SMHI

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Annual report 2012

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1. Exceptional events

- Oxygen conditions were extremely bad in the deep water of the central and northern Baltic Proper. About 14% of the bottom area in the Baltic Proper was affected by anoxia.
- Due to problems with vessel availability and permits to sample in foreign Exclusive Economic Zone (EEZ) fewer expeditions were carried out and fewer stations than originally planned were sampled during 2012, in particular in the Baltic Proper.

2. Meteorological conditions

After a period with very cold weather, at the turn of the months January/February, the weather became dry and, for the season, very warm till the end of March. Then a long period of unstable weather conditions began that, with only short interruptions, continued throughout the year. As a result, 2012 became one of the wettest years ever recorded, with new precipitation records at some stations.

A couple of storms crossed Sweden during the first weeks of 2012. The highest mean wind velocity of the year, 27 m/s, at a coastal station was reported from Vinga, at the west coast, on the 4^{th} of January and from Söderarm, at the east coast on the 14^{th}. However, during the end of January, winter weather prevailed in the whole country and it extended throughout the first weeks of February. The second half of February was comparatively warm, especially in the southern parts. March was the only month during the year that could be characterized by dry weather conditions (however, the western inland parts of northern Sweden received sizeable quantities of precipitation). At the end of March there was a setback, and the warm period was followed by an unsteady and rather cold April. At some locations April was colder than March, which is very uncommon.

Changeable weather conditions also dominated in May, but from the 20^{th} and for one week on, high summer temperatures prevailed. There was no extended period, with stable high pressure conditions during the summer and at most locations no real warmth. The weather was especially bad during the beginning of the summer and it was the coldest June since 1991. At some locations in southern Sweden it was also extremely rainy.

The rainy weather continued in July. August was probably the best summer month, due to a temporary inflow of warm air from the continent.

The weather conditions in September were dominated by low pressures and a lot of rain, mainly in the southwestern and northeastern parts of the country.

The rainy weather continued during October. In the northeast, new precipitation highs were recorded at several stations, many of them with more than 100 years of measurements on record.

During November the weather was rather dry and warm, but during the last days of the month the temperature fell and the snow cover advanced southwards.

Winter arrived in the beginning of December with cold weather and large quantities of snow, mainly in the eastern part of Sweden. Later during the month, the cold ceased and at the end of the year the southwestern part of Sweden was hit by an unusually heavy rainfall.

The ice season 2011/2012

The ice season 2011/2012 was mild in terms of both extent and duration, and also started very late. The first ice in the archipelagos of the Bay of Bothnia was noted on December $8t^{h}$, which was about a month later than the previous winter. The maximum ice extent was reached on February 11^{th} and had an area of 168 000 km^2 (mean for the period 1957 to 2012 is 178 000 km^2).

In the middle of January the ice cover began to grow along the coast of the Bay of Bothnia, the Quark and the Bothnian Sea. The Bay of Bothnia was completely covered with ice on the 1^{th} of February. The ice continued to grow in the Baltic Proper, the Gulf of Finland, the Gulf of Riga and along the west coast.

During February the ice alternated between grooving and breaking up. At the beginning of March the ice broke up in the Baltic archipelagos and by the end of March, the southern Swedish archipelagos, in the Baltic Proper, were free from ice as well as the coast of the Bothnian Sea.
In the middle of April the sea was free from ice up to the Quark. At the beginning of May there were only smaller areas of compact drift ice in the bay of Bothnia and by May 20th the Bay of Bothnia was completely free from ice – about one week earlier than normally.

3. Hydrological conditions

Discharge

The rainy weather during 2012 was also seen in discharges which were higher than normal, and extremely high flows occurred frequently.
The weather during the winter of 2012 was, in the southern part of Sweden, alternating between mild and cold. Snow cover existed in periods, and during mild weather the melting gave rise to increased flows in the watercourses. At most locations, the floods were higher than normal and really high flows occurred in parts of Götaland.
During the second half of March the temperature was above zero far up in the country and at the same time there was a lot of rain. Melting snow, together with rain, increased the flows in many watercourses in southern and northeastern Norrland and in northern Svealand. The run off, in these areas, was unusually high for this time of the year. However, only parts of the snow cover melted at this occasion and the real spring flood occurred during the period April to May. There was a large snow cover in parts of Norrland at this time, but the snow melted slowly and the run off resembled a normal spring flood.
The summer was rainy in parts of the country and the flows in the watercourses were in general above normal. Really high flows occurred in Dalarna, Norrbotten and Småland. In some parts of Götaland the situation was the opposite. During June to September the flows were below normal in parts of southeastern Sweden.
The autumn of 2012 can be considered as wet. The flows were generally above normal and at some locations they were very high.

4. Hydrographic conditions

Sea water levels

The winter of 2012 began with high sea water levels followed by decreasing levels. During spring and summer the levels fluctuated around the normal but rose again in the fall. The year ended with low water levels, caused by the northeasterly winds.

In mid-January, there was a change in weather conditions to a high pressure situation with north-easterly winds that gradually lowered the sea levels around the Swedish coast. On the 21th of February, the lowest water level during the year was observed in Skanör, -

100 cm. During spring the water levels were around mean values. Only for a short period, water levels dropped along the west coast, due to easterly winds. On May 1th, -72 cm was observed in Kungsvik. During summer the water levels were normal, due to stable weather conditions with light winds. Between June 3rd and September 3rd water levels stayed between +50 cm and -50 cm at all stations. In connection with the first autumn storms, the water level rose rapidly above normal. On September 15th, +111 cm was observed in Kalix. During autumn southwesterly winds continued to dominate, which resulted in water levels remaining above normal. At the end of November water levels began to fall again at all measurement sites, due to northeasterly winds. On the 23rd of December, -96 cm was measured in Viken due to strong winds. Long and frequent periods of high water levels and the lack of generally low water during spring made the annual mean water level higher than normal at almost all stations.

Inflows to the Baltic

The cumulative flow out of the Baltic Sea in 2012 was higher than average and higher than in 2011, mainly due to high precipitation. Some small inflows in February and December led to some oxygenation of the deep water in the southern Baltic.

During January, northeasterly winds forced water through the Sound, out of the Baltic Proper. As a result, an inflow, through the Sound, of approximately 35 km^3 during February improved the oxygen conditions in the Arkona- and Bornholm Basins. Thereafter the outflow continued and the inflows during March to June were very weak. A minor inflow (15 km^3) took place in July. The high precipitation and large flows in the watercourses during autumn resulted in continuous outflows through the Sound. At Christmas and the following period water levels rose along the West coast and gave rise to an inflow of ca. 30 km^3 , that again improved the oxygen situation in the southwestern part of the Baltic Proper, but probably too small to affect the central parts.

The latest major inflow occurred during the winter 2003-2004 and before that during the winter 1993.

a. Skagerrak, Kattegat and the Sound

Surface water temperatures in Skagerrak were normal throughout the whole year. In Kattegat, surface water temperatures were above mean in January, but otherwise normal. In January, inorganic nitrogen and silicate showed elevated concentrations, in the surface water of the eastern area in Skagerrak. Concentrations of phosphate and inorganic nitrogen were below mean (for the period 1995-2004) in these areas in December. Otherwise, all nutrients showed values typical for the season, during the year, in Skagerrak.
In the Kattegat surface water, phosphate and silicate had normal concentrations throughout the year. However, silicate showed clearly enhanced values at the beginning

and end of the year, due to outflow from the Baltic, and also during a shorter period in late spring.
The lowest oxygen concentration in the bottom water was measured during October in the central part of the Sound, 1.73 ml/l, corresponding to a saturation of 28%. In the open Kattegat, the lowest concentration was 2.71 ml/l, equivalent to a saturation of 40%, measured at the station Anholt E, in August.
In the open Skagerrak there is normally no shortage of oxygen in the deep water. The lowest value in 2012 was found at the station Släggö, in the mouth of the Gullmar fjord, where concentrations fell to 2.82 ml/l in September.

There were no extraordinary events in the phytoplankton situation during the year. Potentially toxic species were seldom present and were rarely observed above their warning limits. Similar to 2011 the dinoflagellate genus *Ceratium* bloomed during autumn.
The chlorophyll *a* concentrations from selected stations in the area show the same picture as the phytoplankton analysis, a peak due to the spring bloom late February – early March, followed by low concentrations throughout the year except for a minor rise during autumn.

The potentially toxic dinoflagellate genus *Dinophysis* is the genus causing most problems for mussel farmers at the Swedish west coast, due to its presence more or less throughout the year, even though mostly in low amounts. This genus can produce toxins that when accumulated in mussels may cause stomach illness in consumers. For this reason *Dinophysis* is under regular surveillance and mussels are regularly tested for toxins. During 2012, DST (Diarrheic Shellfish Toxin) was measured above the limit set for harvesting a few times all together, in January and the period September to November.

b. Baltic Proper

Due to problems with vessel availability and permits to sample in foreign EEZ fewer expeditions than expected were carried out and fewer stations tha originally planned were sampled during 2012.

Surface water temperatures were at normal levels during the main part of the year, excluding the first month when they were slightly above mean for the season.
The concentrations of inorganic nitrogen were at typical levels throughout the year in the whole area. The spring bloom occurred in late March/early April and thereafter nitrogen concentrations remained below the detection limit until October.
In the Arkona Basin and Hanö Bight, phosphate and silicate showed clearly elevated levels during the whole year. Also in the Bornholm Basin phosphate and silicate were above mean all months, but not as high as in the Arkona and Hanö areas. In the remainder of the Baltic Proper phosphate and silicate were enhanced during the first half of the year, but at normal levels during the second half, with the exception for silicate that had concentrations above mean in the northern part of the Baltic Proper the whole year.

Hydrogen sulphide was present in the bottom water of the Eastern-, Northern- and Western Gotland Basins throughout the year. It was also found, in the bottom water at the station BCS III-10 in the southeastern Baltic Proper, in January.
Acute oxygen deficiency (<2ml/l) were measured in the bottom water of the Arkona Basin in August and in the Bornholm Basin during most of the year. As a result of the inflow, in December the previous year, the oxygen concentration in parts of the Bornholm Basin was as high as 5.25 ml/l in January.

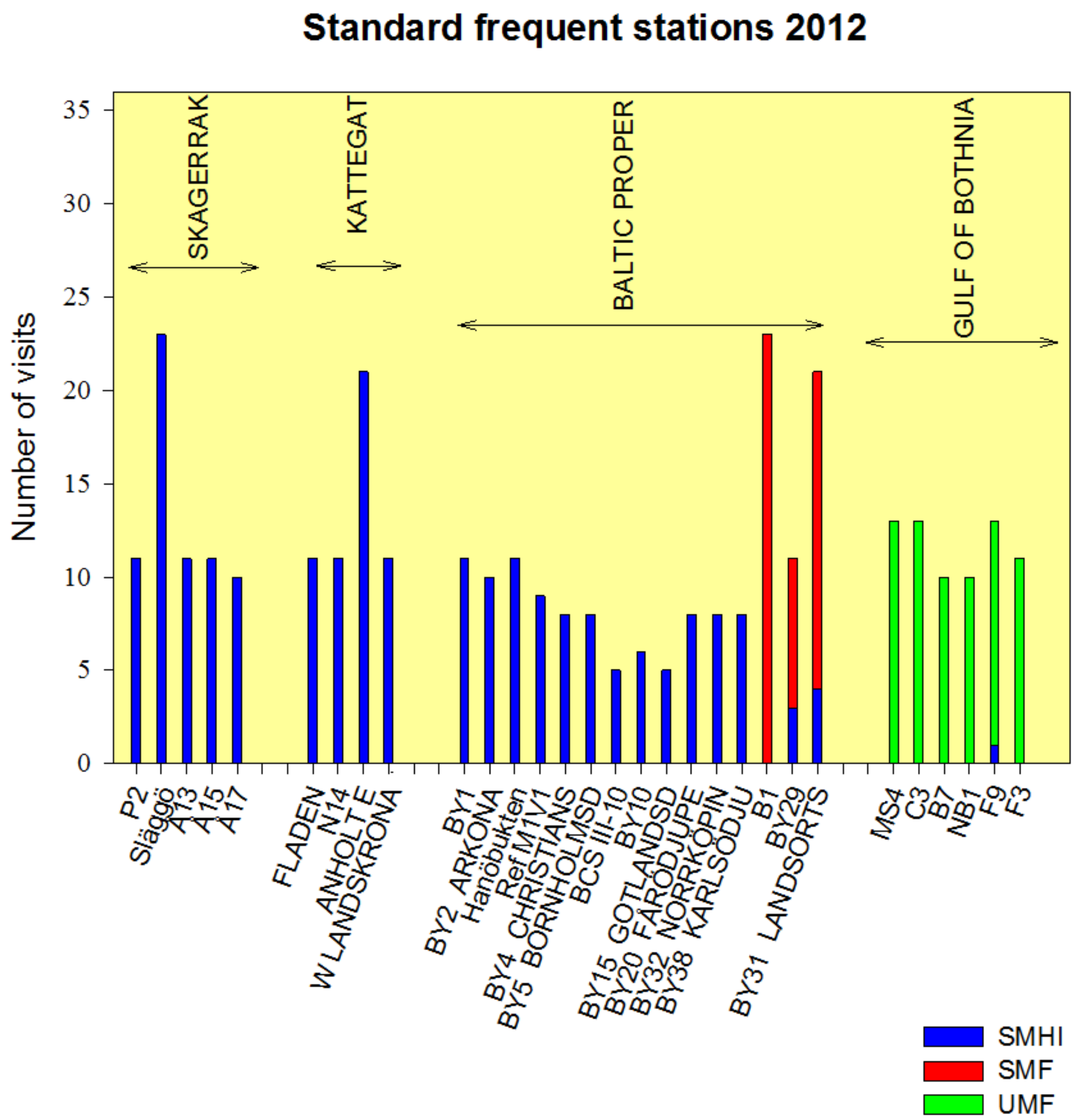
The oxygen situation in the deep water of the Baltic Proper continues to be very serious. In 2012 about one seventh (~14%) of the bottom area in the Baltic Proper was affected by anoxia (oxygen free, with toxic hydrogen sulphide present) corresponding to ~9% of the water volume. Acute oxygen deficiency, with concentrations <2ml/l, affects about 27% of the bottom area, or about 17% of the volume. The largest affected volume and area with anoxic conditions, since regular measurements started in the 1960s, was recorded 2011.
In November/December a large inflow occurred which improved the situation in the Arkona Basin and some effects could also be seen in the Bornholm Basin. This inflow will probably affect the central parts of the Baltic Proper during 2013.

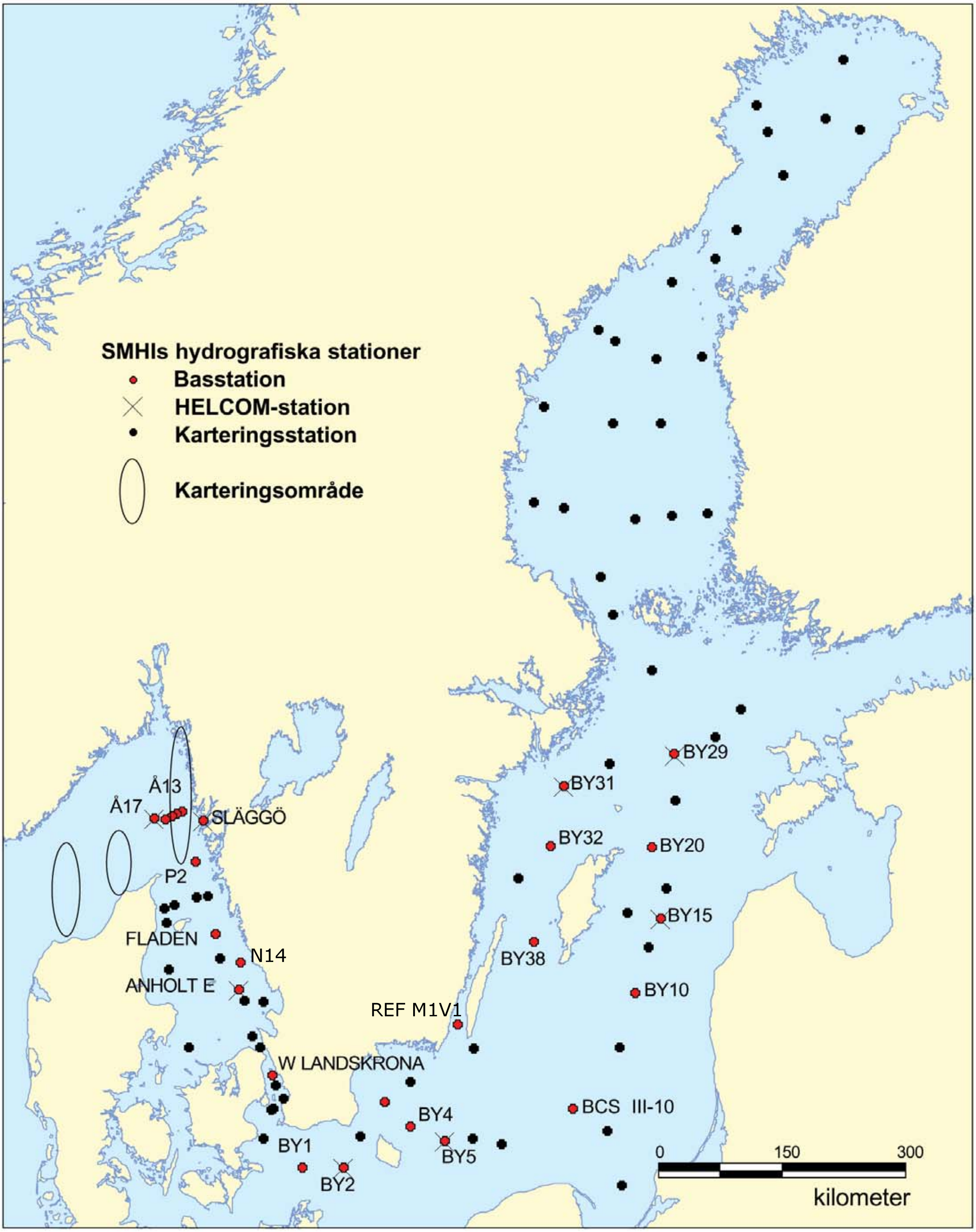
The usual spring bloom was not recorded at most of the stations in the Baltic Proper, but a delayed spring peak of chlorophyll *a* was present at BY2 in April. Apart from this, the chlorophyll *a* concentrations were within average or somewhat below normal during the year. The chlorophyll *a* concentrations were within average most of 2012, but just above average in the Bothnian Sea and the Bothnian Bay (stations C3 and F9/A13) towards the end of the year

During summer, surface accumulations of cyanobacteria were observed in the Baltic Proper six weeks from the 8^{th} of July until the 20^{th} of August, using the satellite observation system BAWS (Baltic Algae Watch System). The accumulations had the largest areal extension the 25^{th} of July. Surface blooms of cyanobacteria were present on the eastern side of the Bothnian Sea during three weeks, starting at the end of July. The rather cold and windy weather mixed the surface layer, thereby preventing surface accumulations to develop. The results from phytoplankton analyses in July showed that even though surface accumulations were scarce, rather high amounts of cyanobacteria were mixed into the water column.
As a whole the cyanobacteria bloom of 2012 can be considered as weak.

