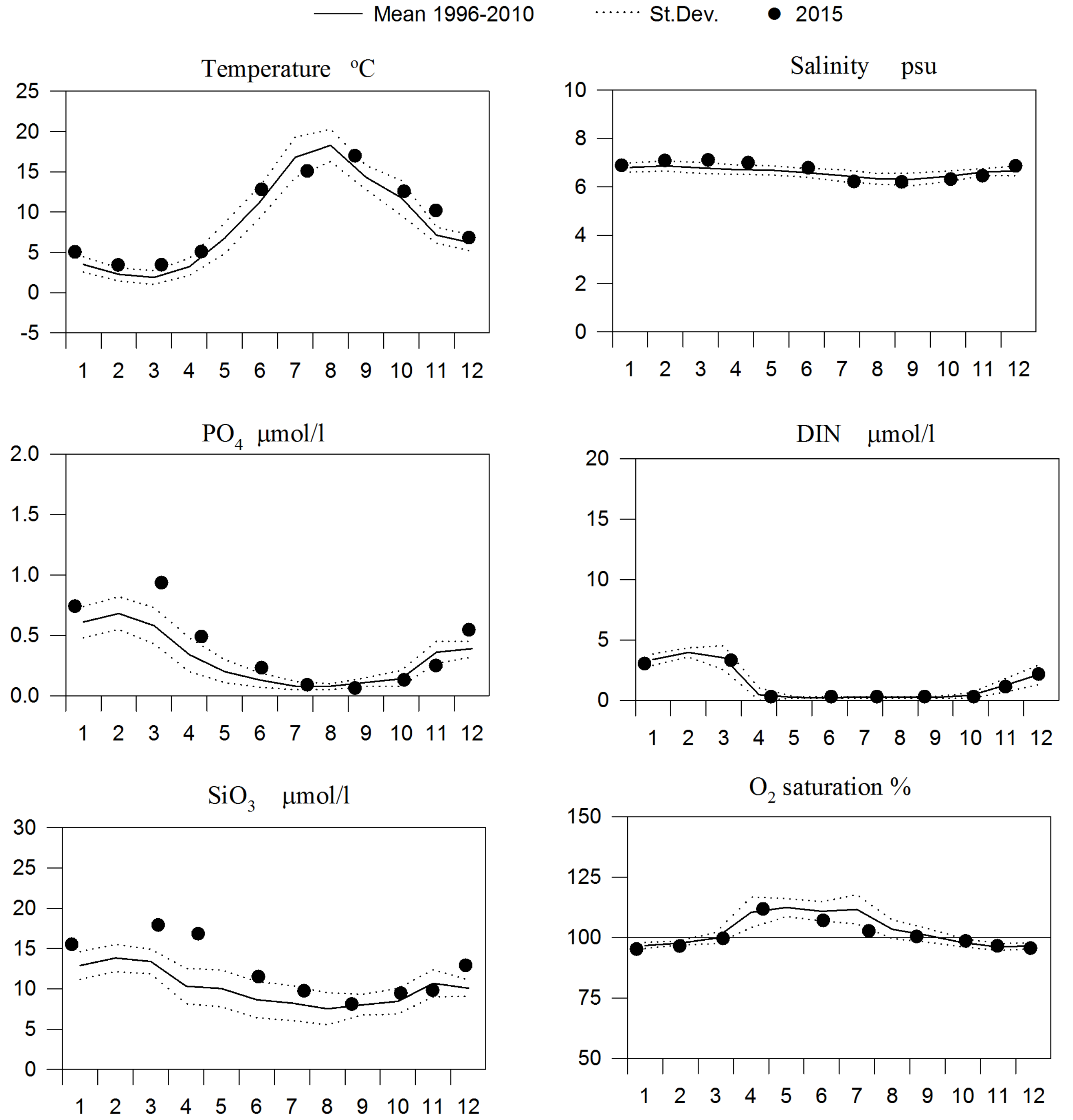


STATION BY31 DEEP WATER (440m)