c. Gulf of Bothnia

Number of visits at standard frequent stations

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HELCOM-station
Karteringsstation
Karteringsområde
Å13
Å17
SLÄGGÖ
P2
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ANHOLT E
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BY1
BY2
BY4
BY5
BCS III-10
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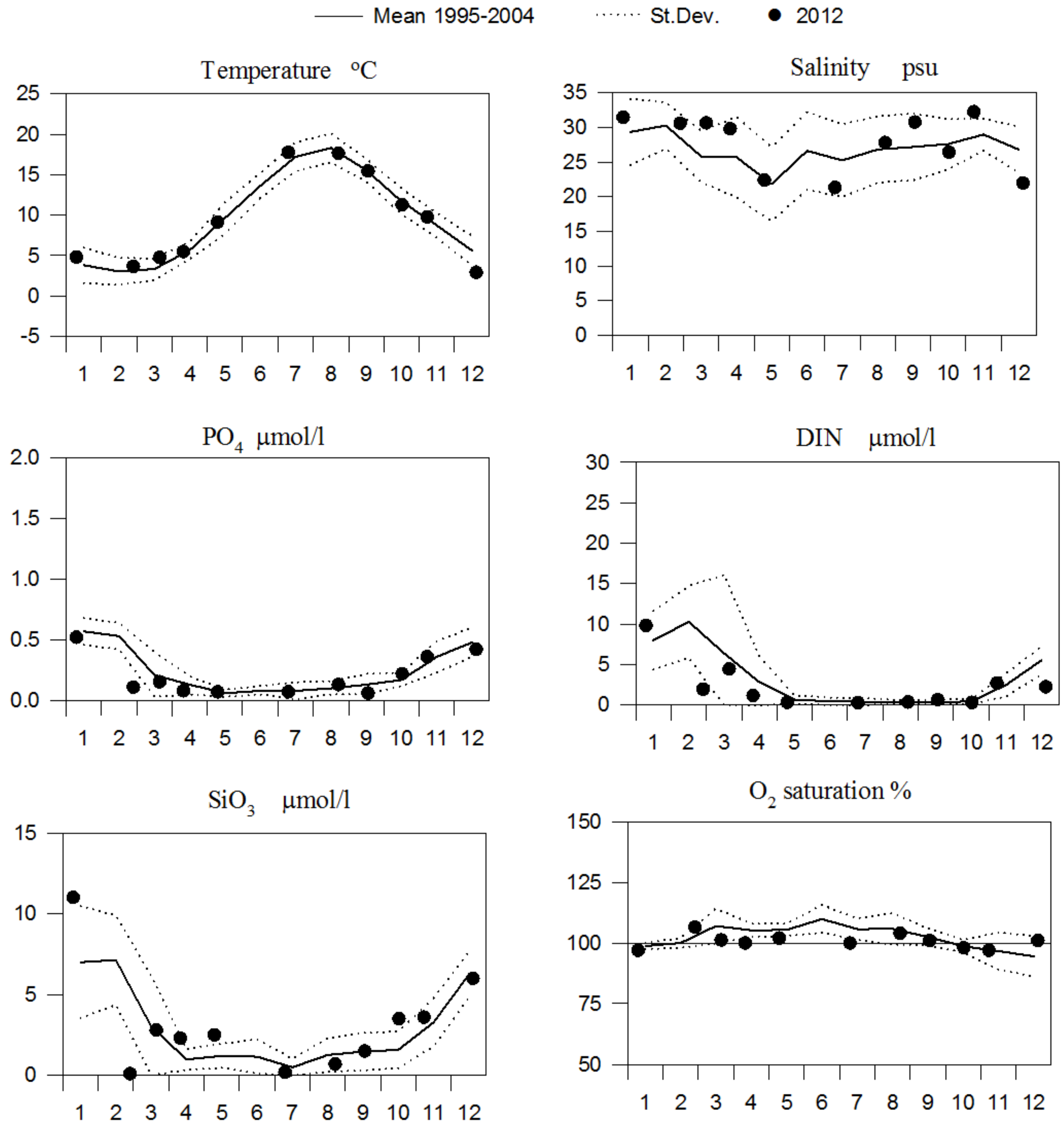
BY29
0
150
300
kilometer

STATION P2 SURFACE WATER

Annual Cycles



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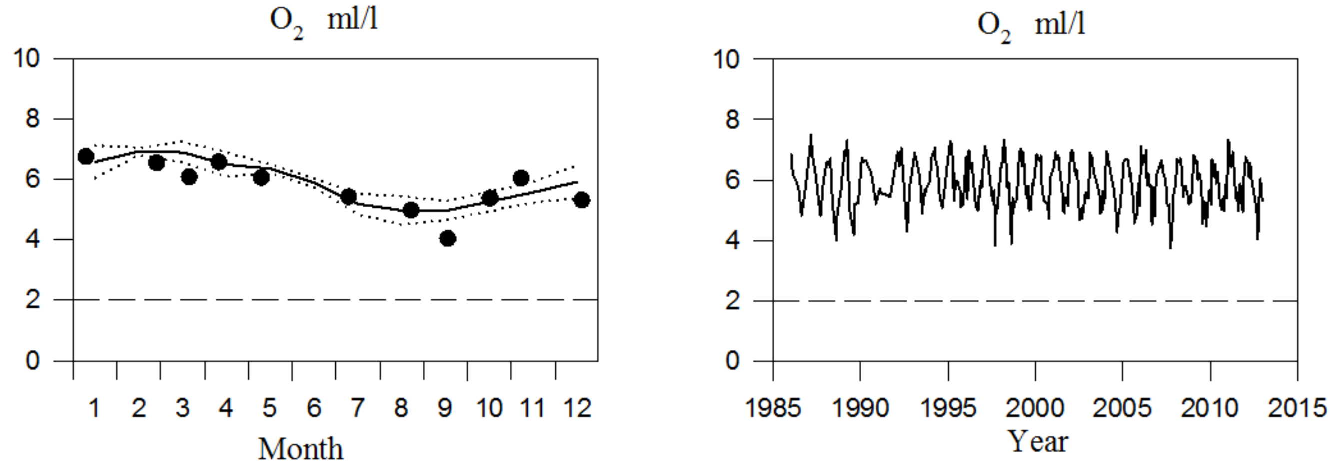

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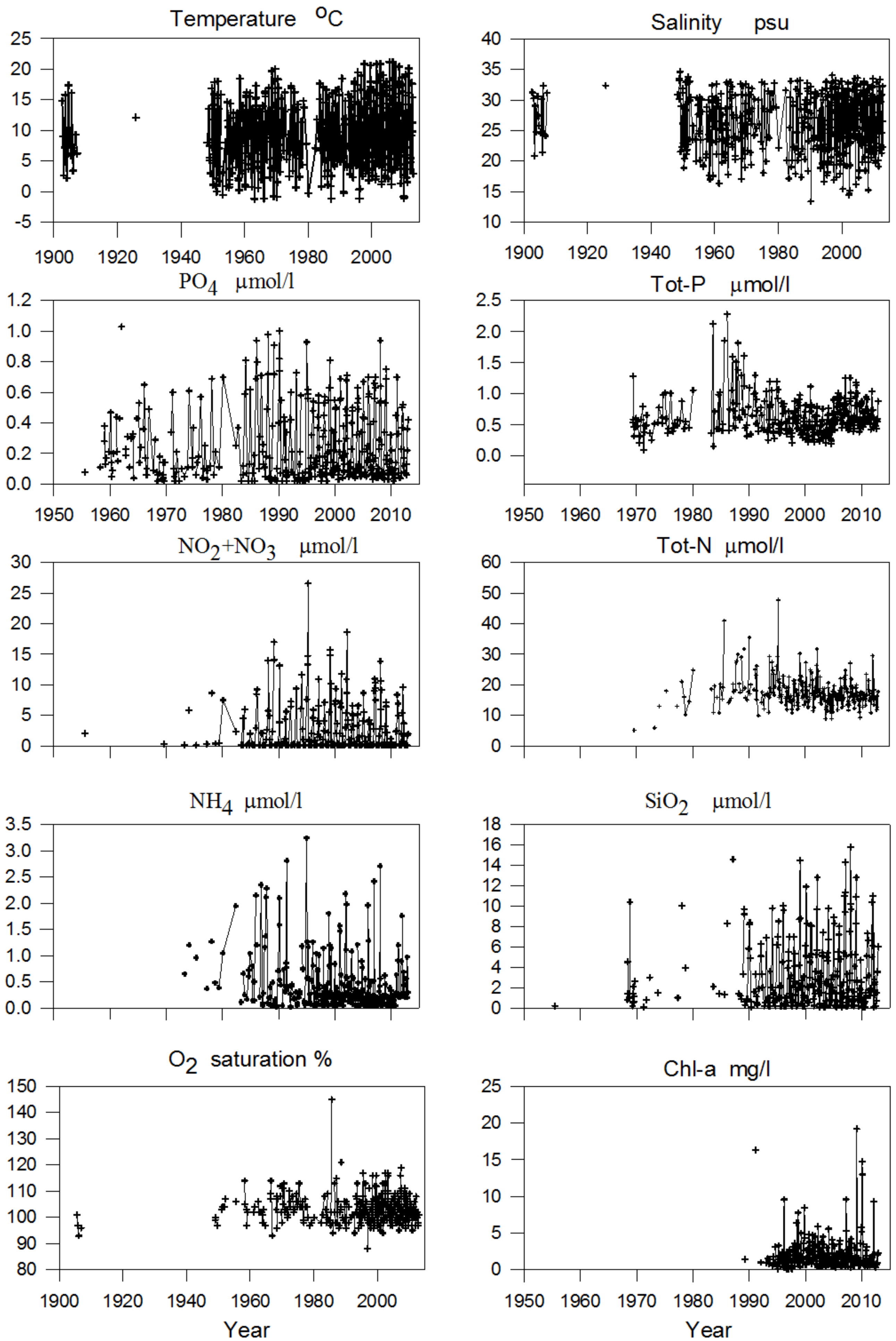
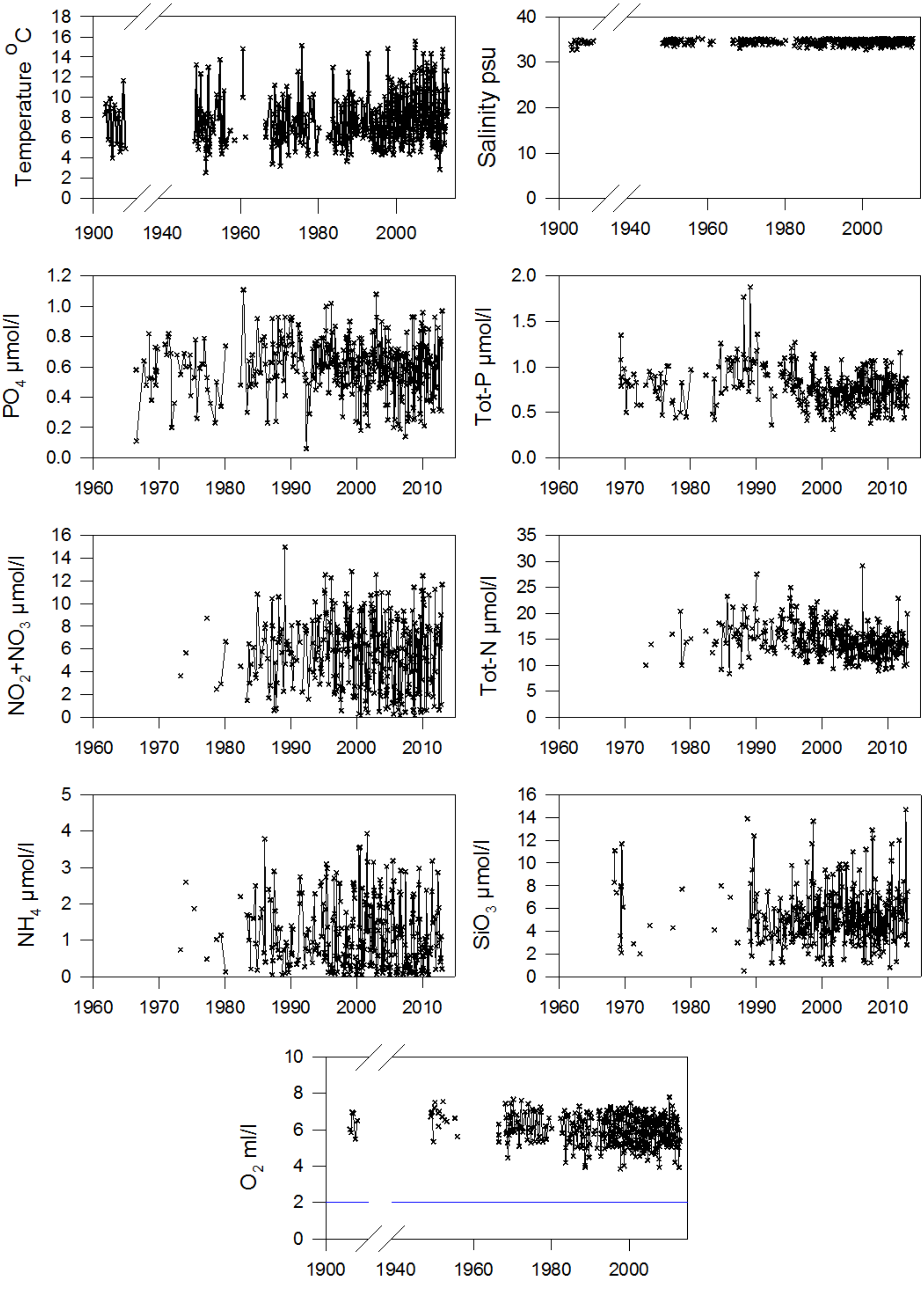
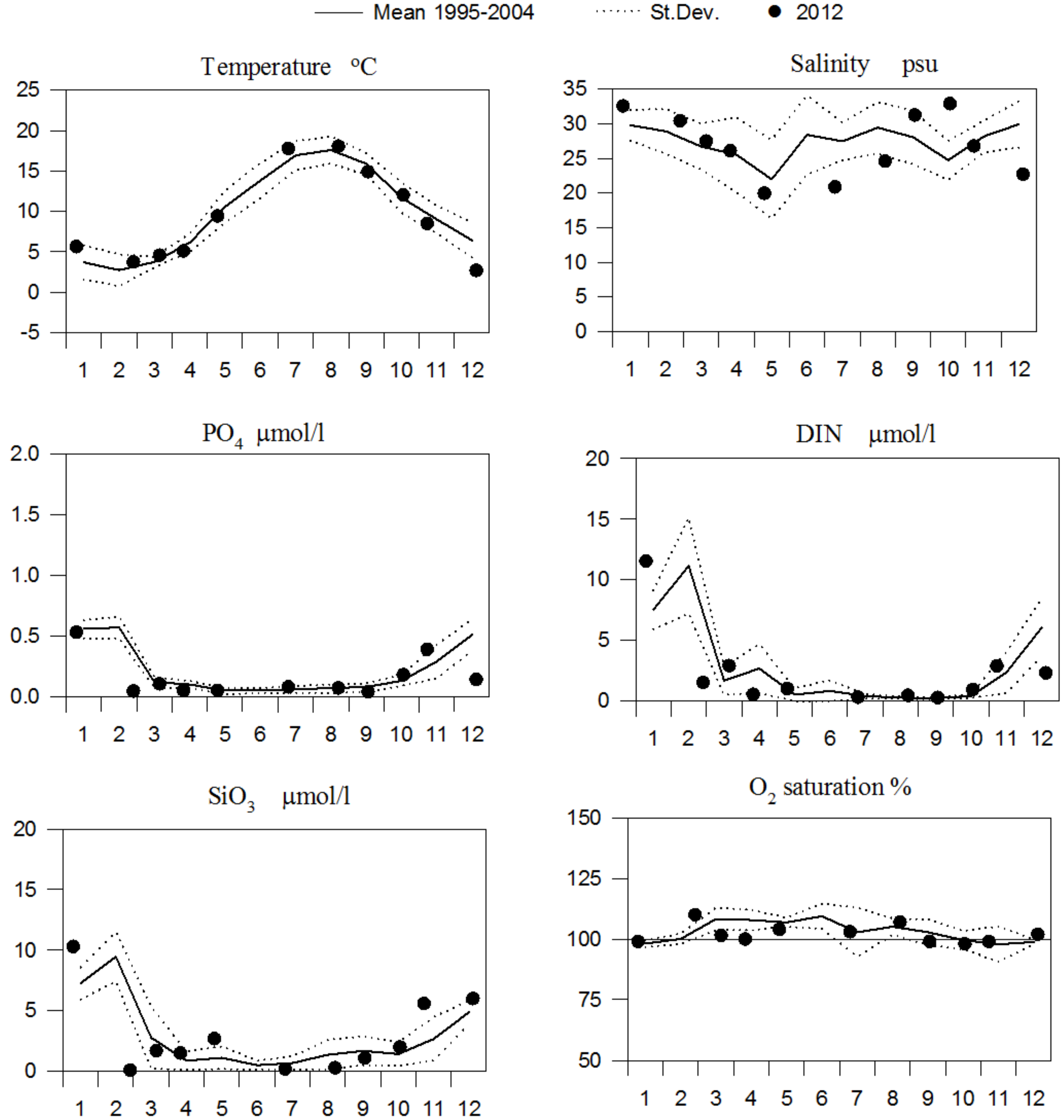


STATION P2 DEEP WATER (75m)



STATION Å13 SURFACE WATER

Annual Cycles



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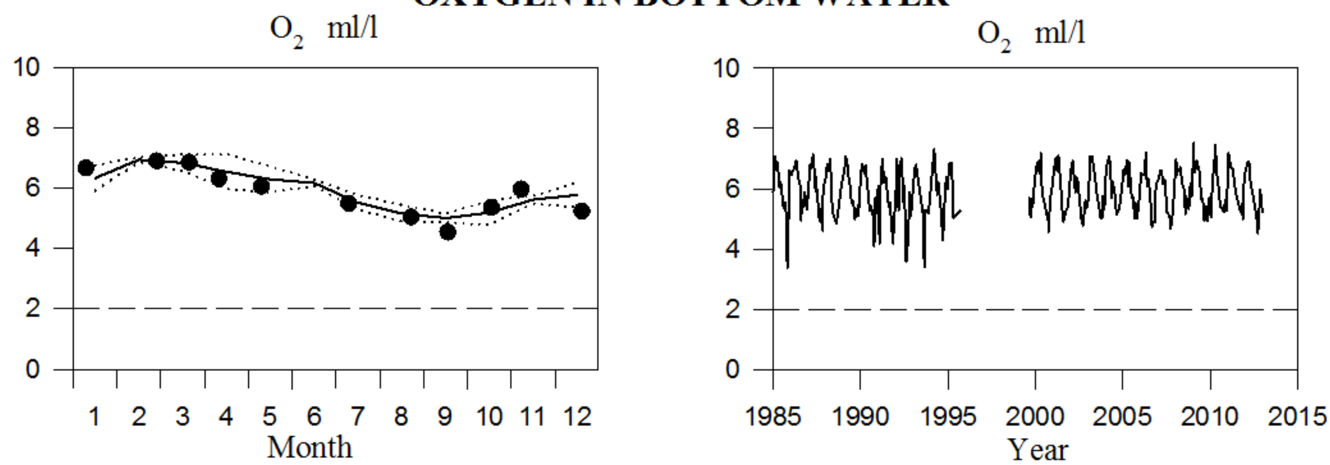

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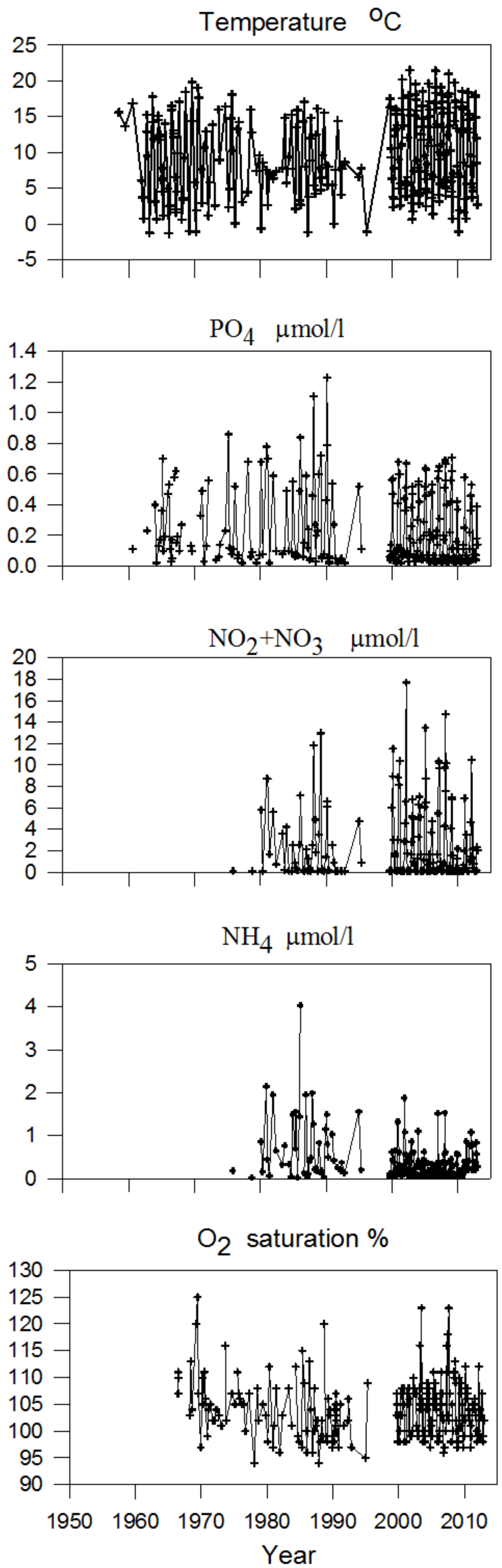

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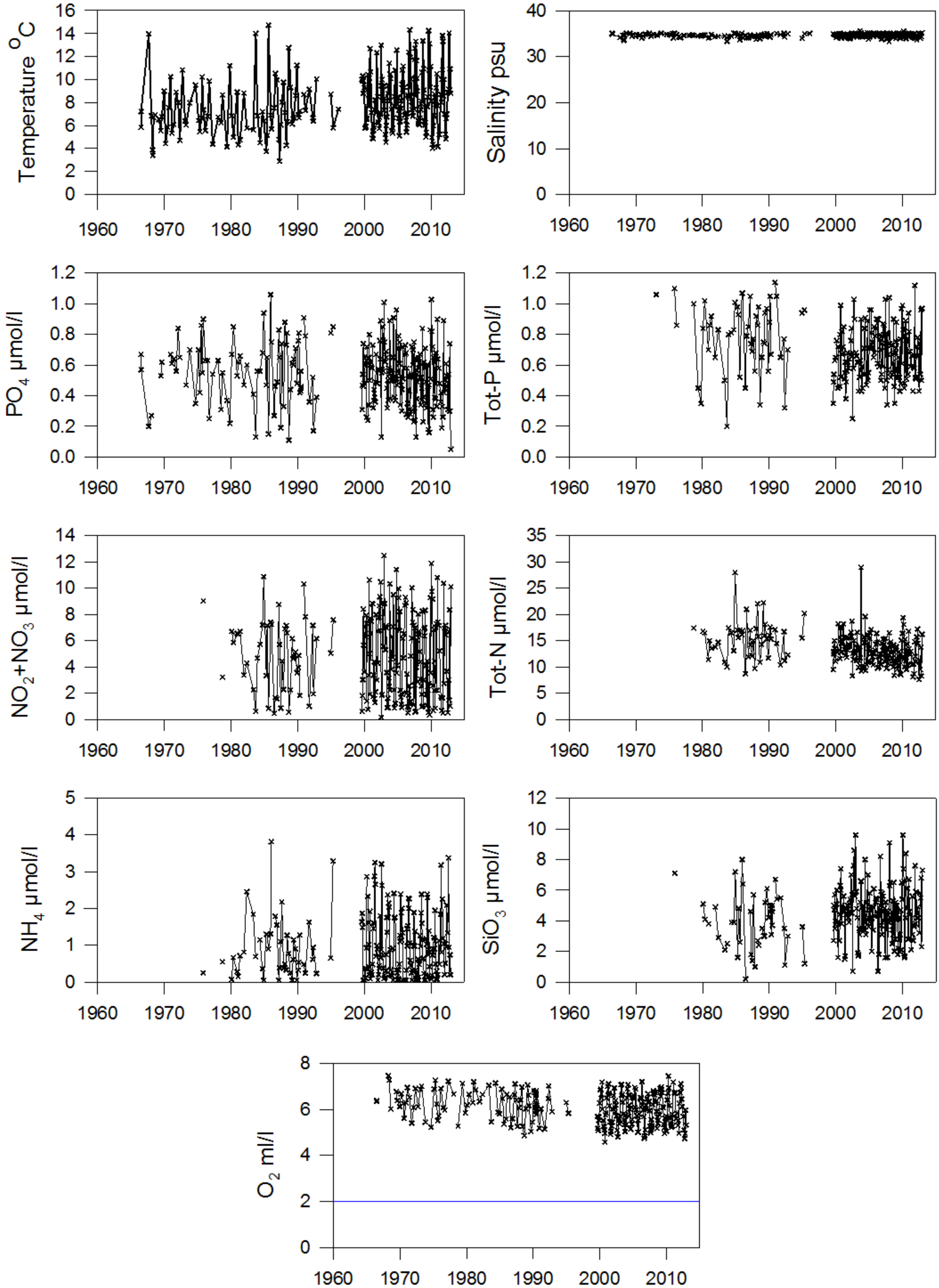
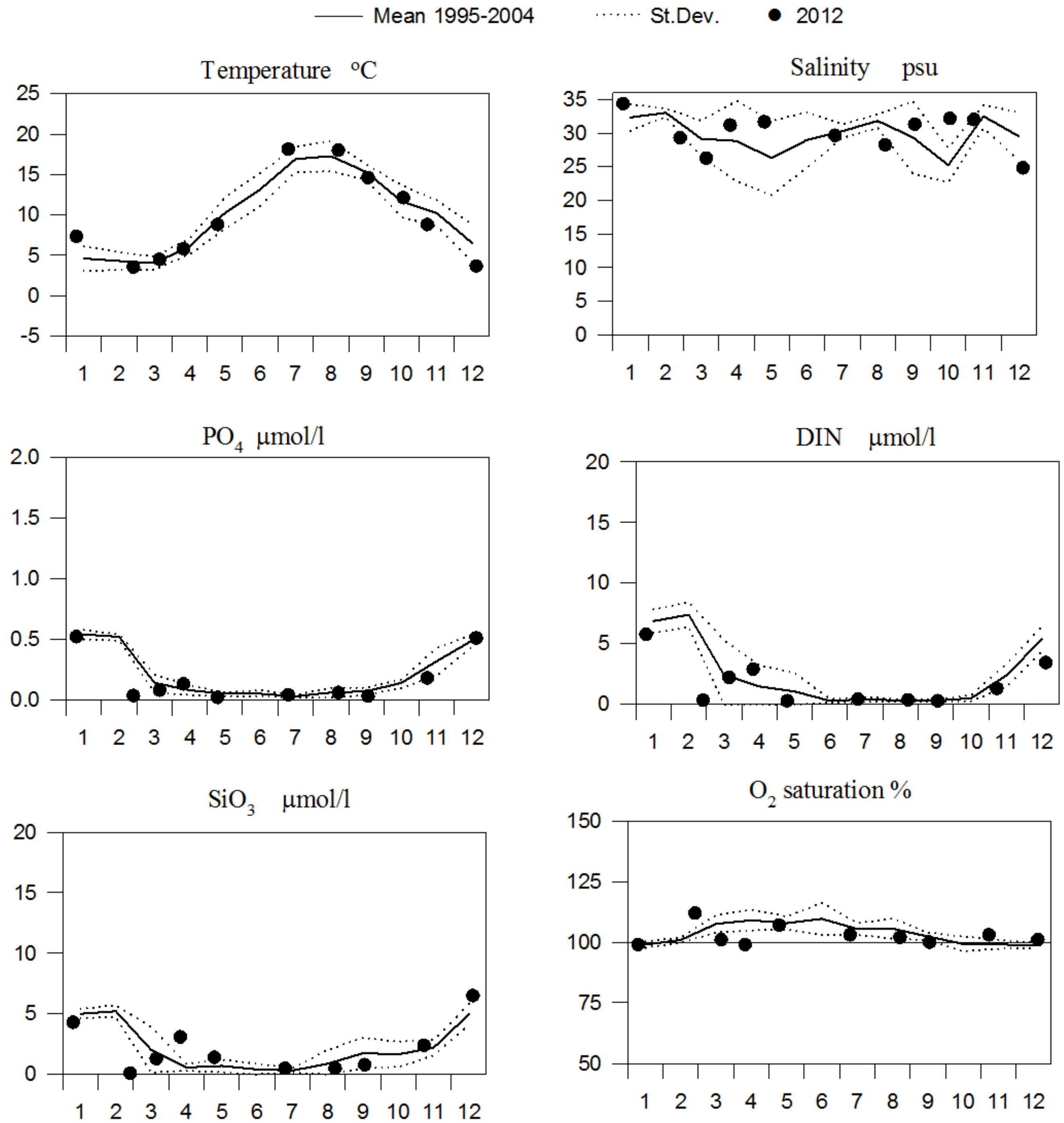


STATION Å15 SURFACE WATER

Annual Cycles



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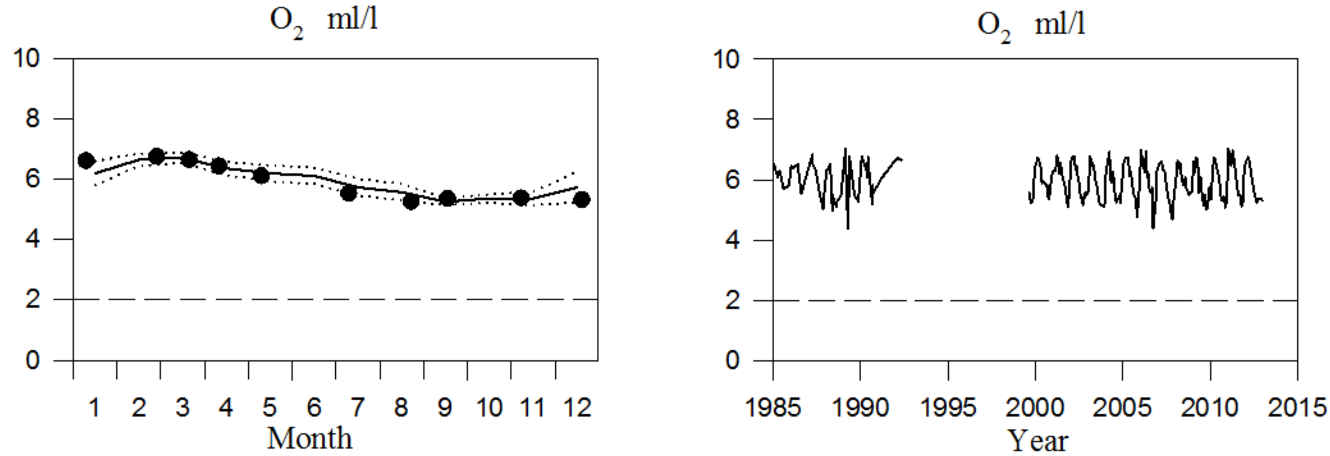

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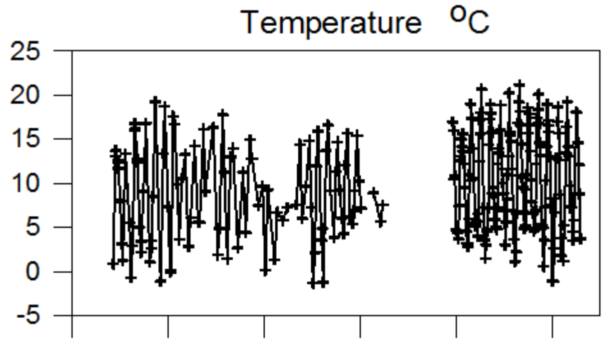
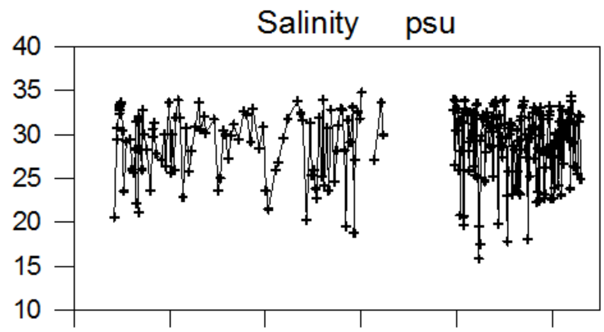
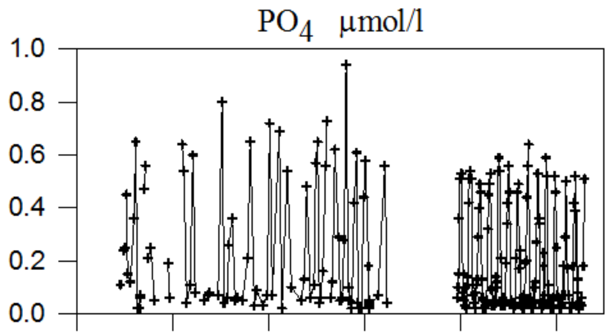
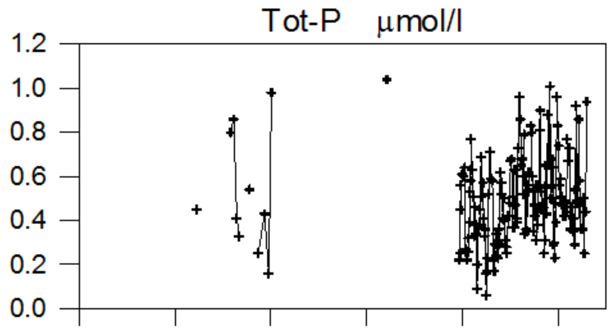
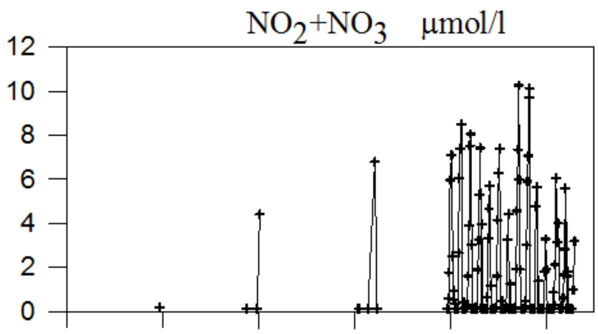
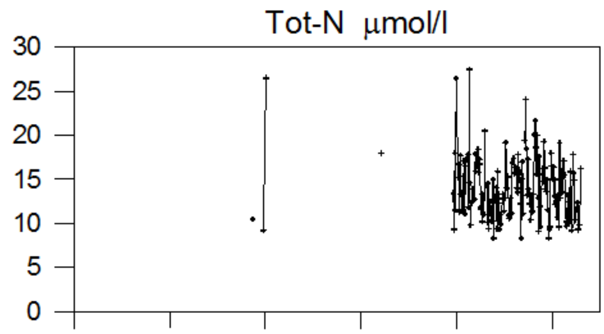