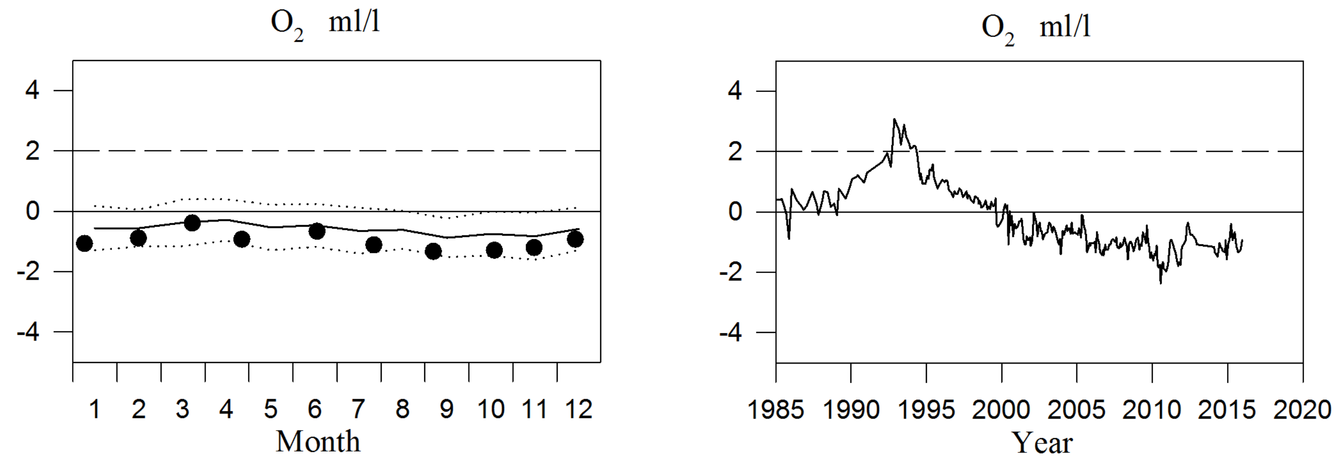


STATION BY32 SURFACE WATER

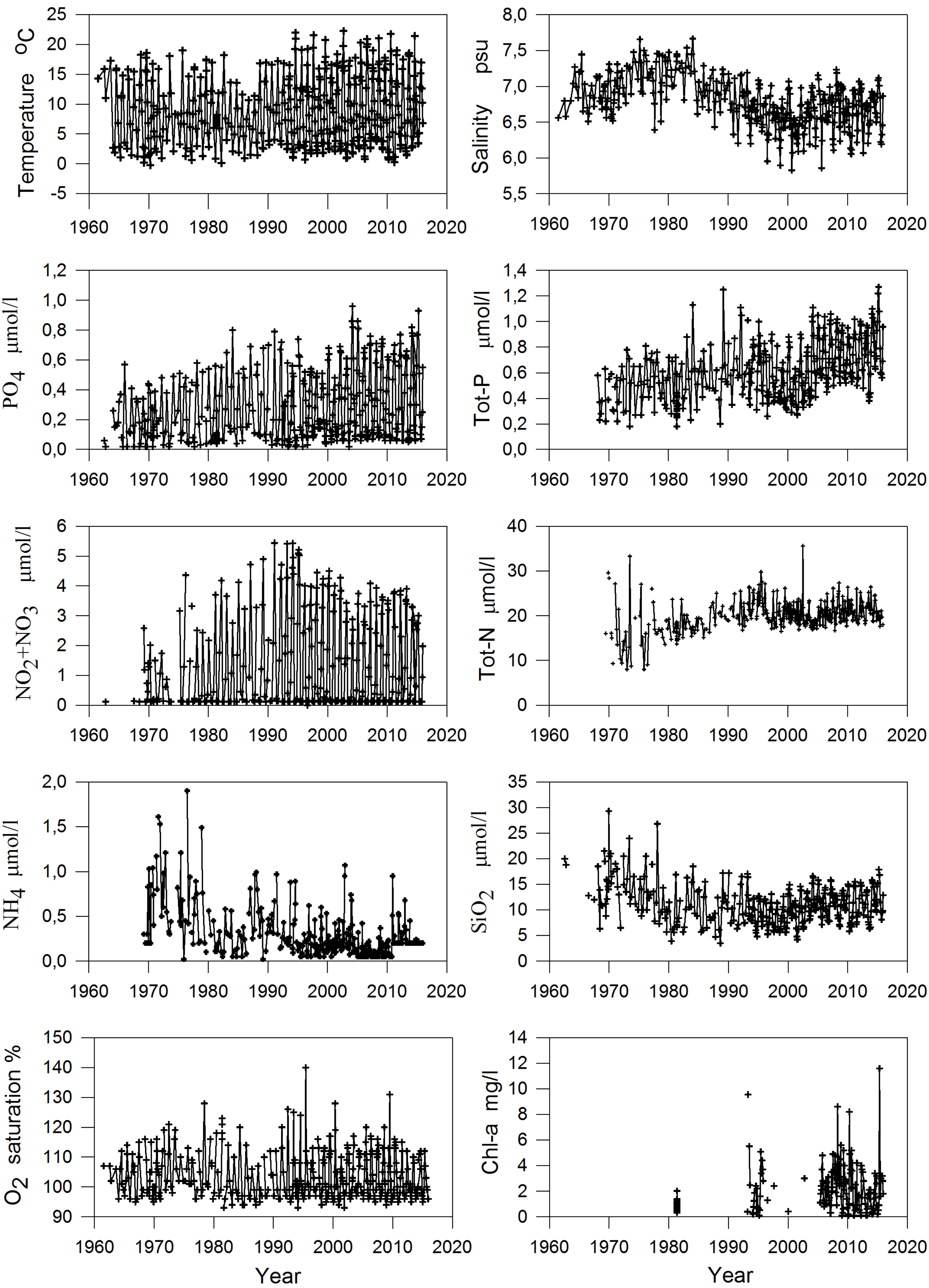
Annual Cycles



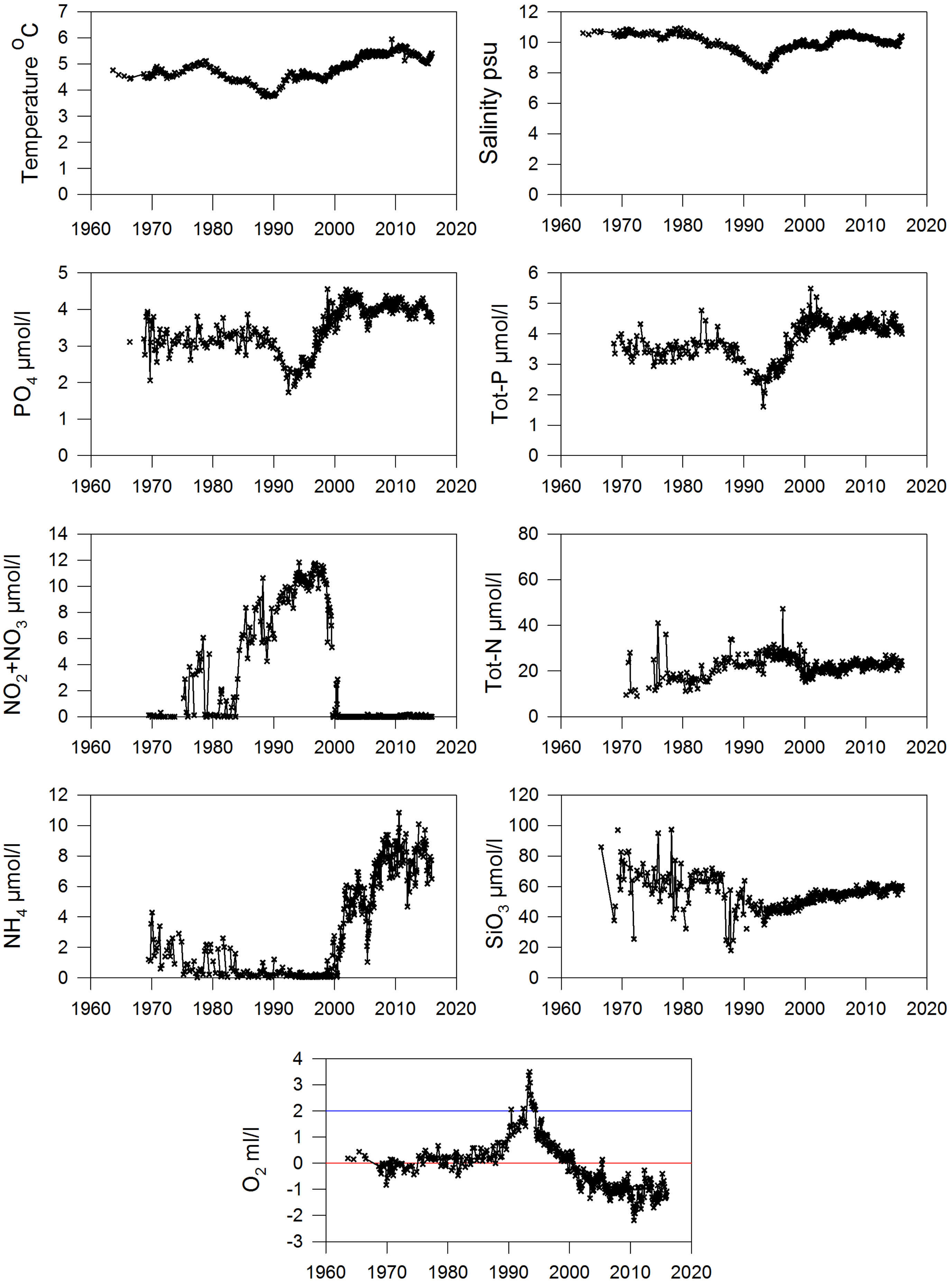
OXYGEN IN BOTTOM WATER (depth > 175m)