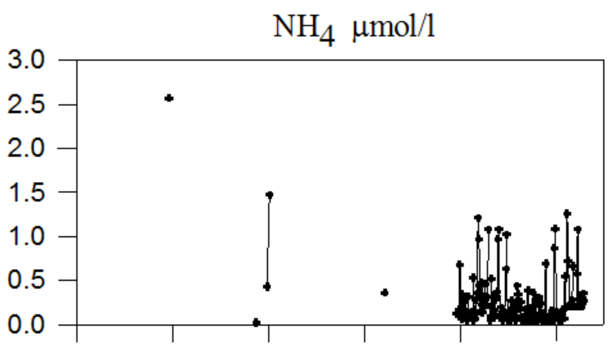


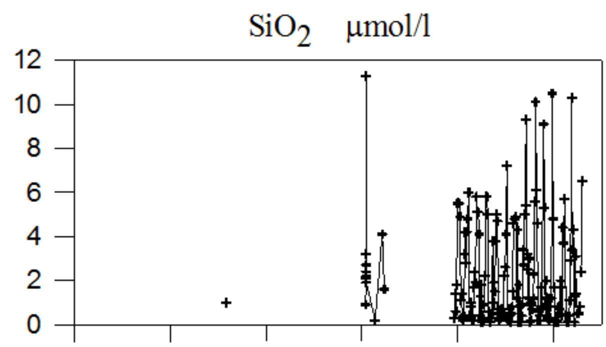


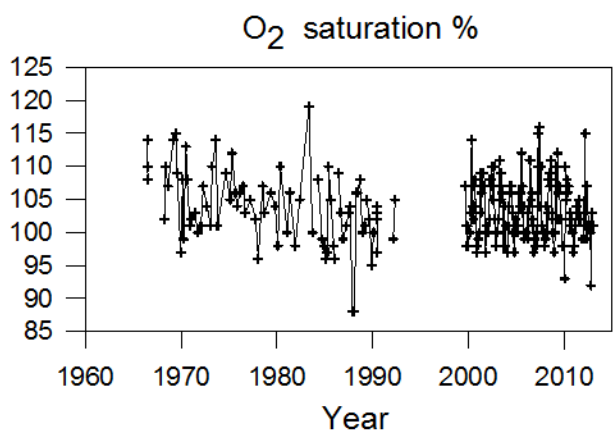


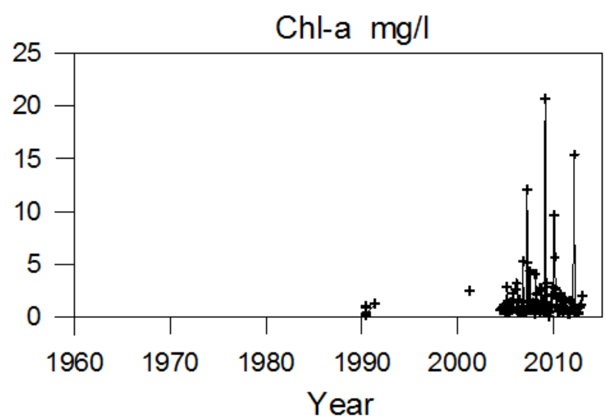




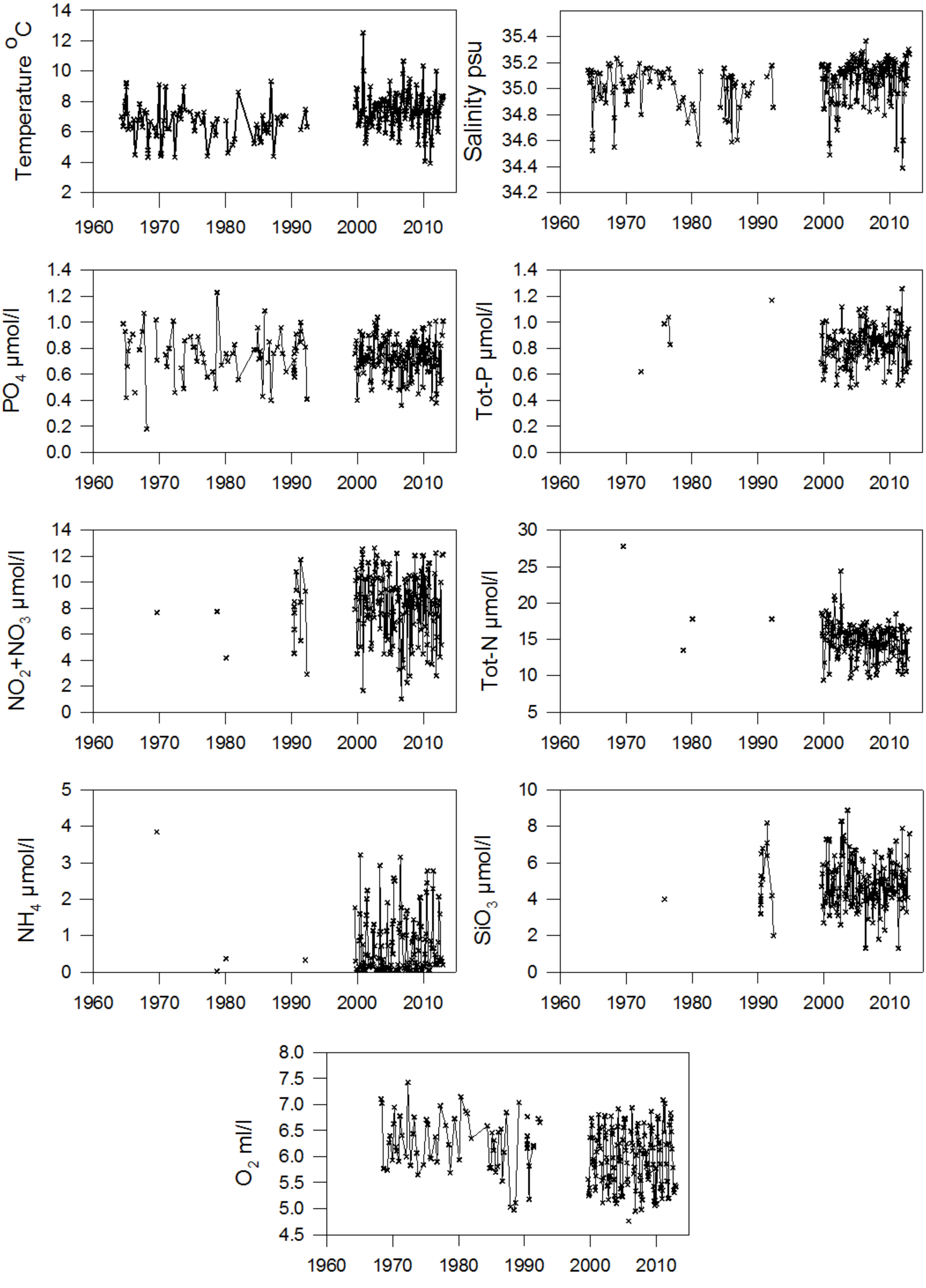






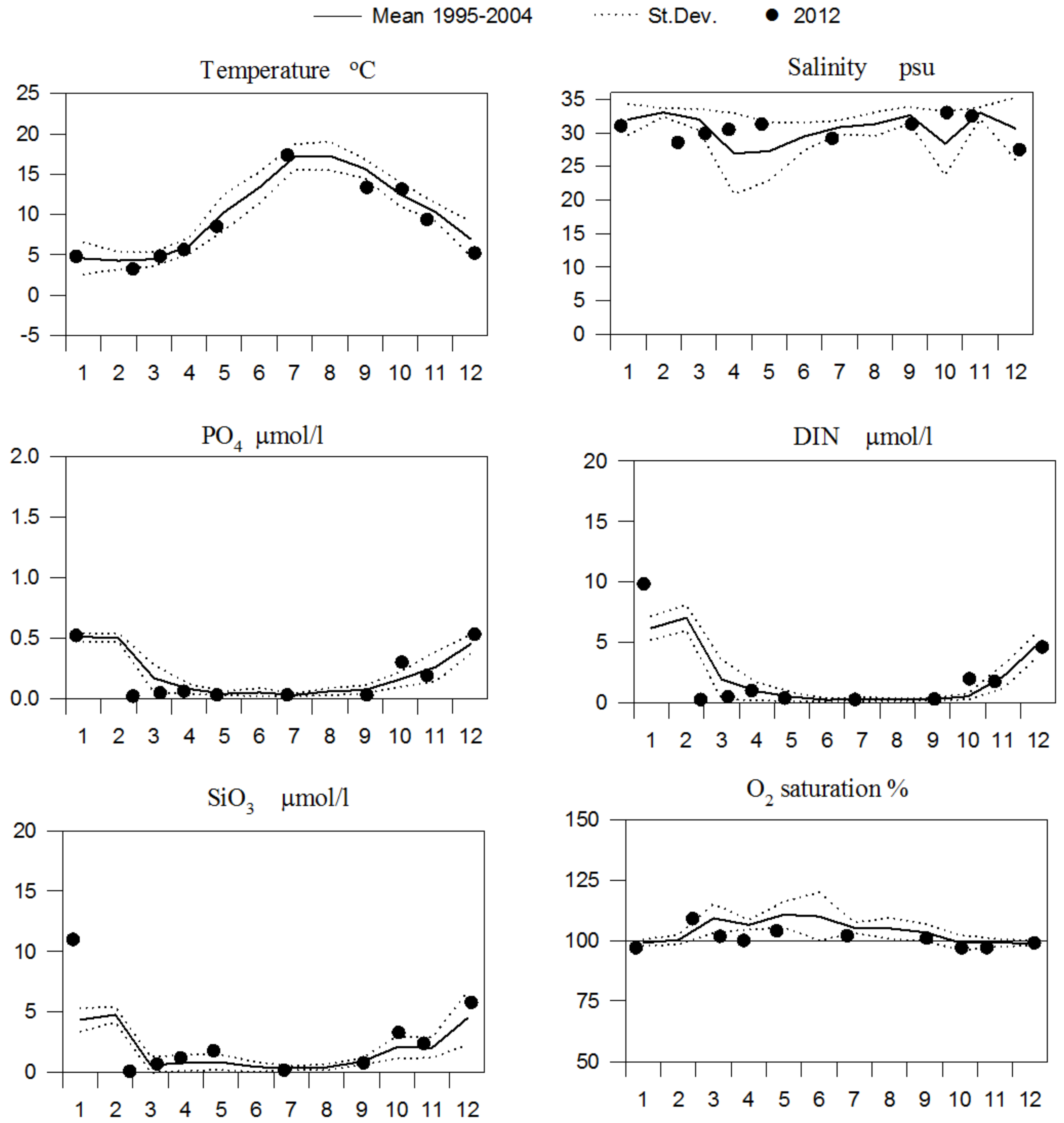


STATION Å15 DEEP WATER (125m)



STATION Å17 SURFACE WATER

Annual Cycles



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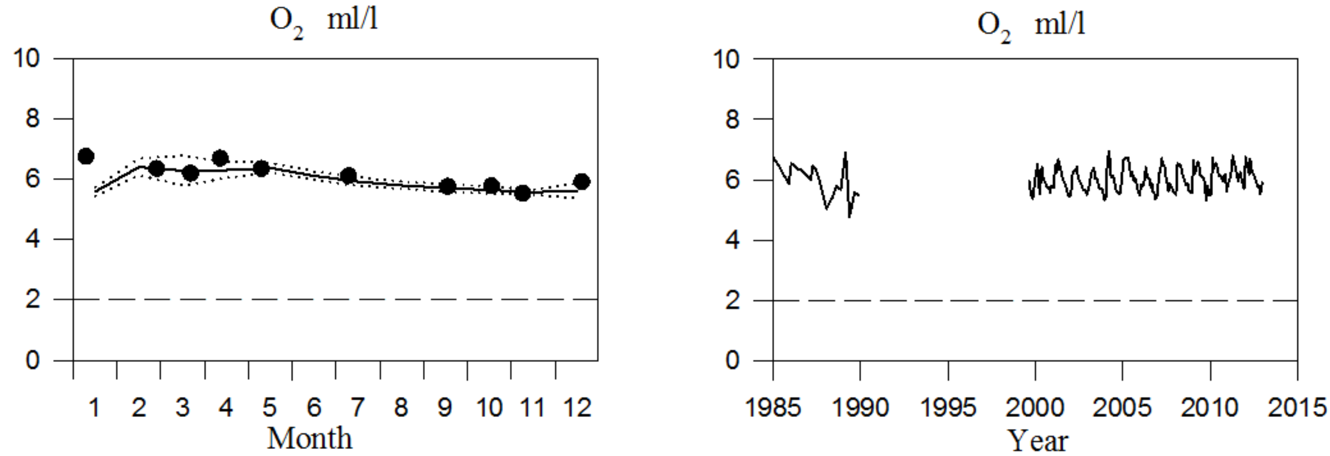

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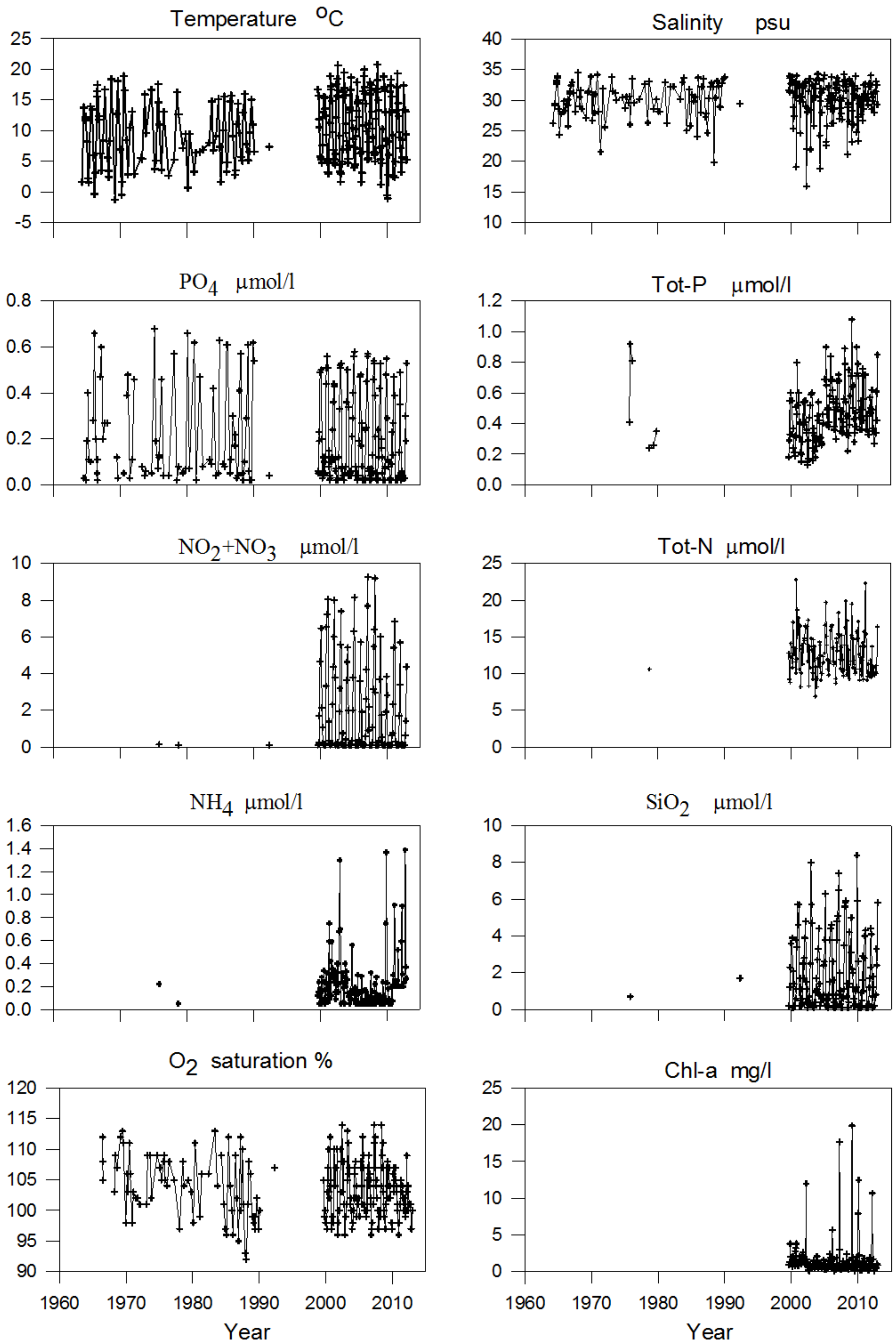

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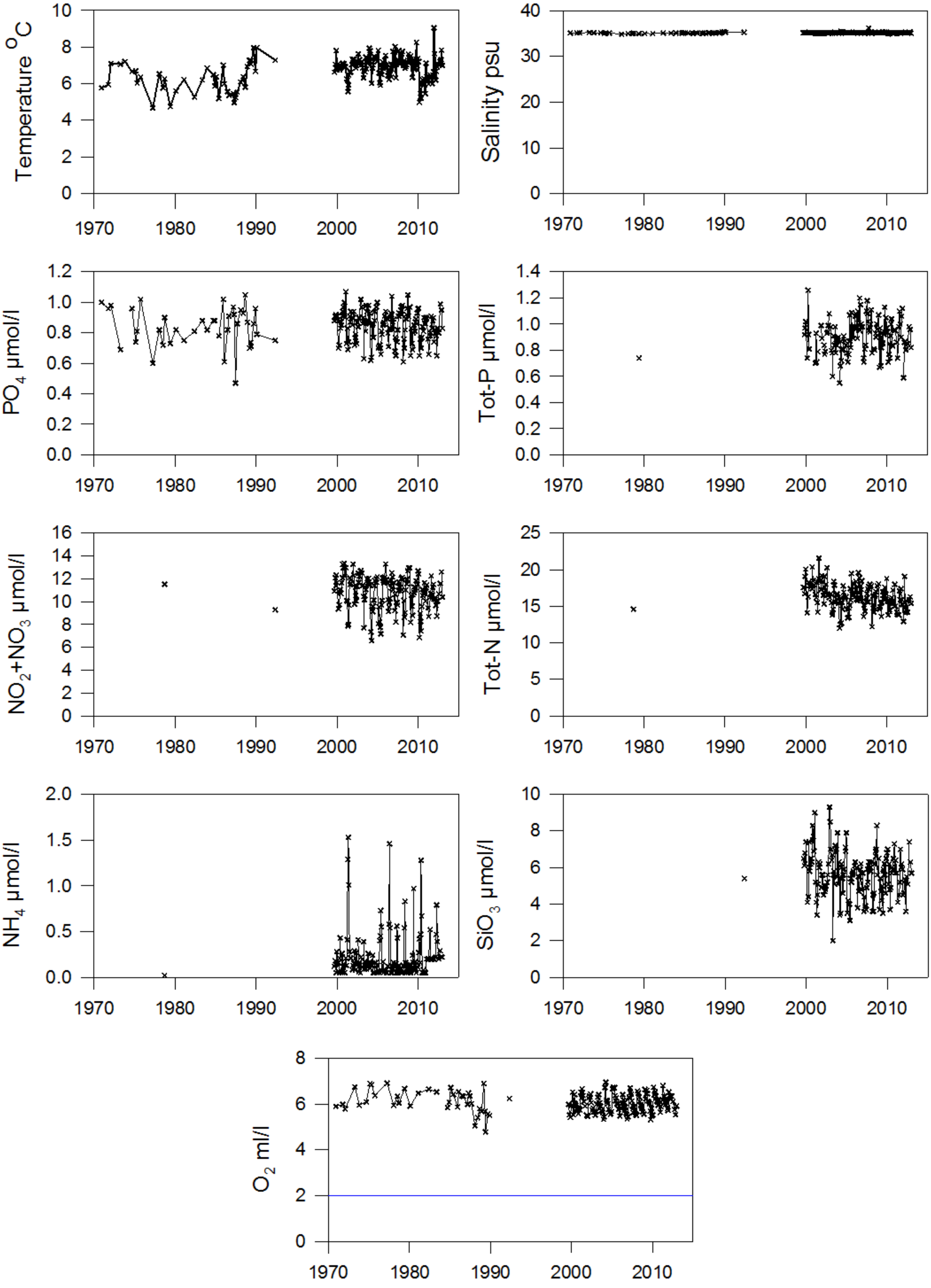
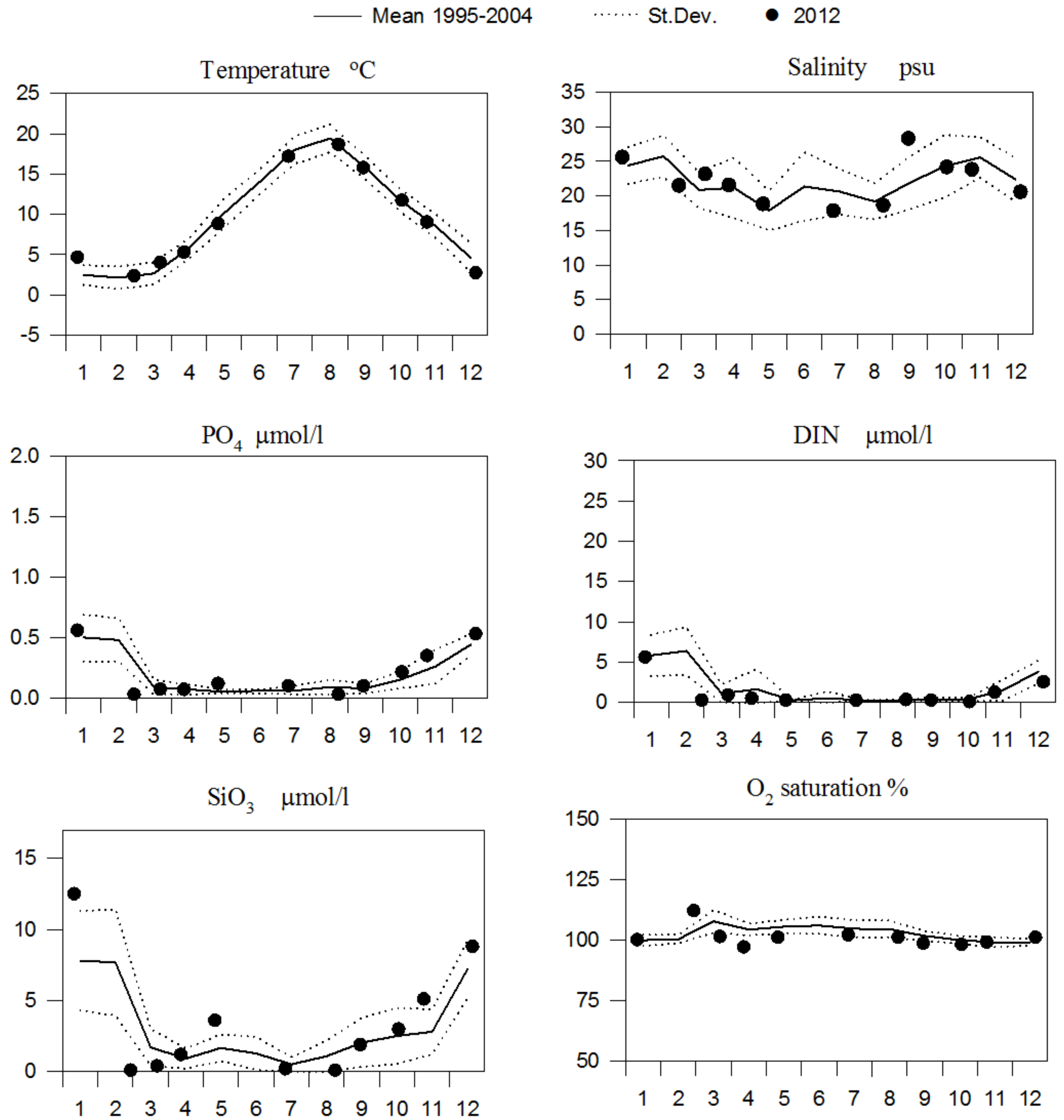


STATION FLADEN SURFACE WATER

Annual Cycles



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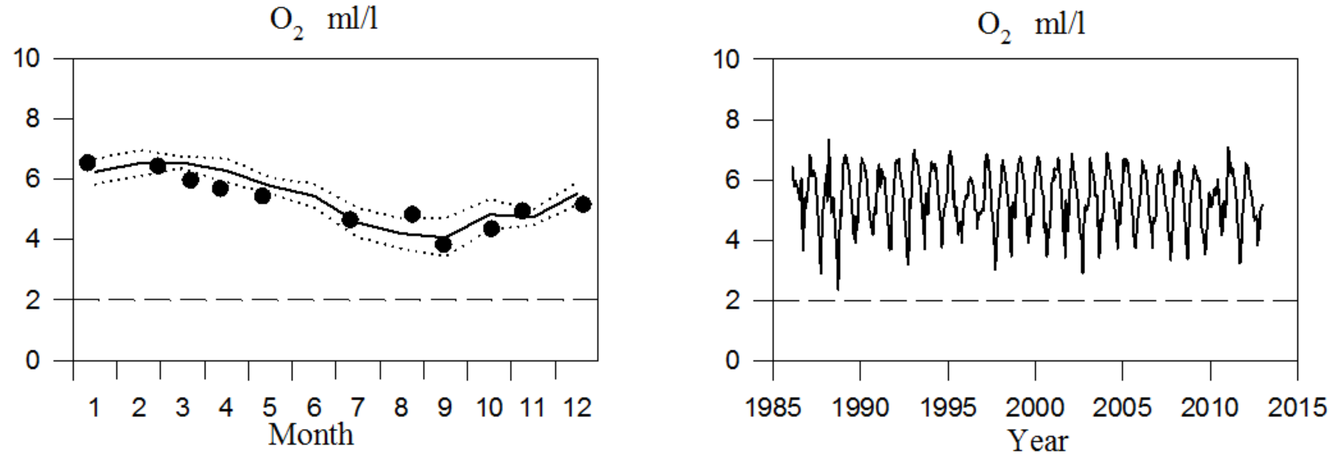

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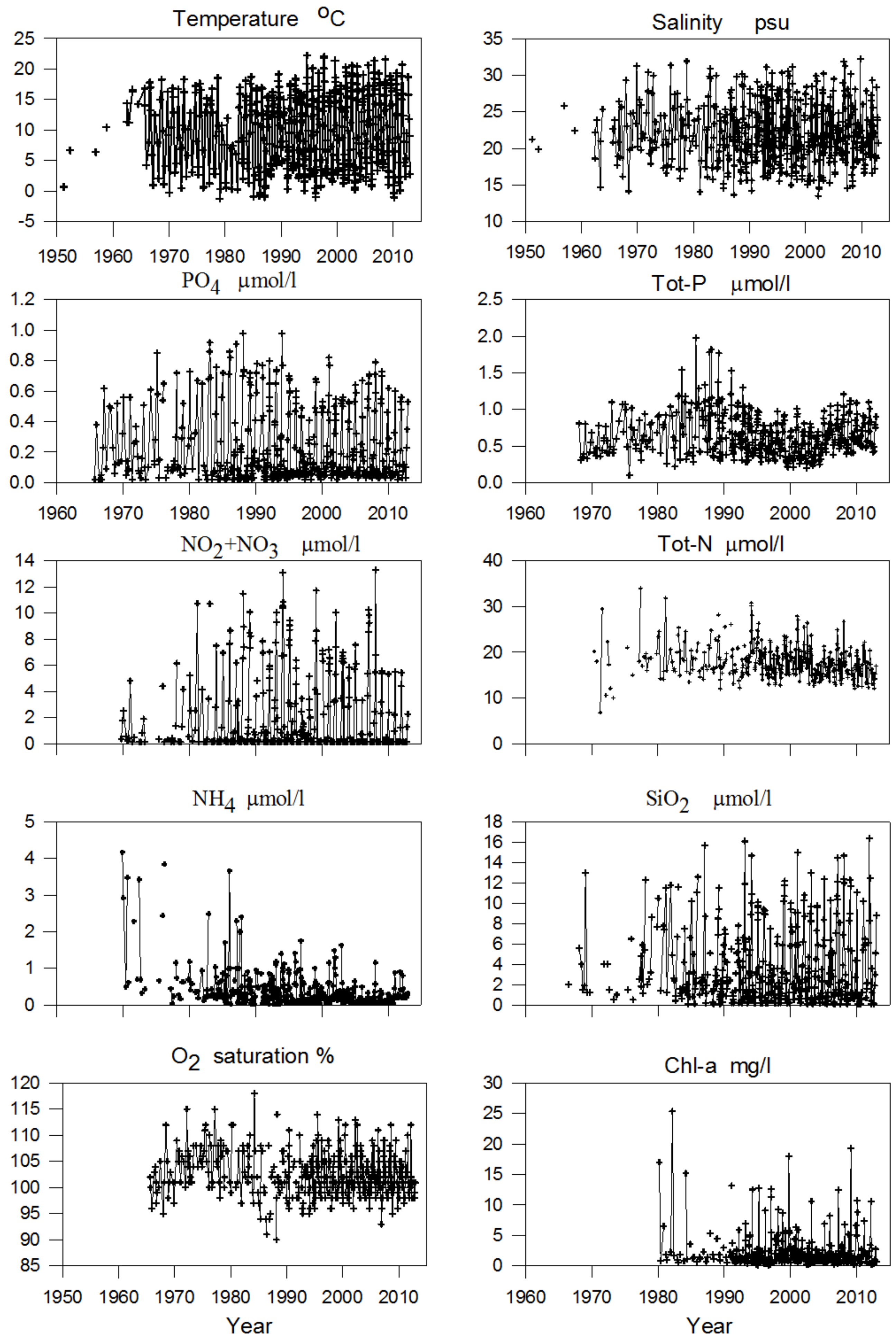

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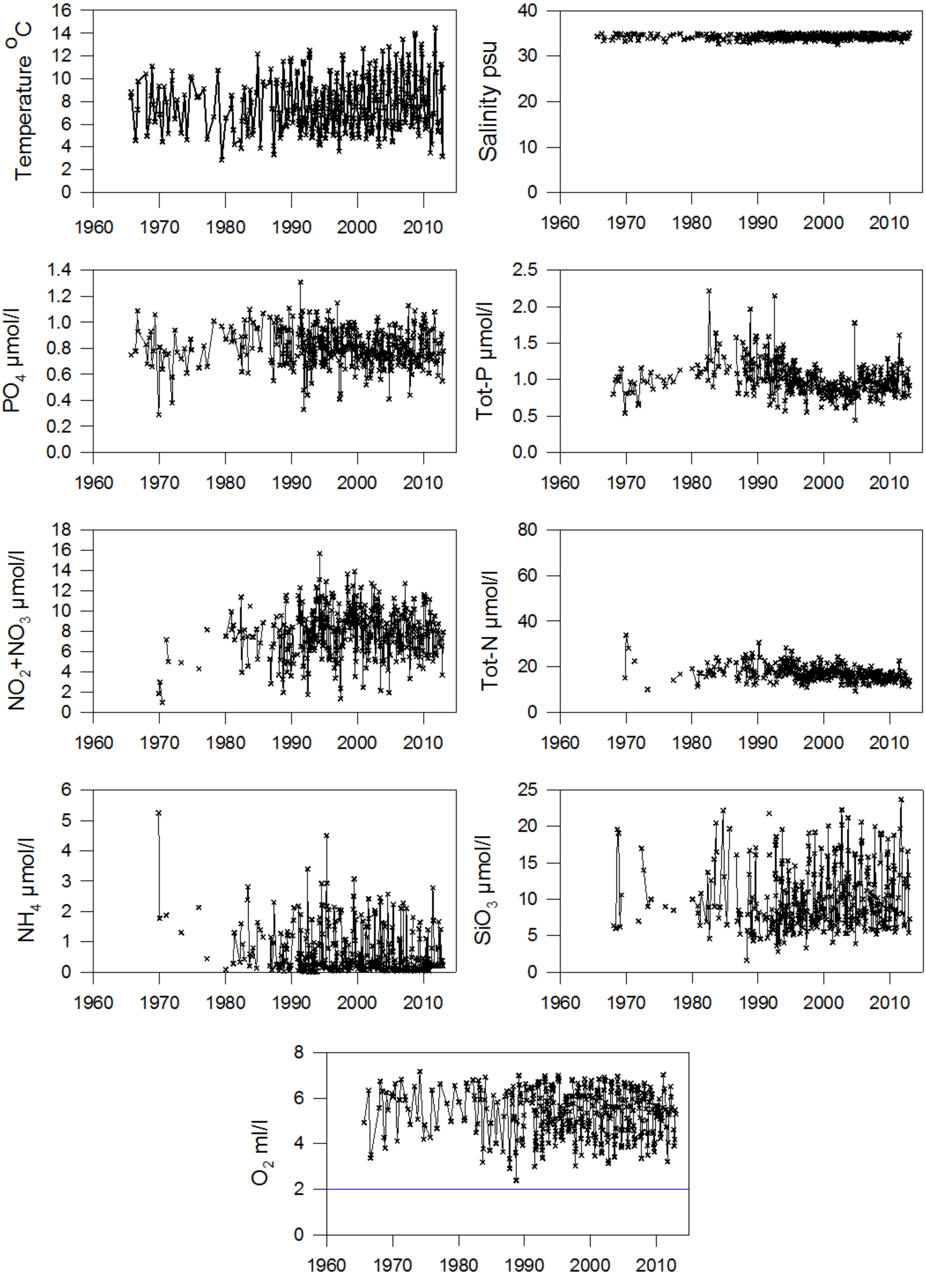
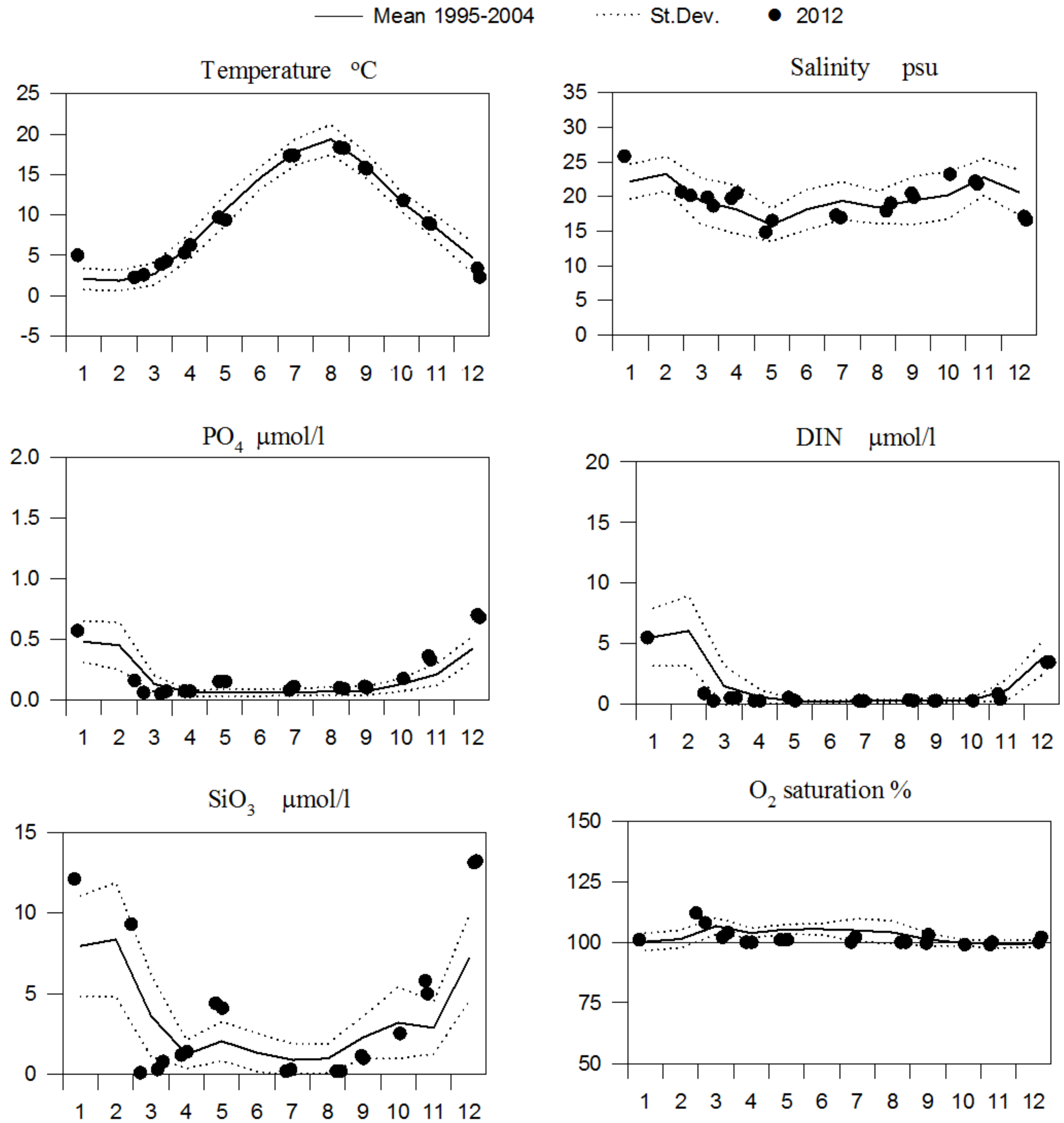


STATION ANHOLT E SURFACE WATER

Annual Cycles



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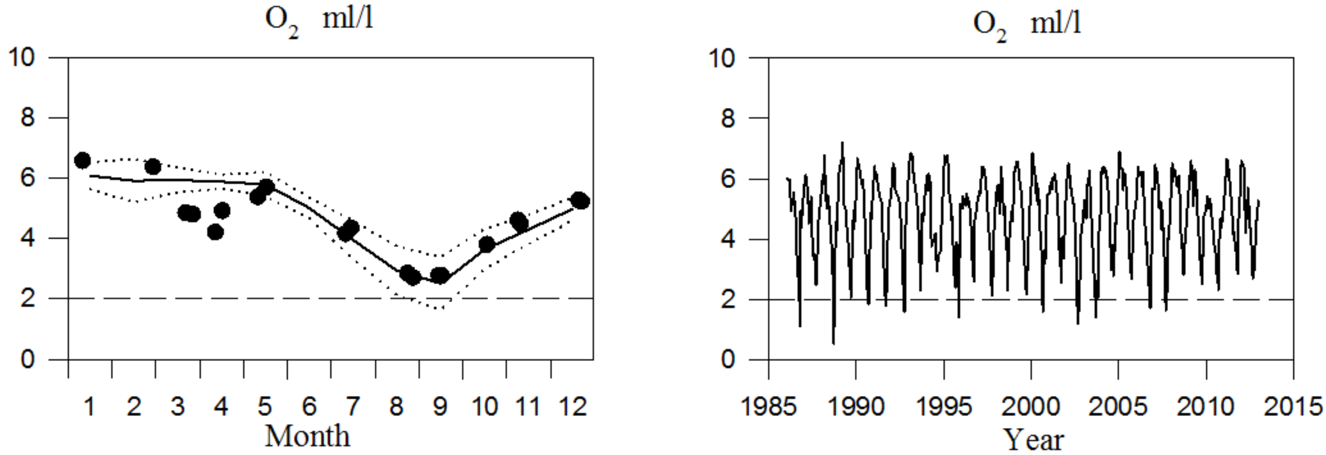

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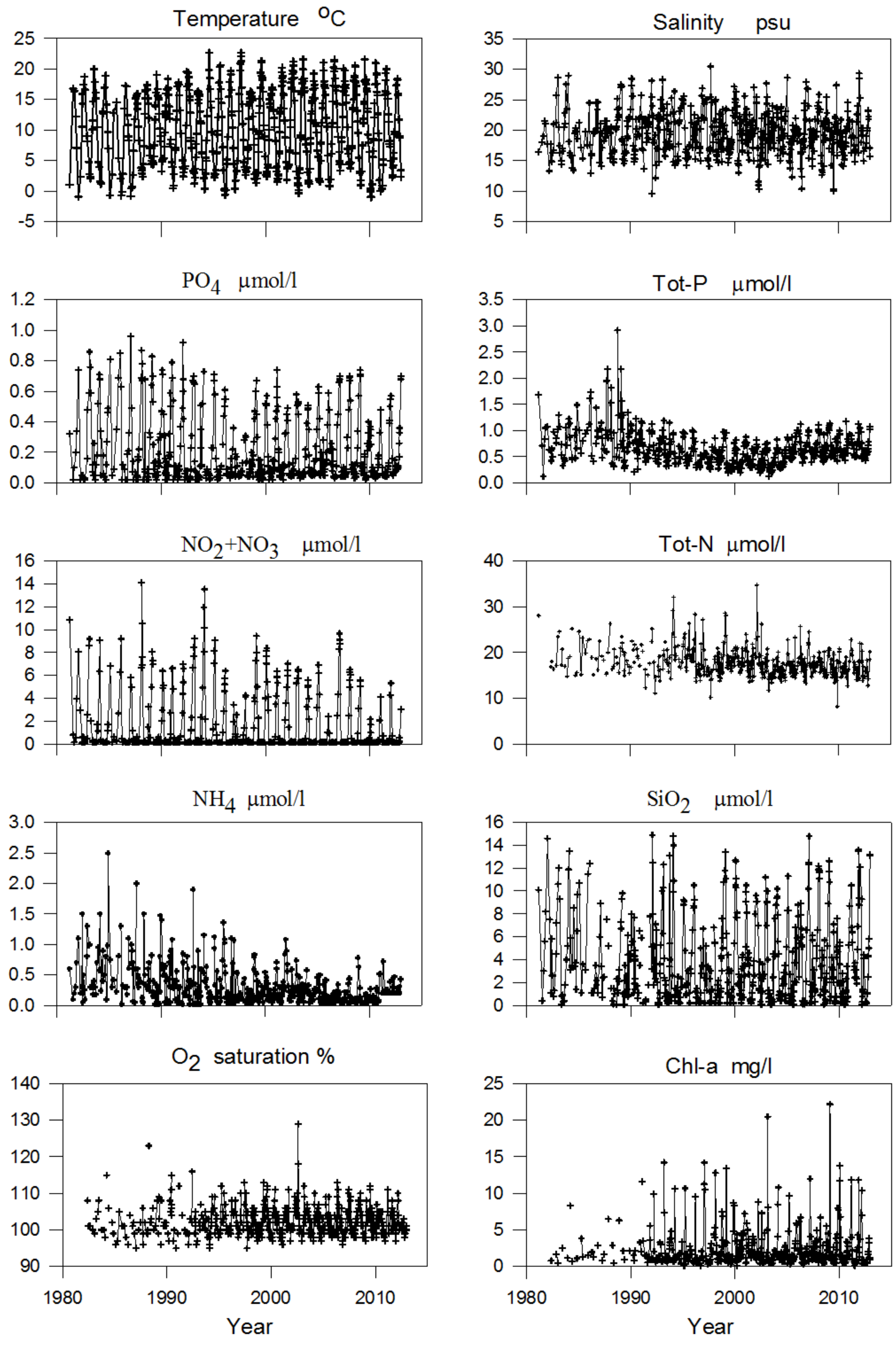