STATION BY32 SURFACE WATER



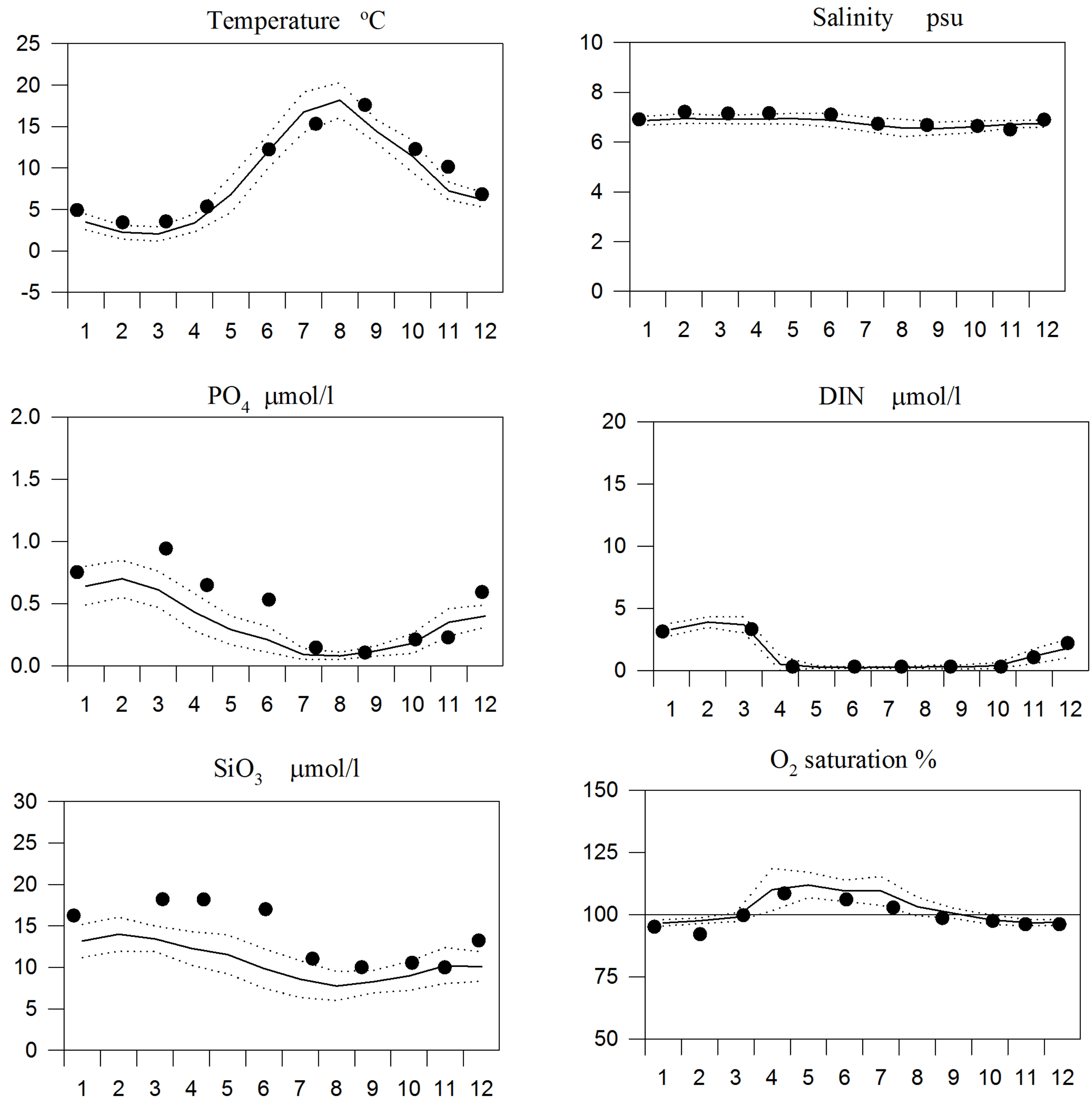
STATION BY32 DEEP WATER (175m)