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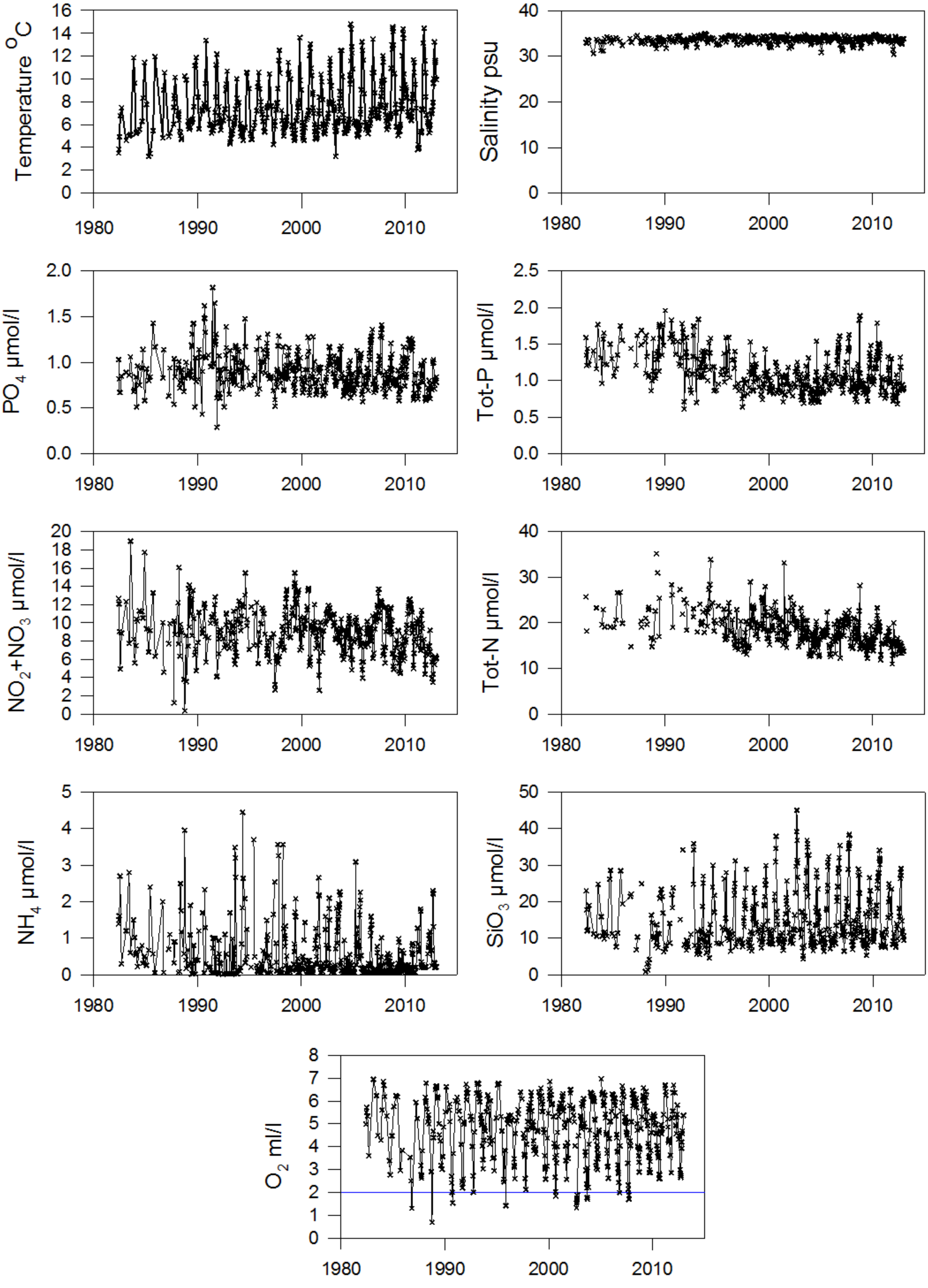
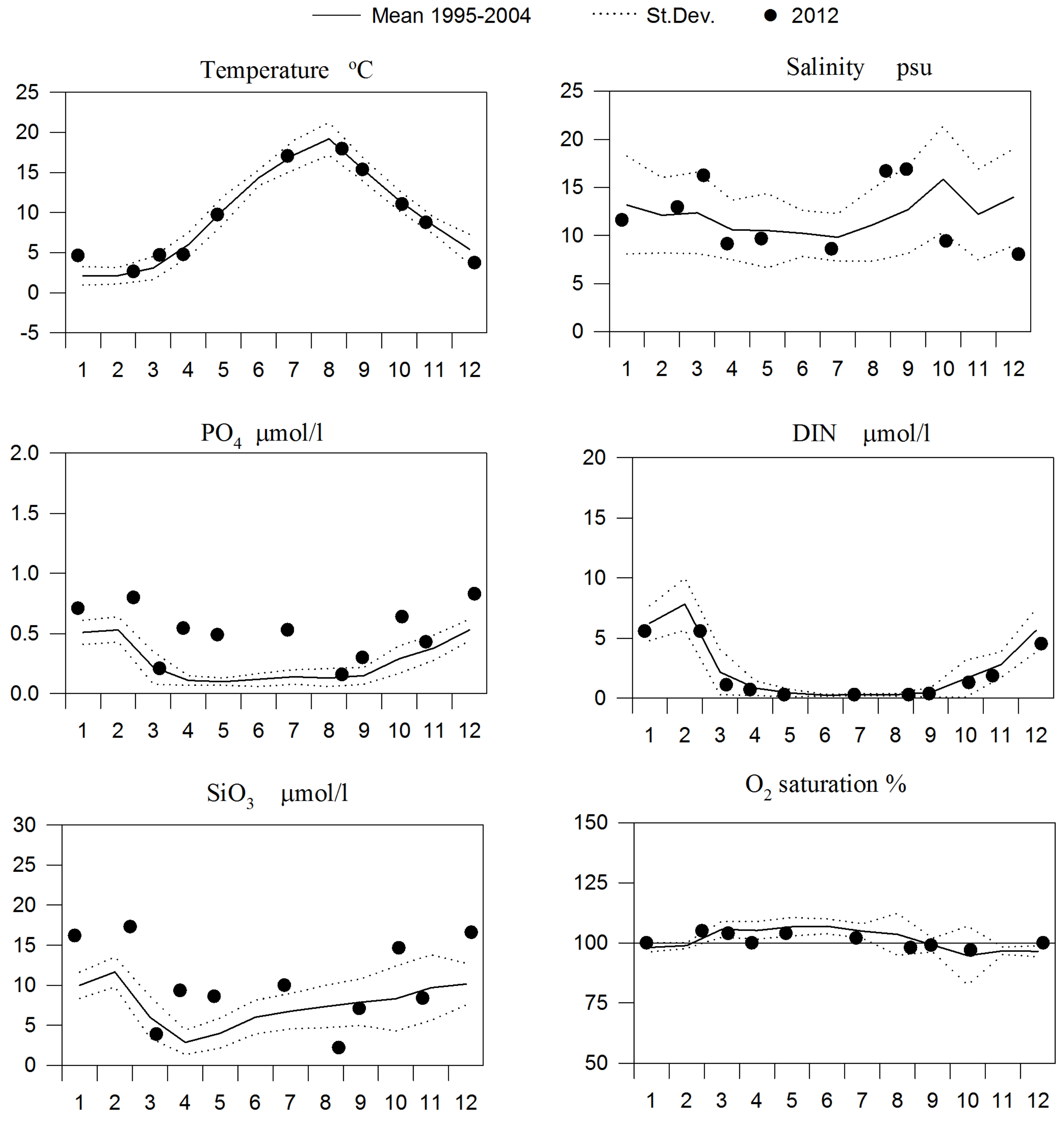


STATION W LANDSKRONA SURFACE WATER

Annual Cycles



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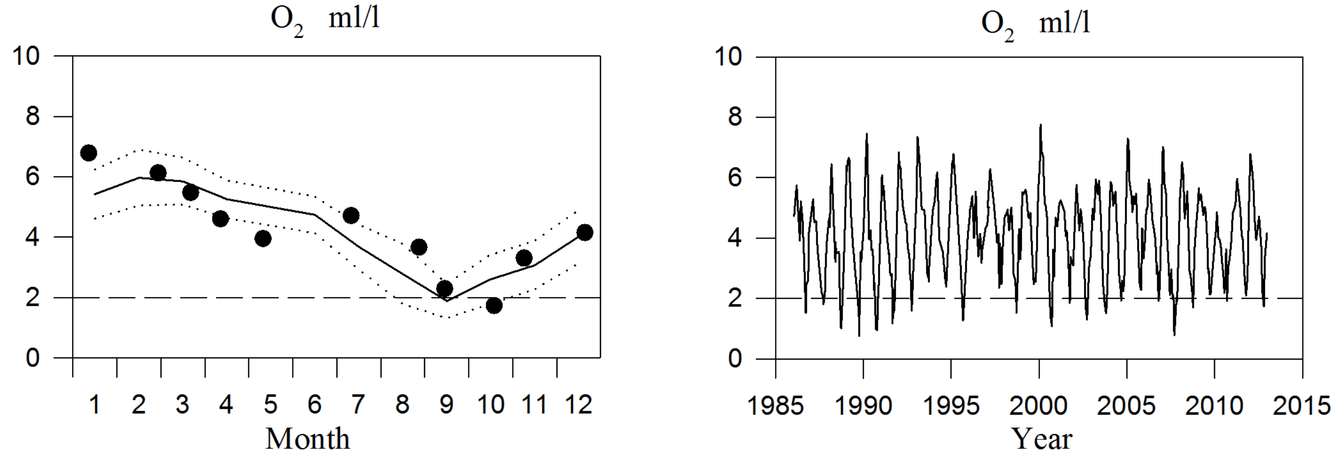

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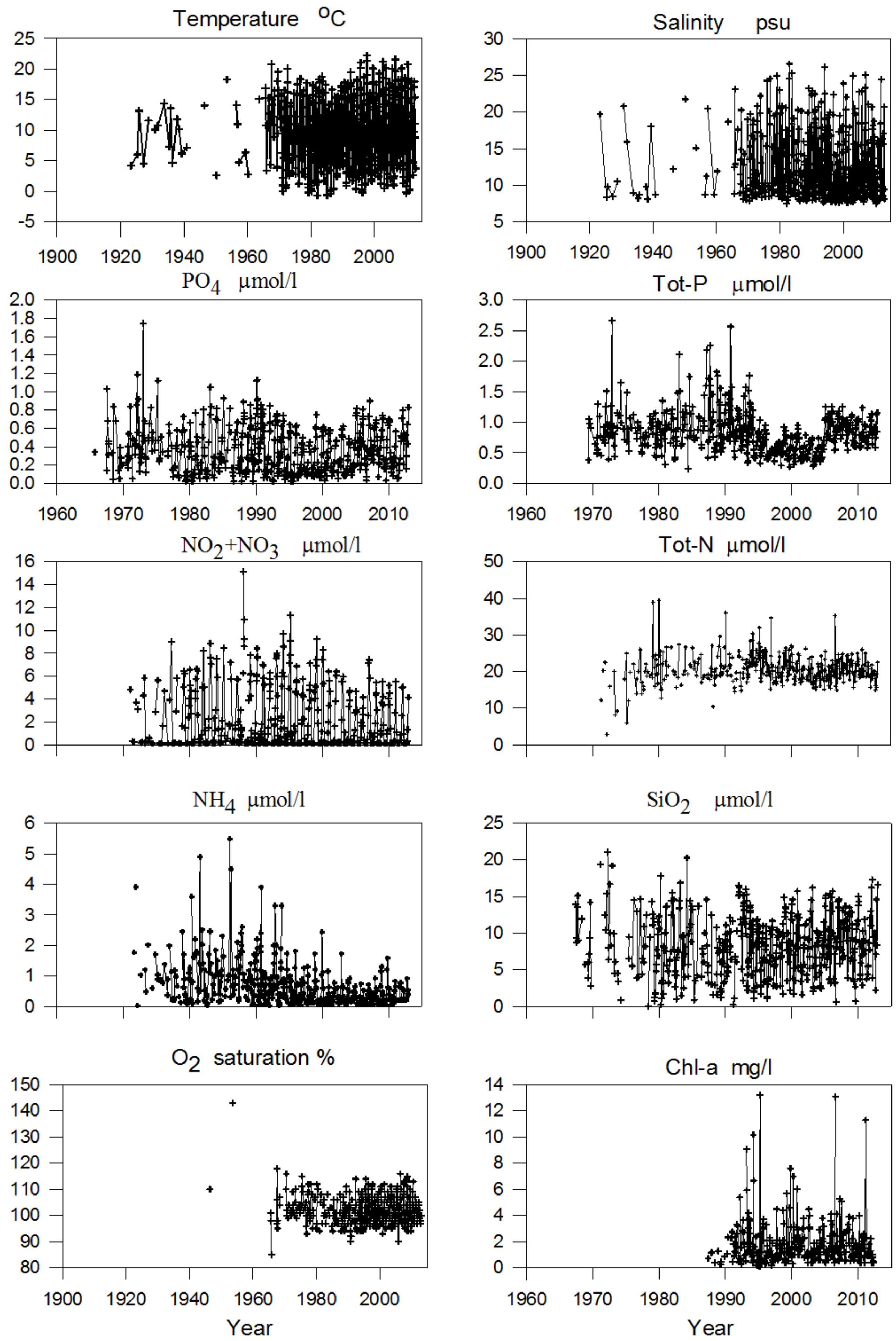

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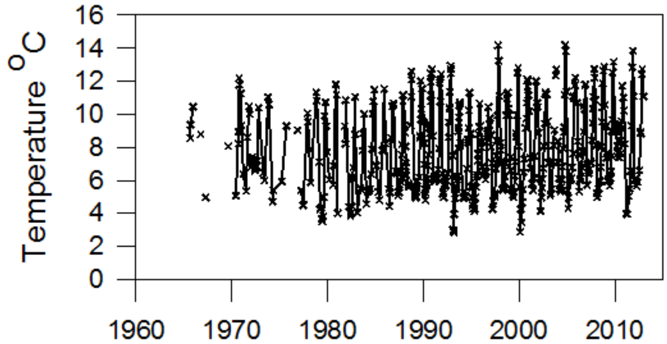
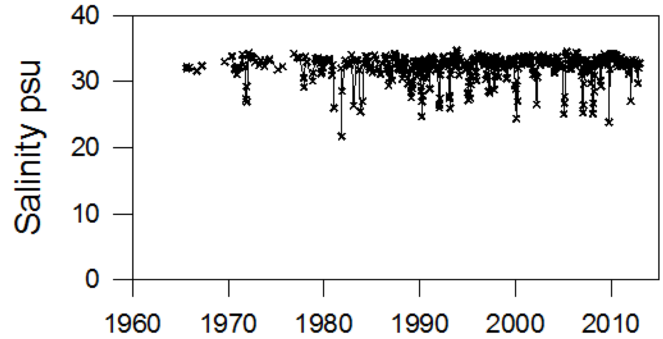
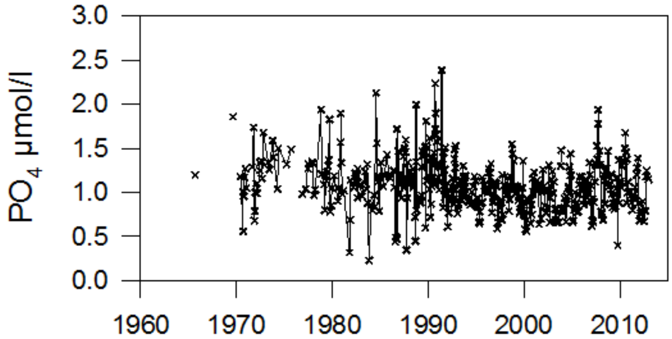
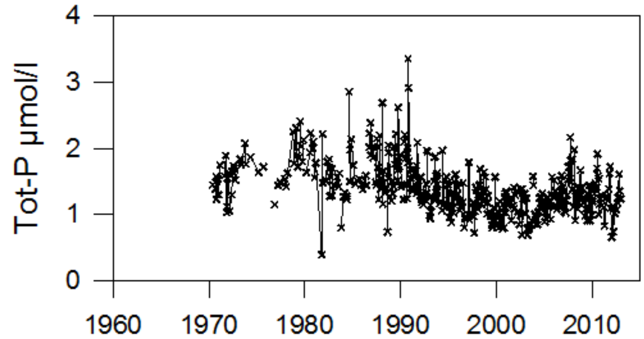
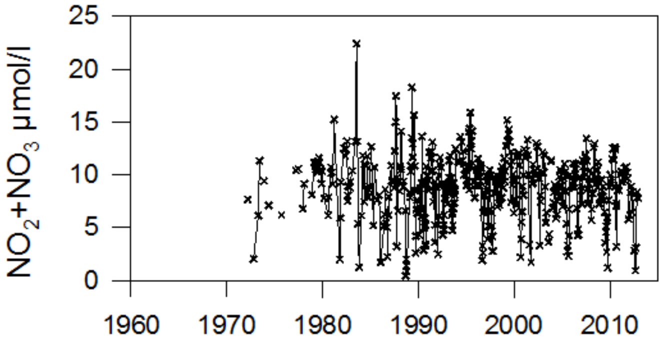
STATION W LANDSKRONA DEEP WATER (40m)

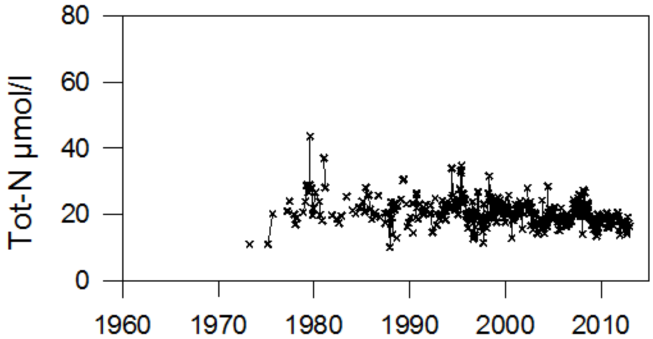


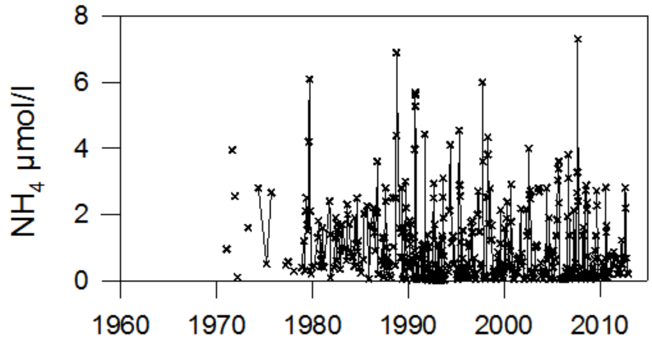


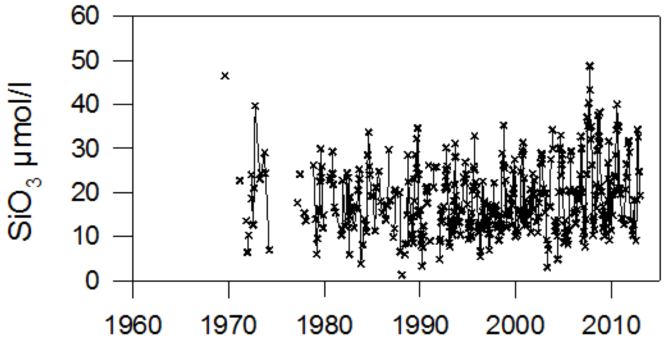


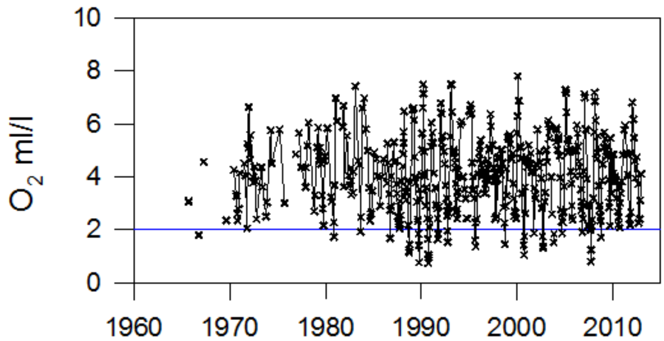






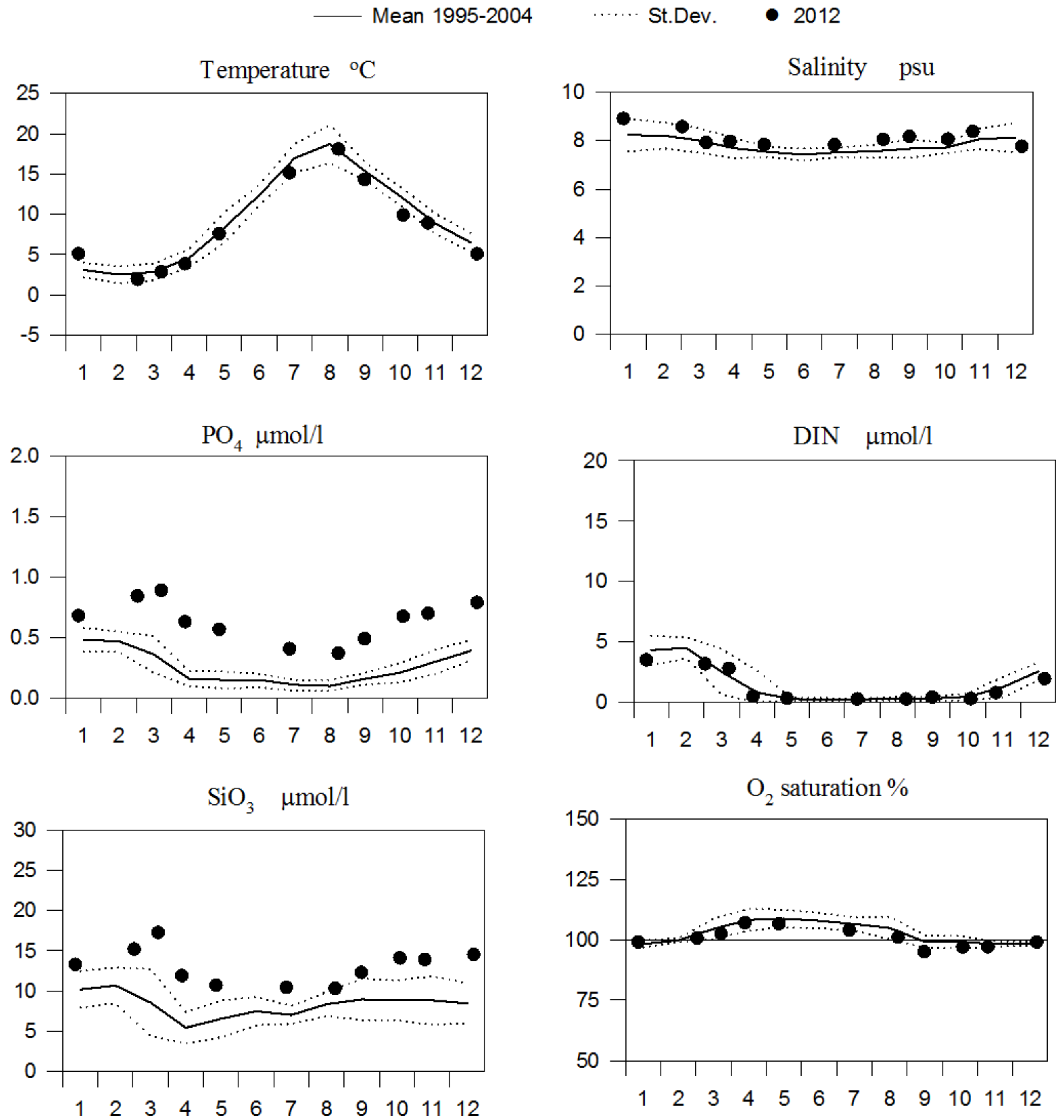




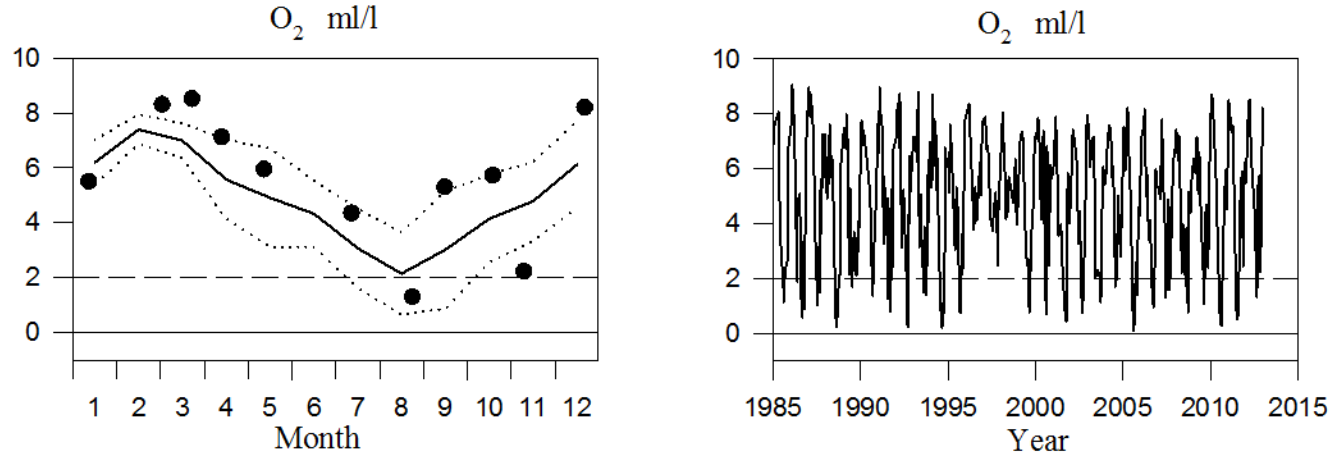


STATION BY1 SURFACE WATER

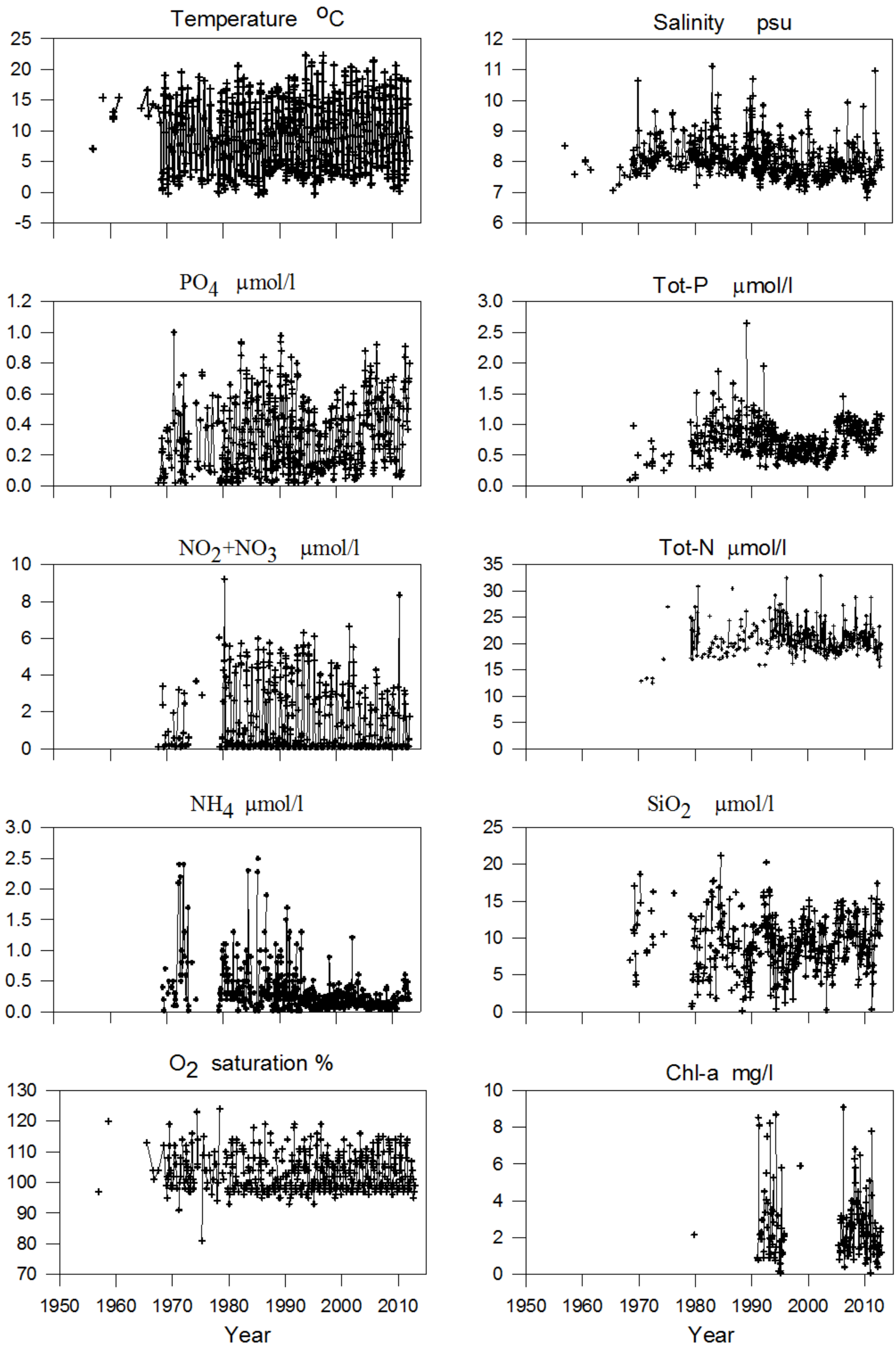
Annual Cycles



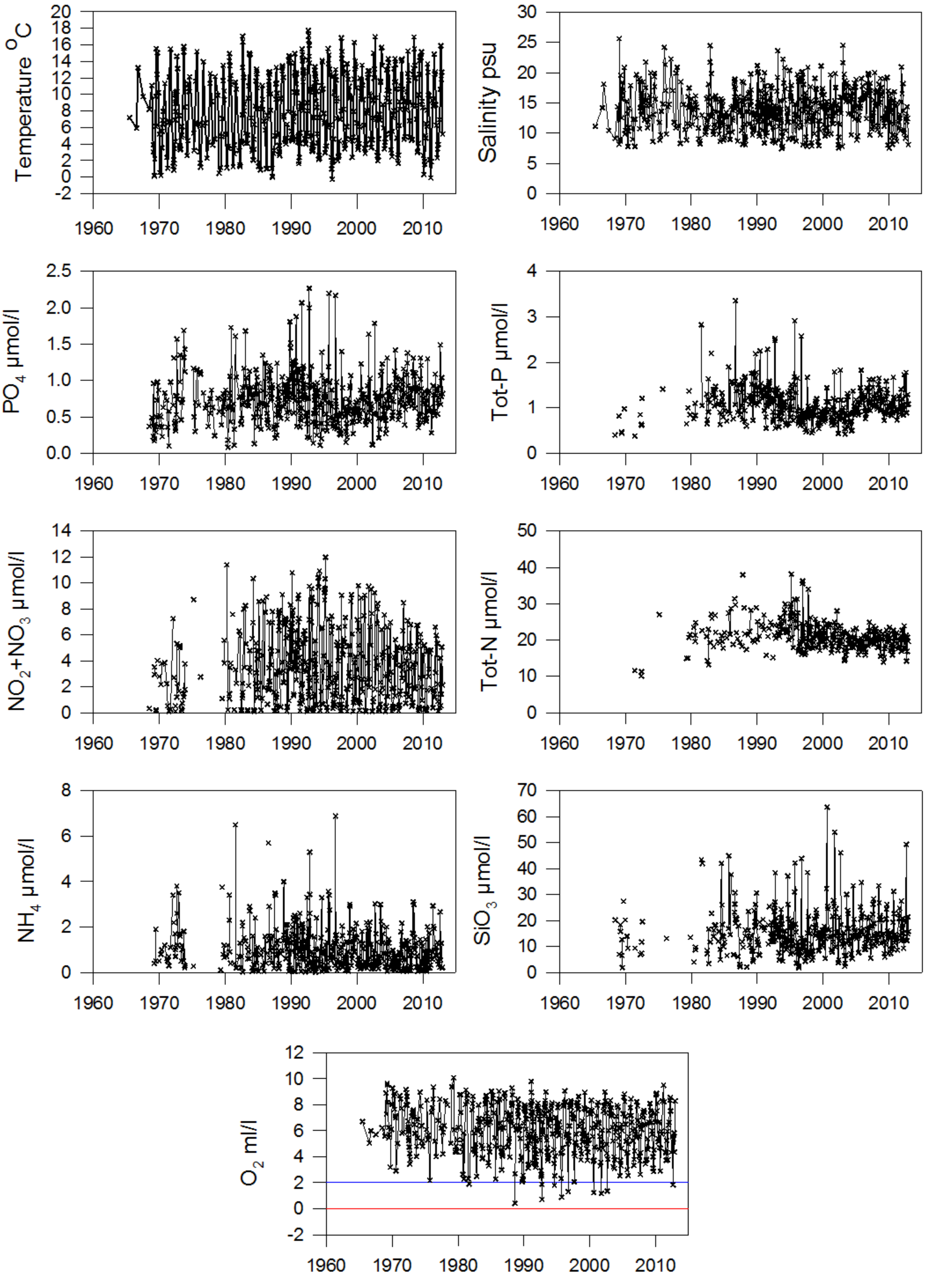
OXYGEN IN BOTTOM WATER



STATION BY1 SURFACE WATER



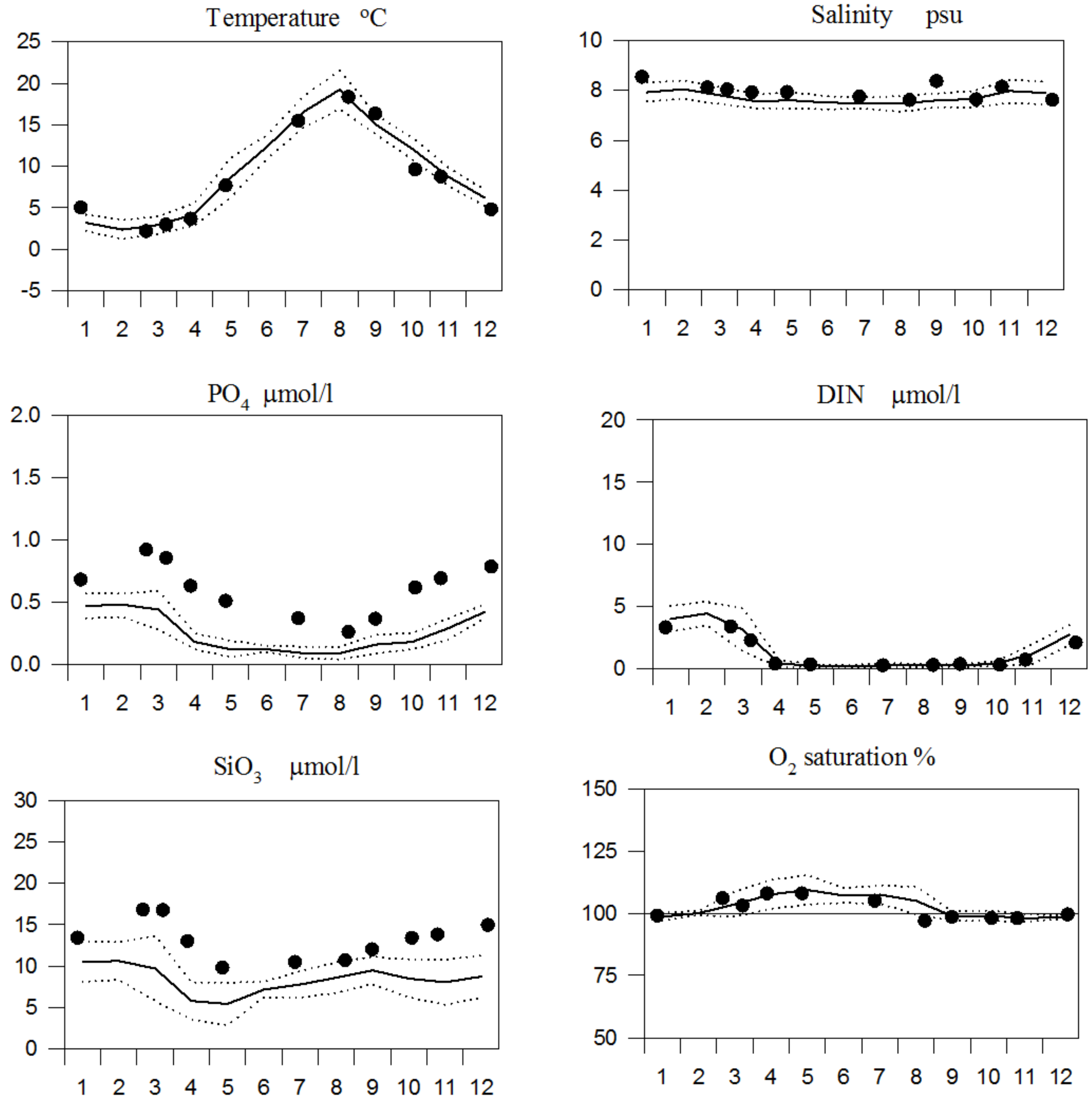
STATION BY1 DEEP WATER (40m)