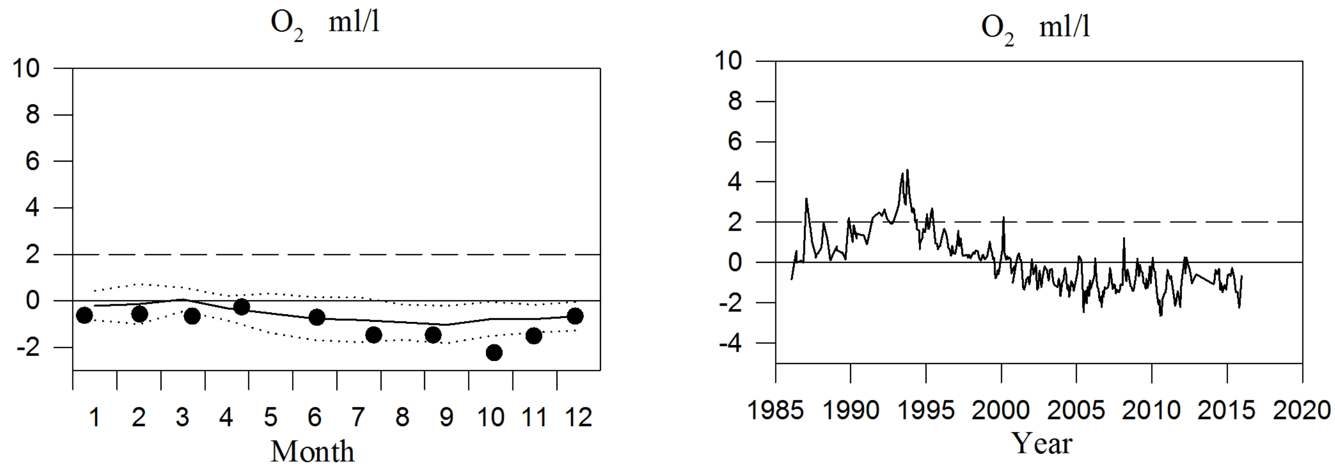
STATION BY38 SURFACE WATER

Annual Cycles

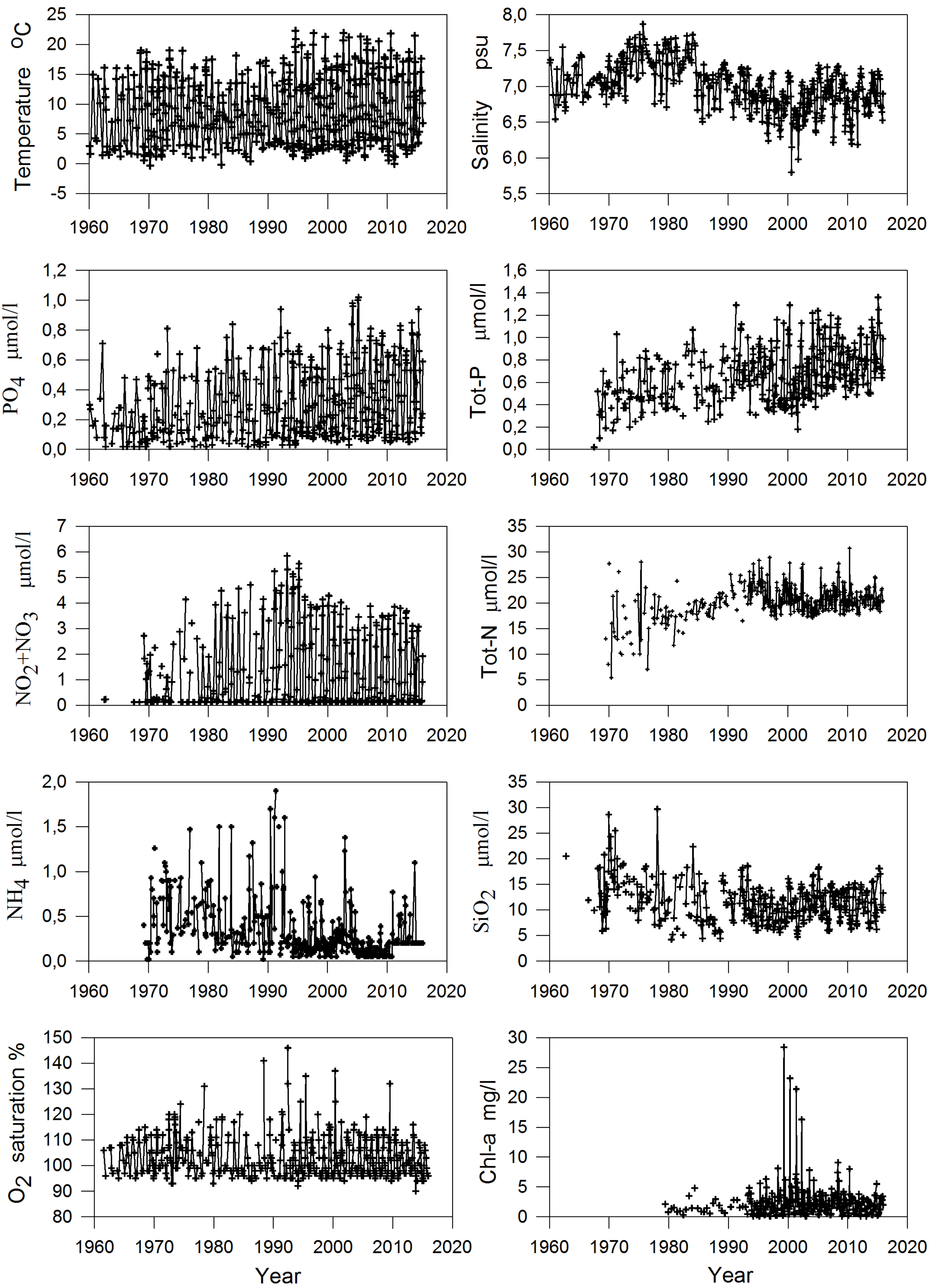
Mean 1996-2010 St.Dev. ● 2015



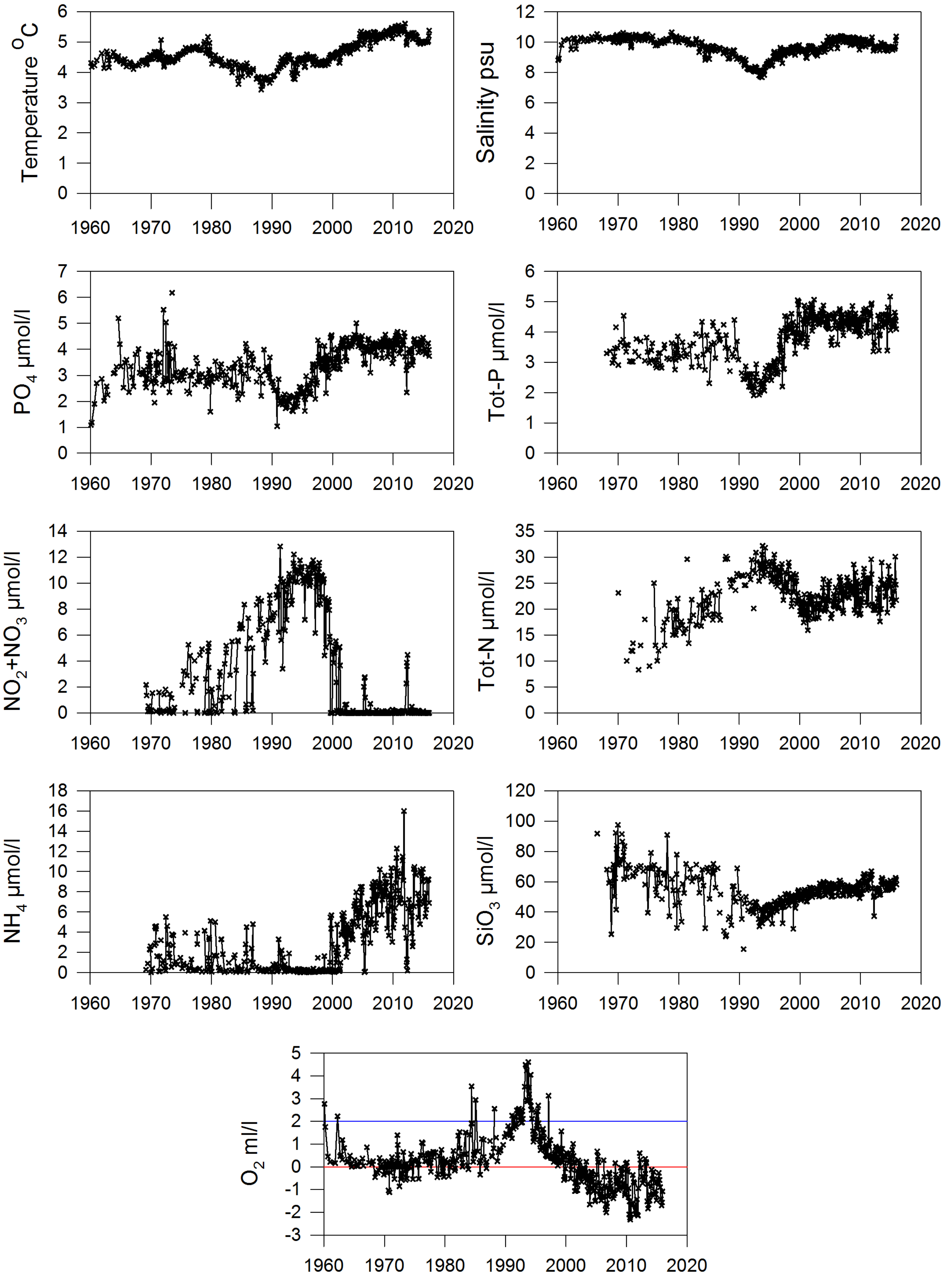
OXYGEN IN BOTTOM WATER (> 100m)



STATION BY38 SURFACE WATER



STATION BY38 DEEP WATER (100m)

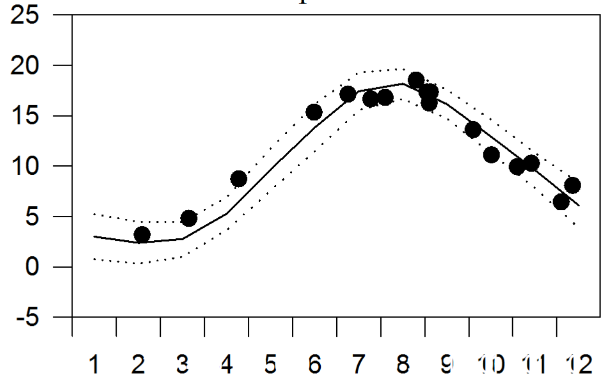


STATION SLÄGGÖ SURFACE WATER

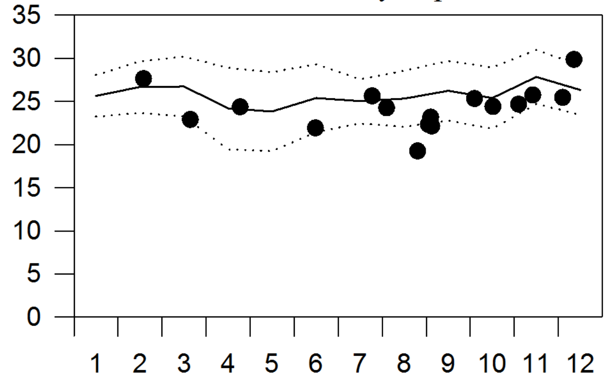
Annual Cycles

Mean 1996-2010 St.Dev. 2015

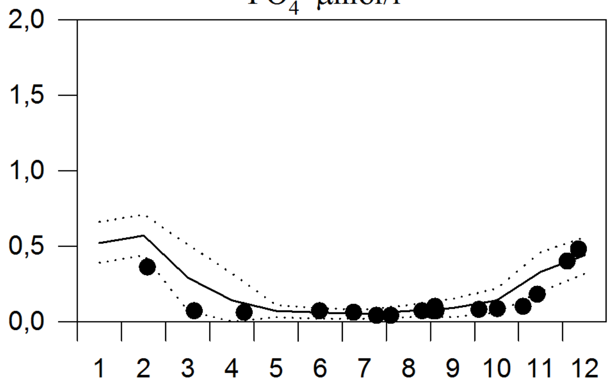
Temperature °C



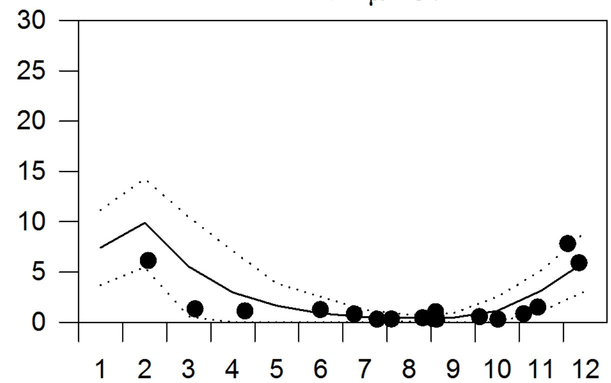
Salinity psu



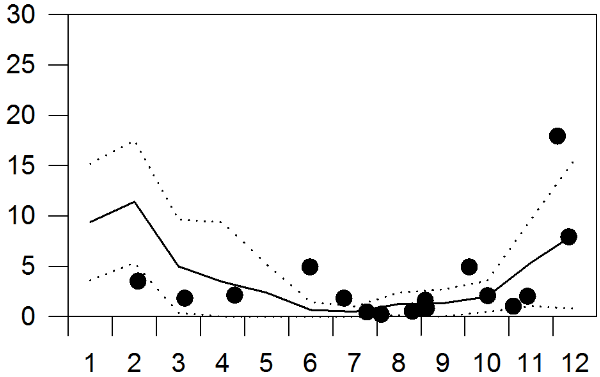
PO_4 µmol/l



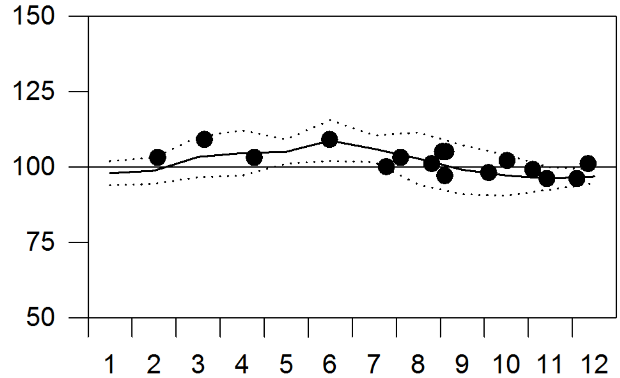
DIN µmol/l



SiO_3 µmol/l

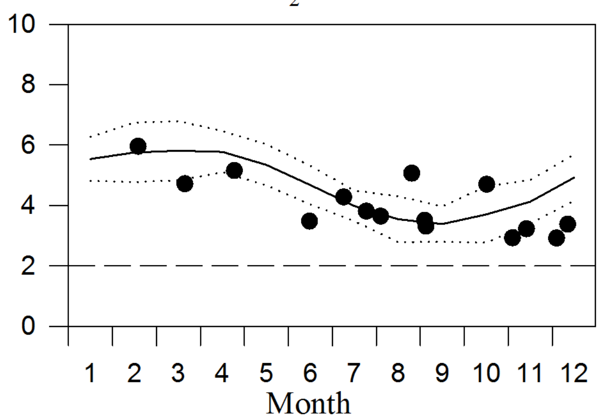


O_2 saturation %

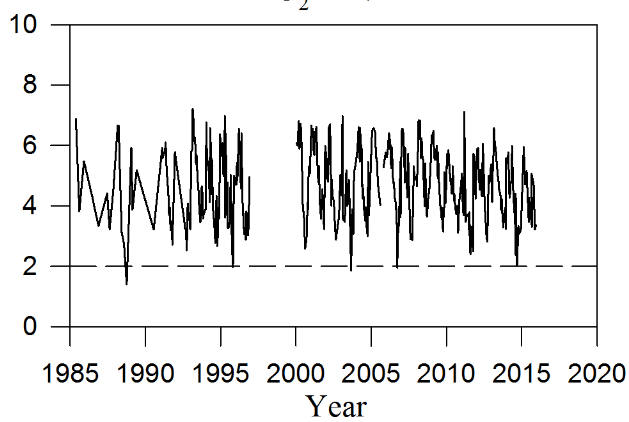


OXYGEN IN BOTTOM WATER (depth >50m)

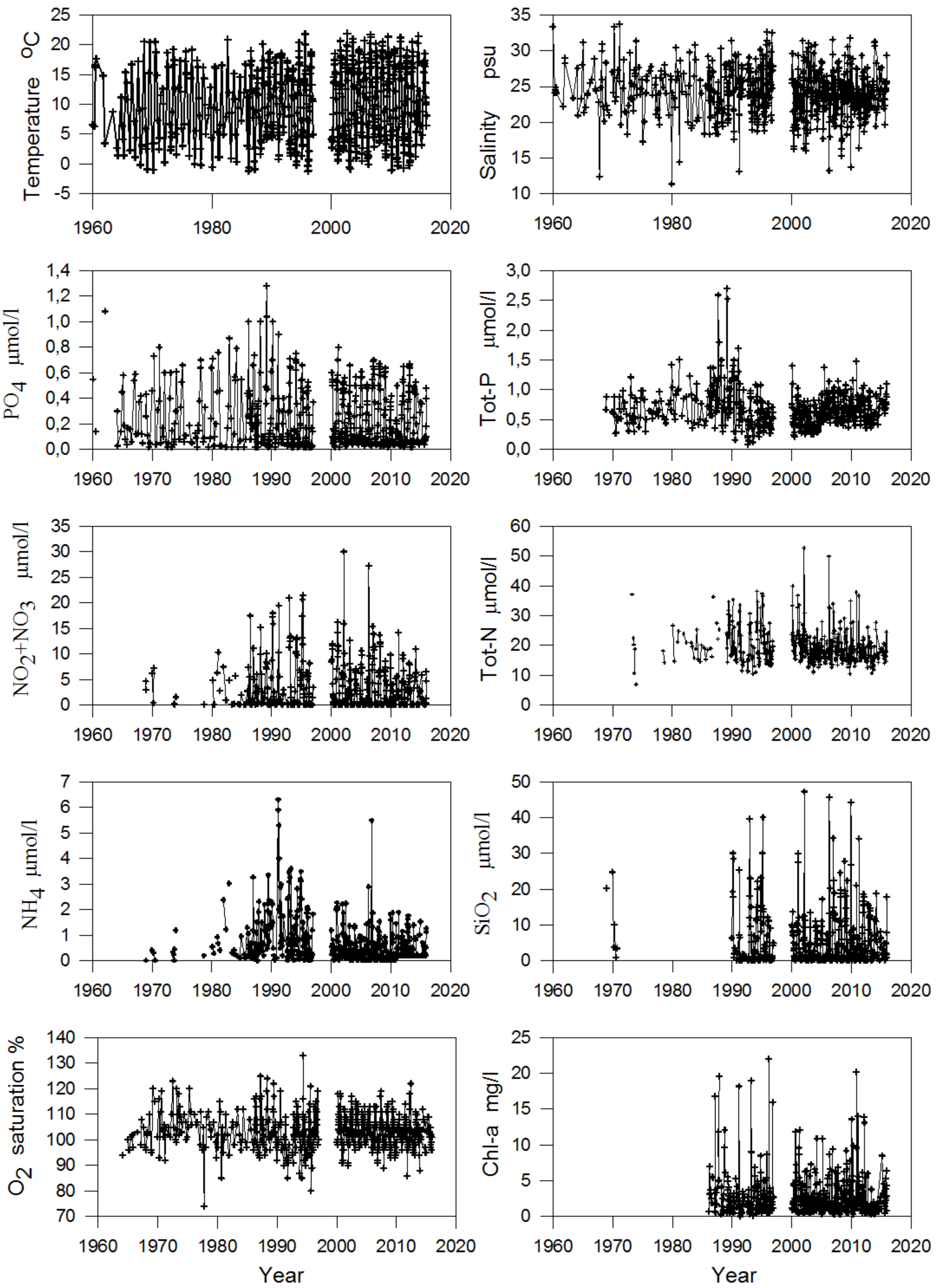
O_2 ml/l



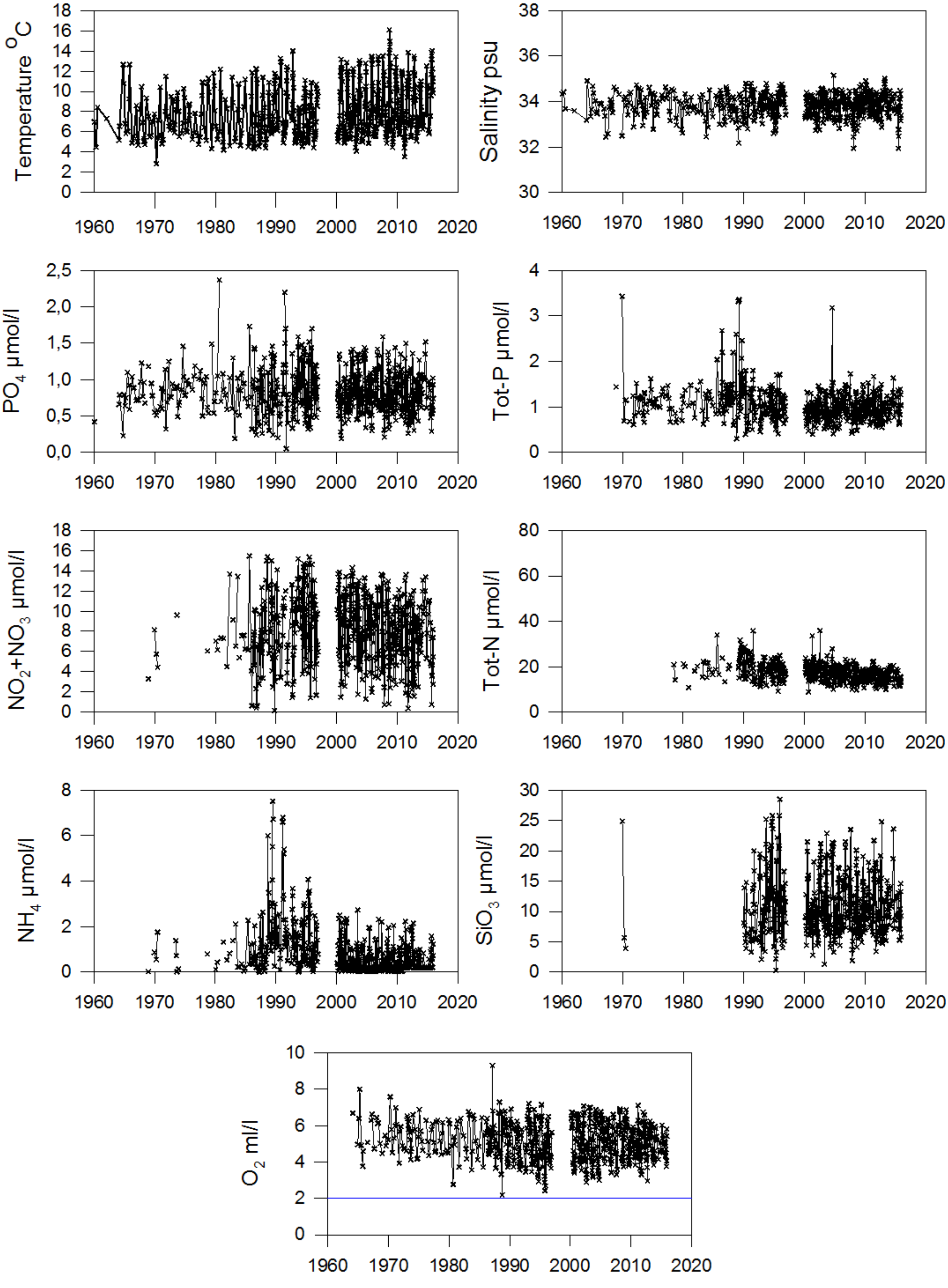
O_2 ml/l



STATION SLÄGGÖ SURFACE WATER

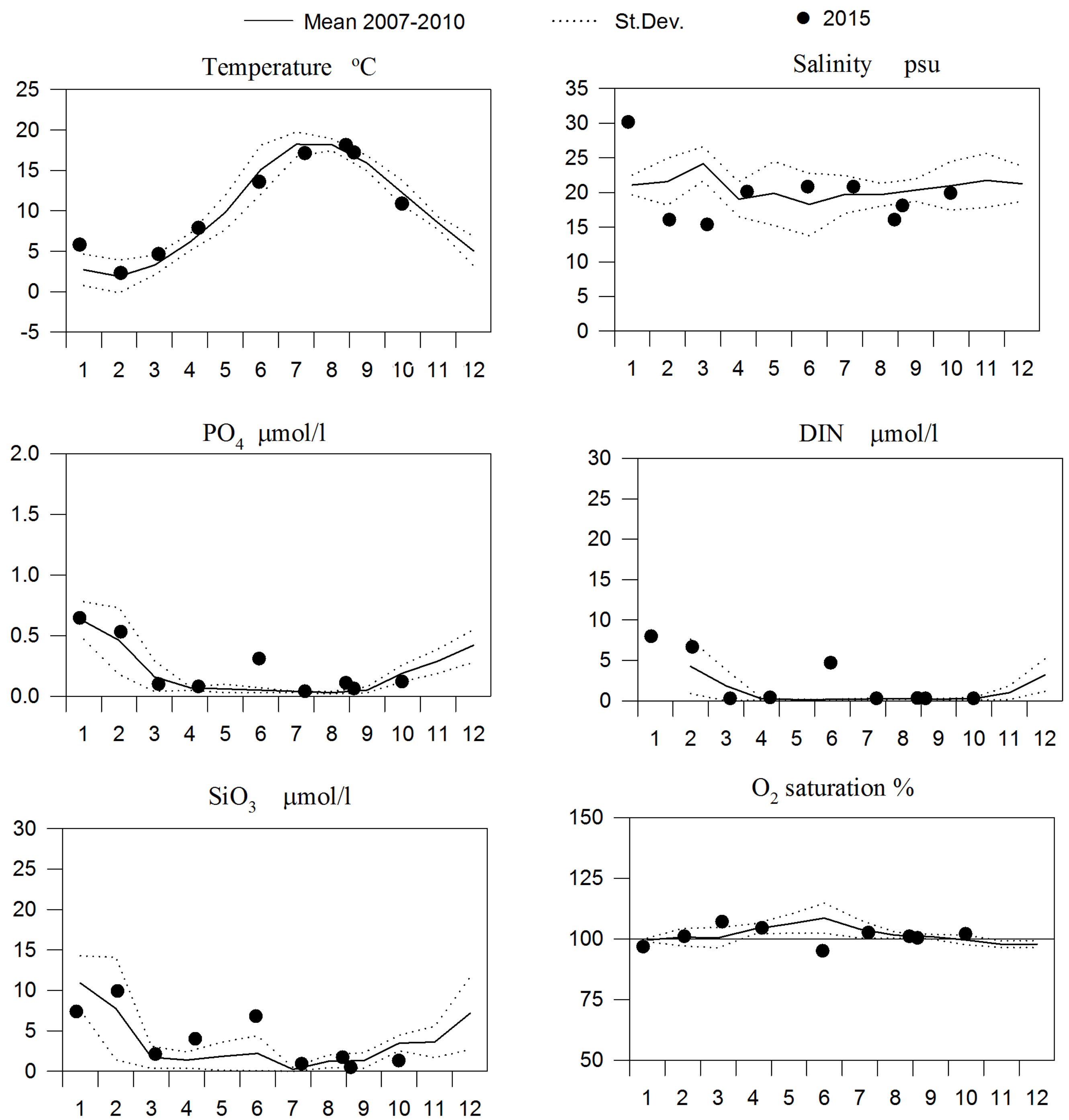


STATION SLÄGGÖ DEEP WATER (50m)

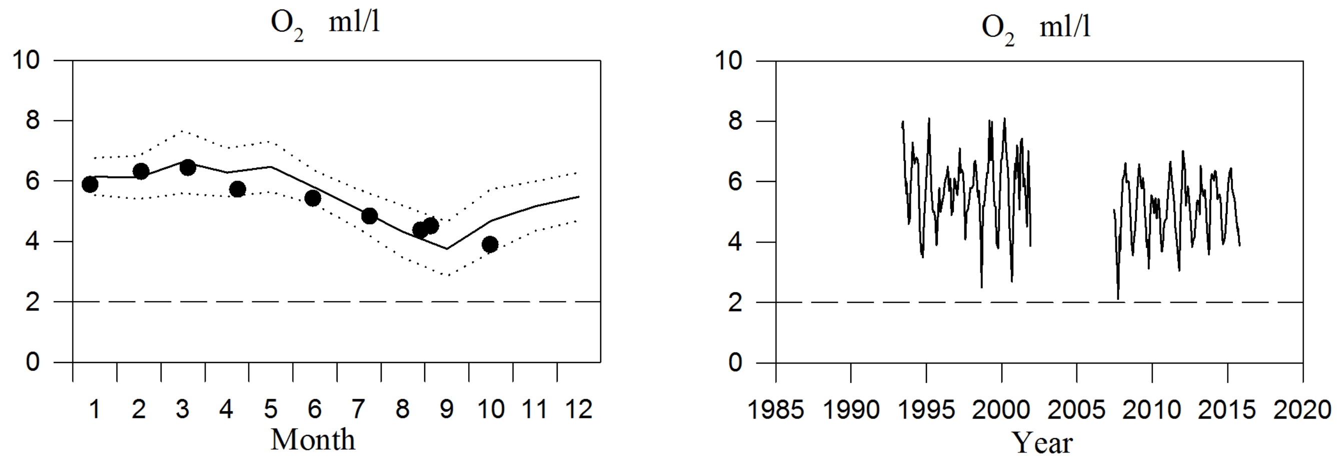


STATION N14 Falkenberg SURFACE WATER

Annual Cycles

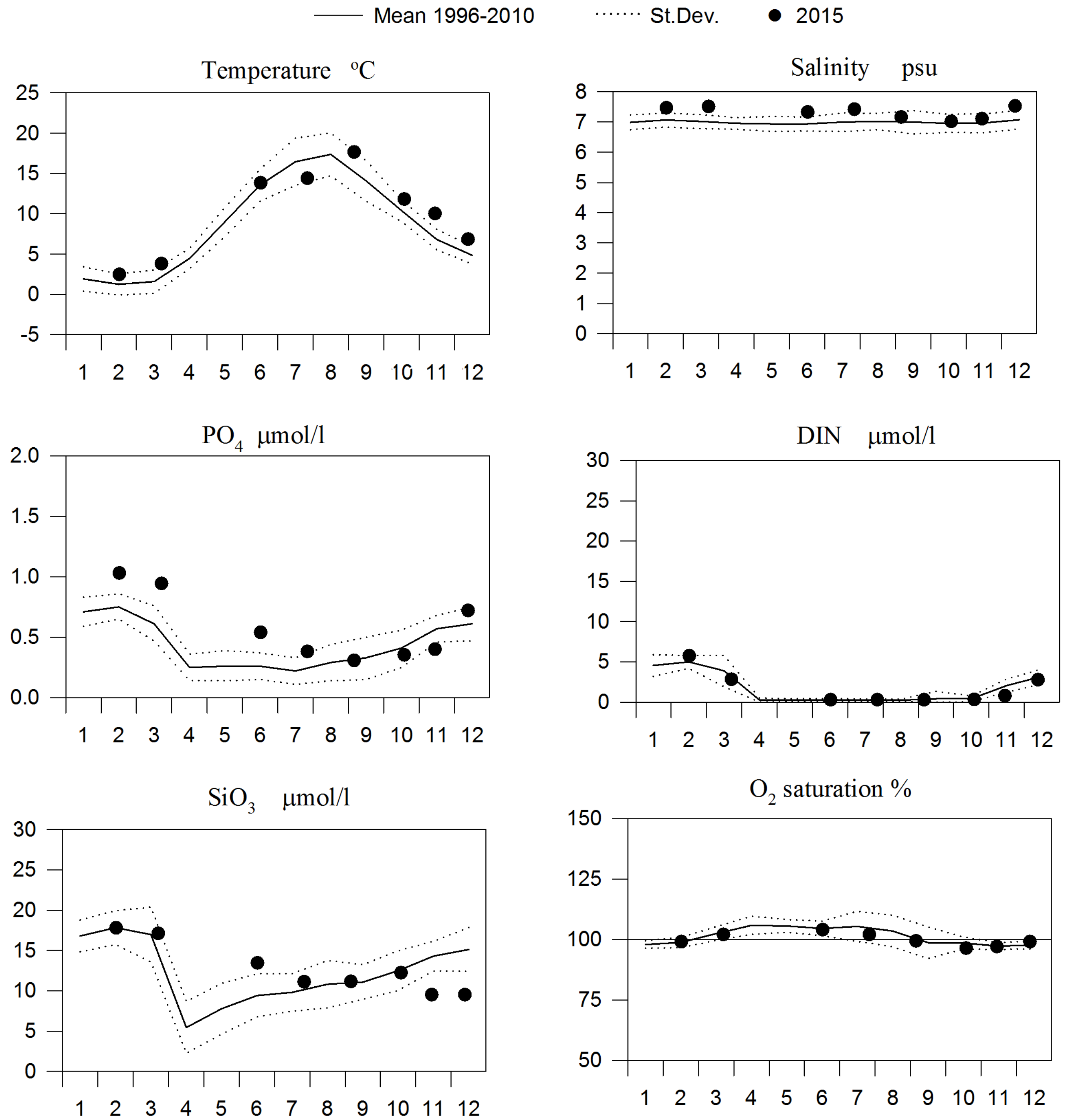


OXYGEN IN BOTTOM WATER (depth > 25m)



STATION REF M1V1 SURFACE WATER

Annual Cycles



OXYGEN IN BOTTOM WATER (depth >15m)