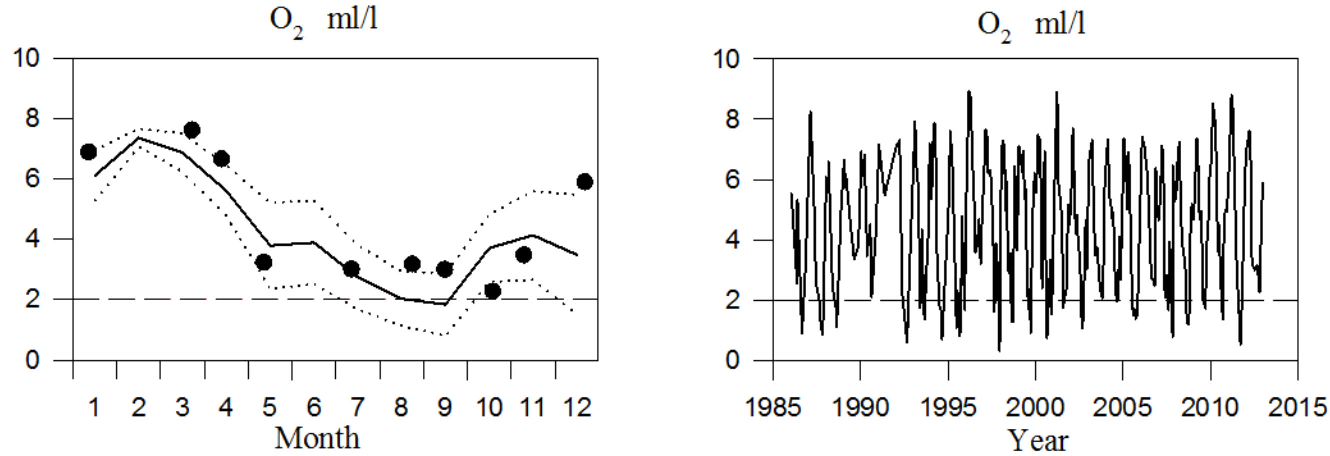
STATION BY2 SURFACE WATER

Annual Cycles

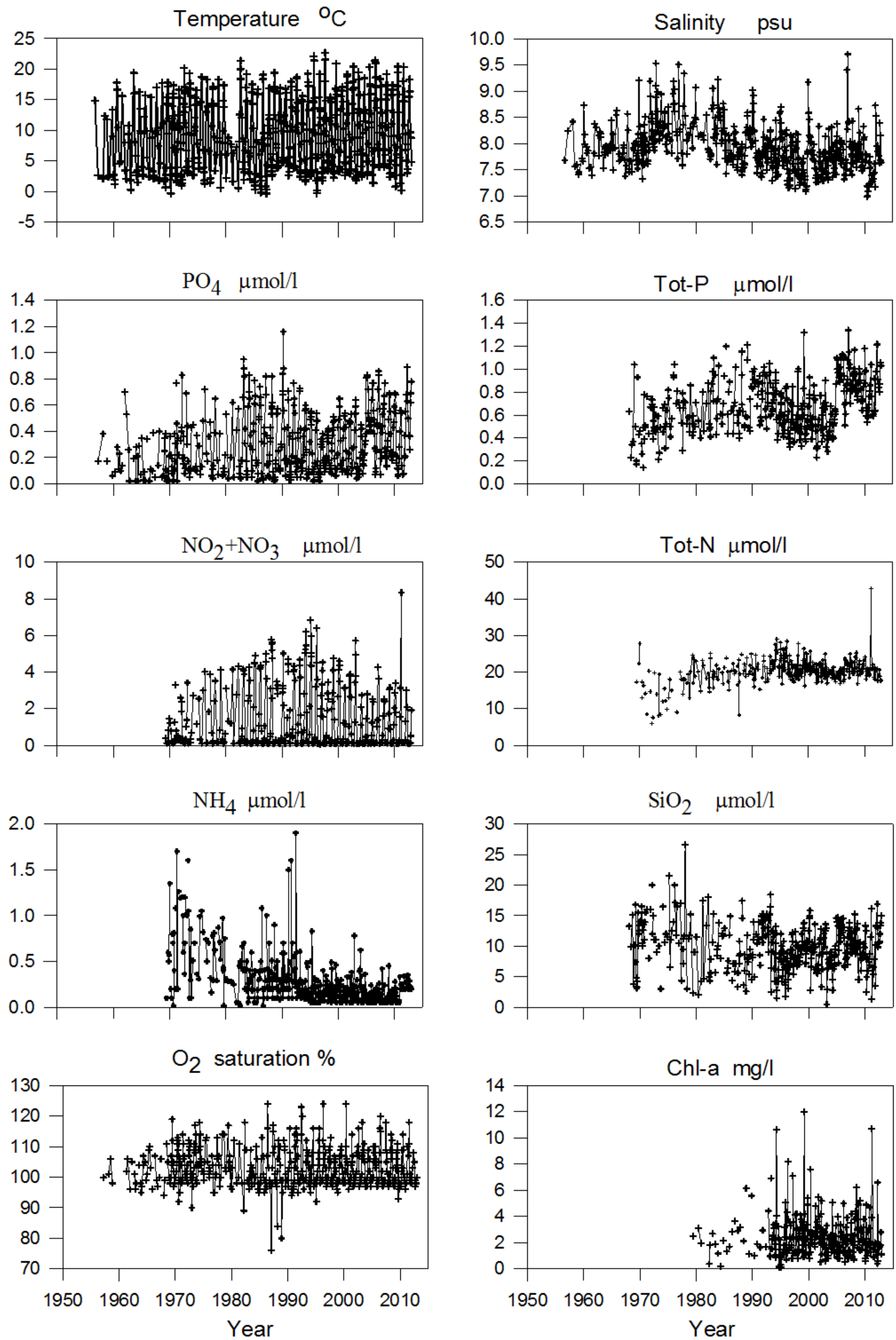
—— Mean 1995-2004 ······ St.Dev. ● 2012



OXYGEN IN BOTTOM WATER



STATION BY2 SURFACE WATER



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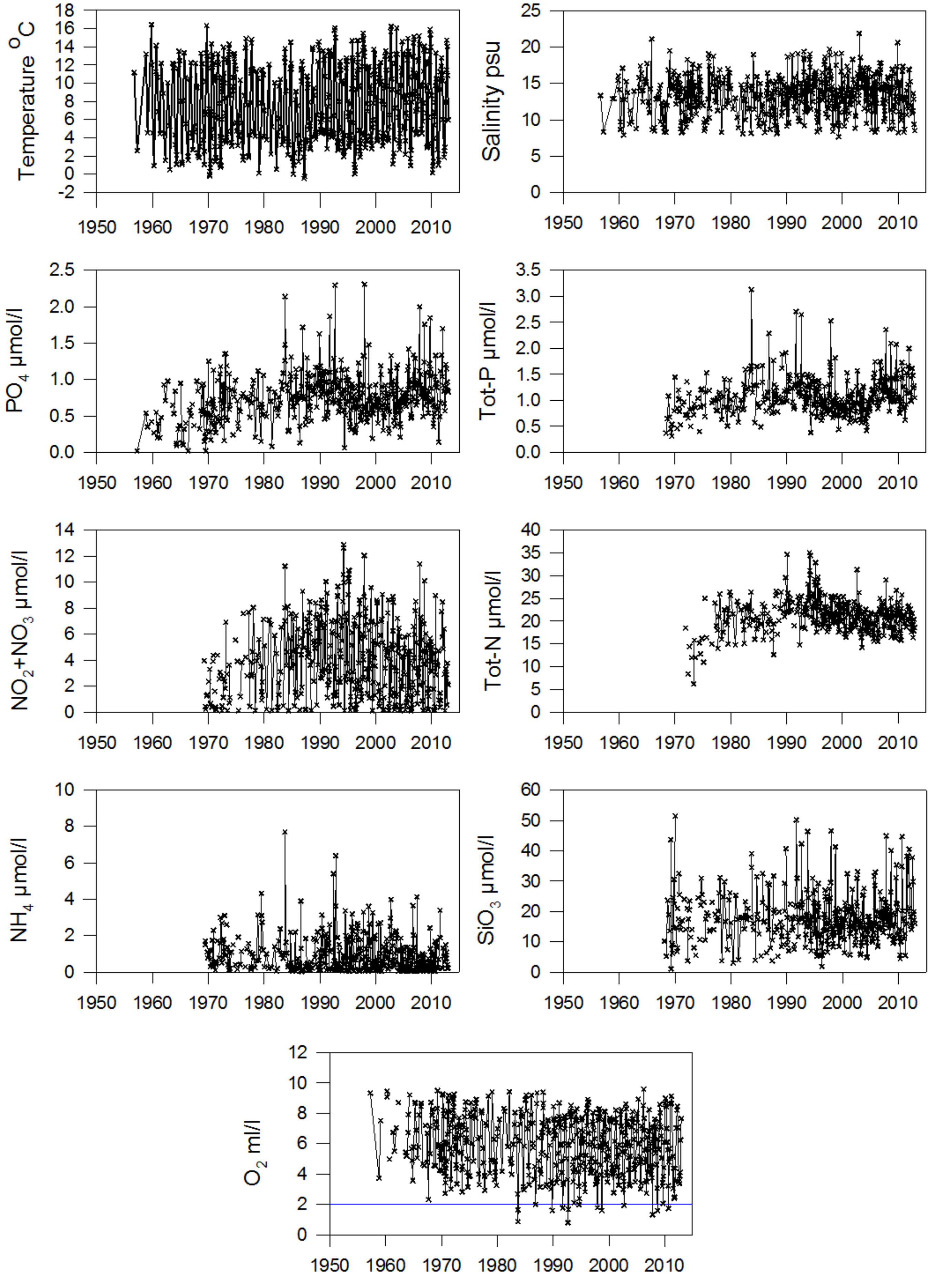
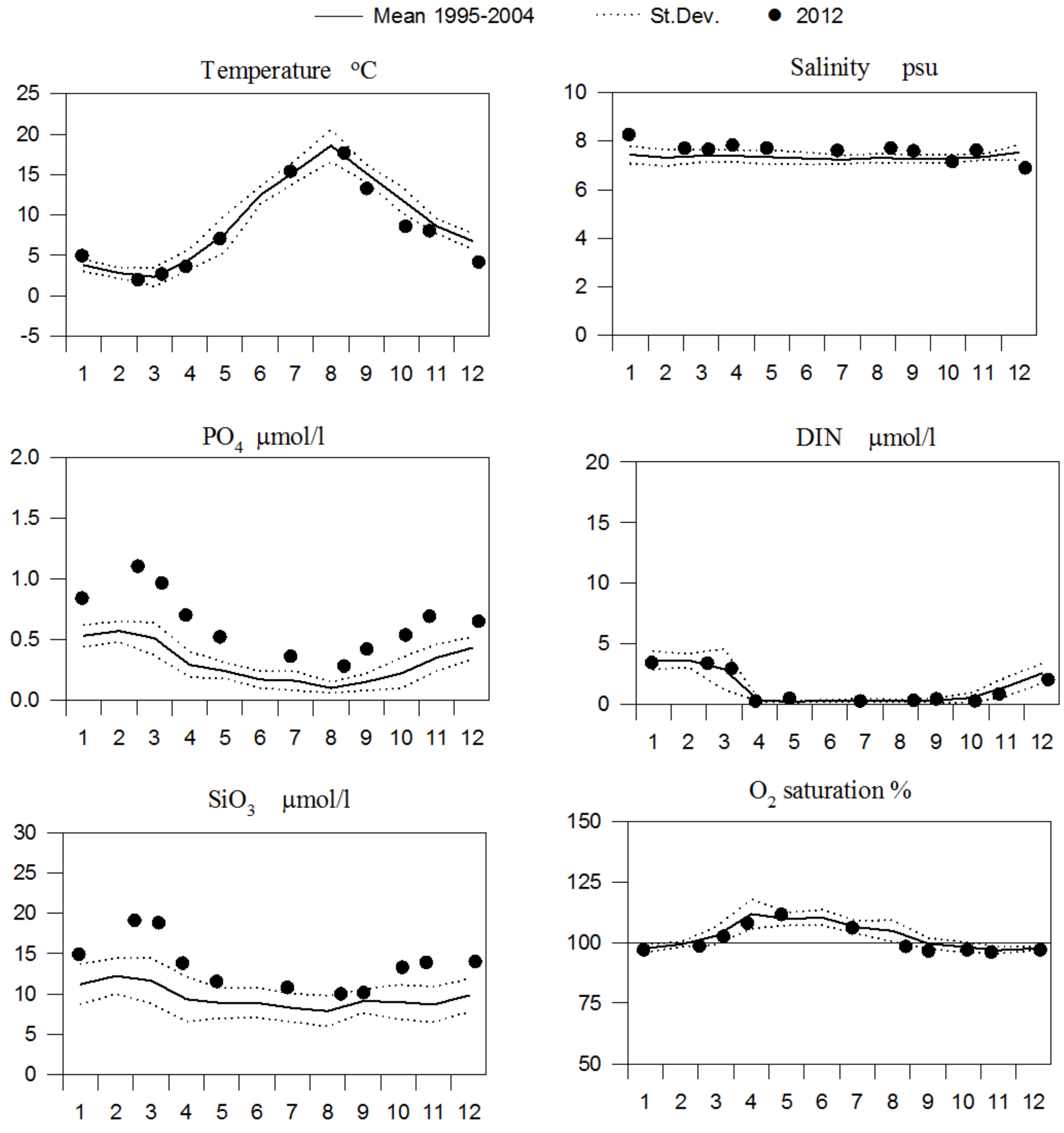
STATION BY2 DEEP WATER (40m)

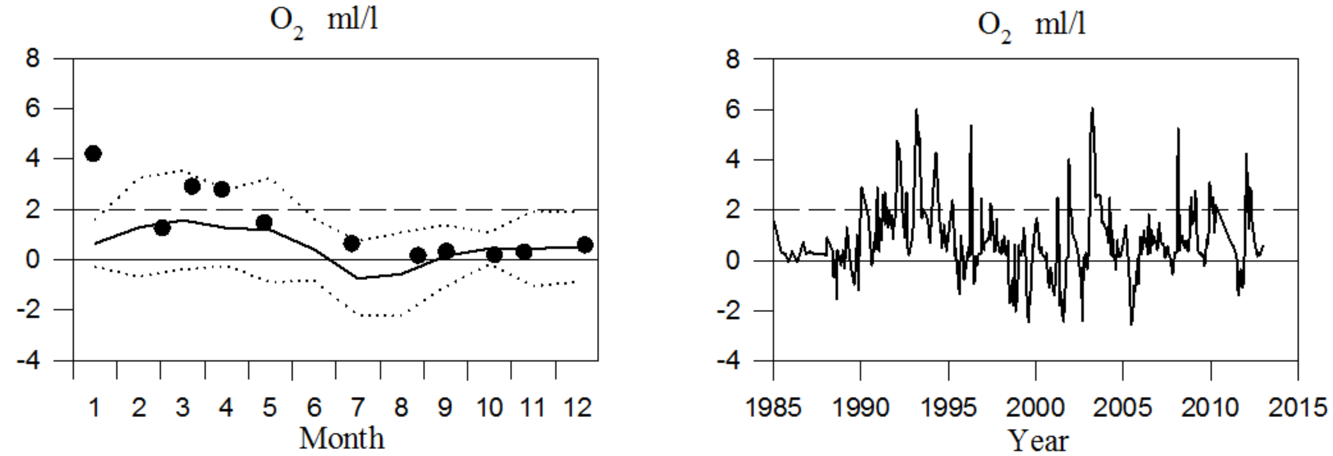


STATION HANÖBUKTEN SURFACE WATER

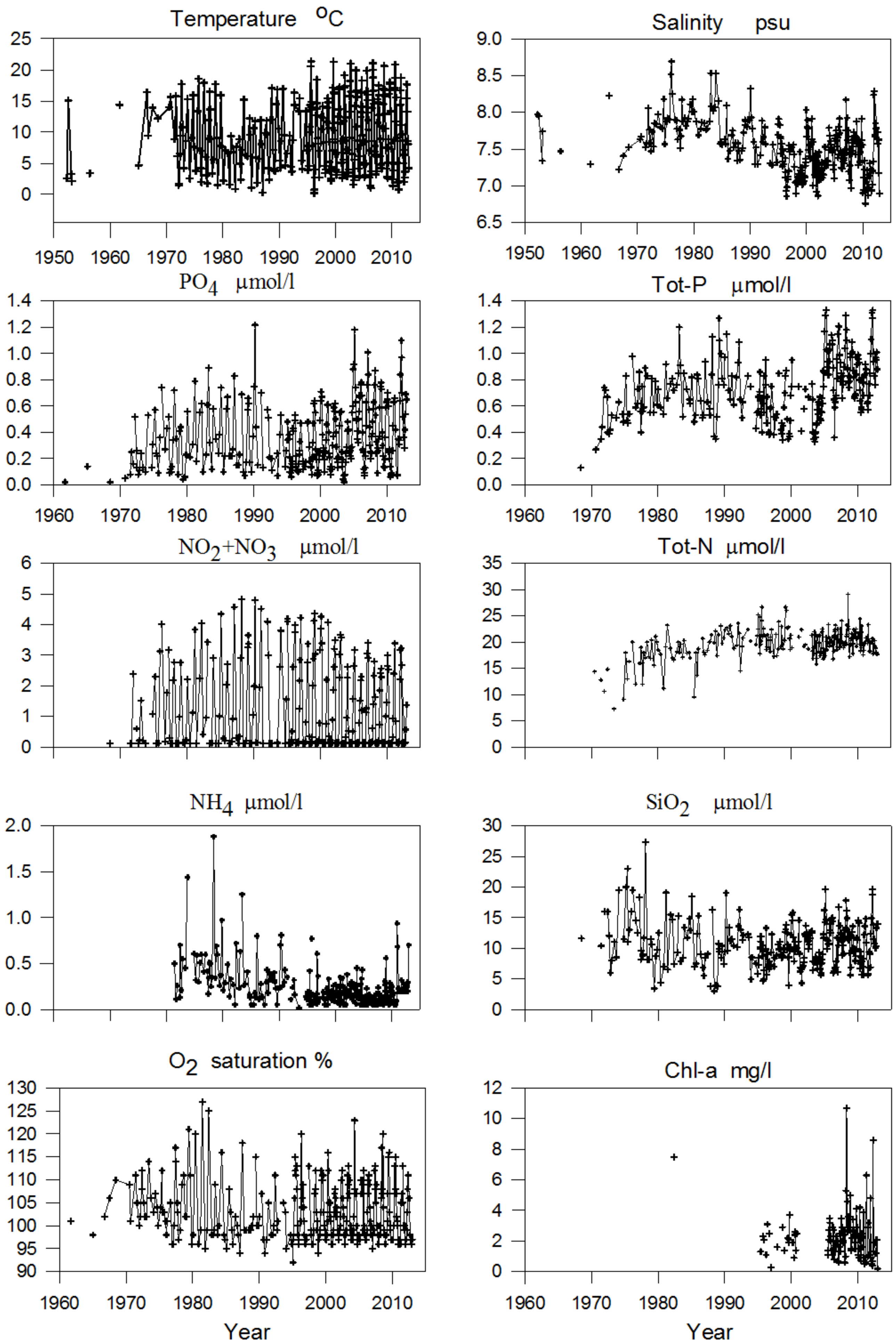
Annual Cycles



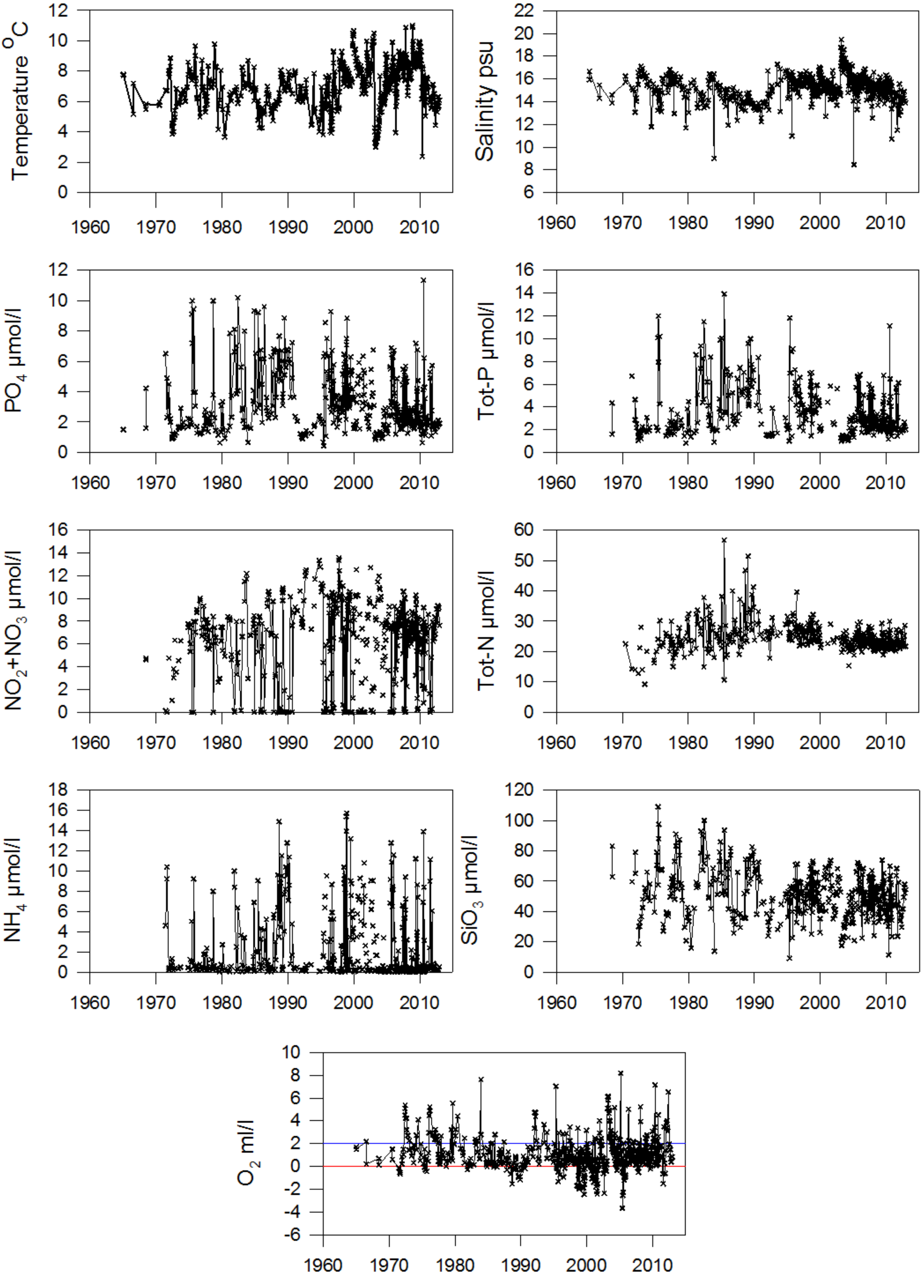
OXYGEN IN BOTTOM WATER



STATION HANÖBUKTEN SURFACE WATER



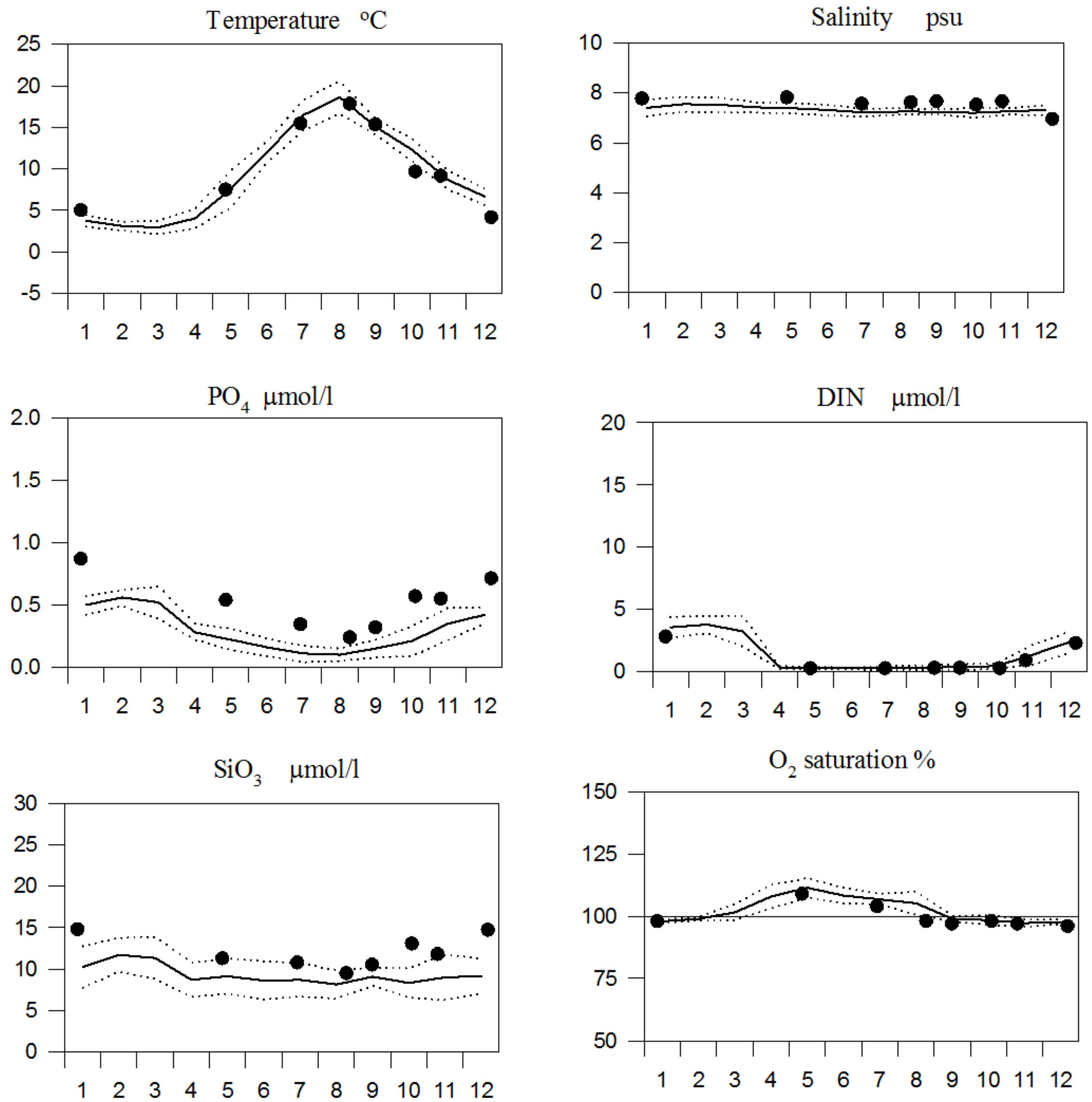
STATION HANÖBUKTEN DEEP WATER (70m)



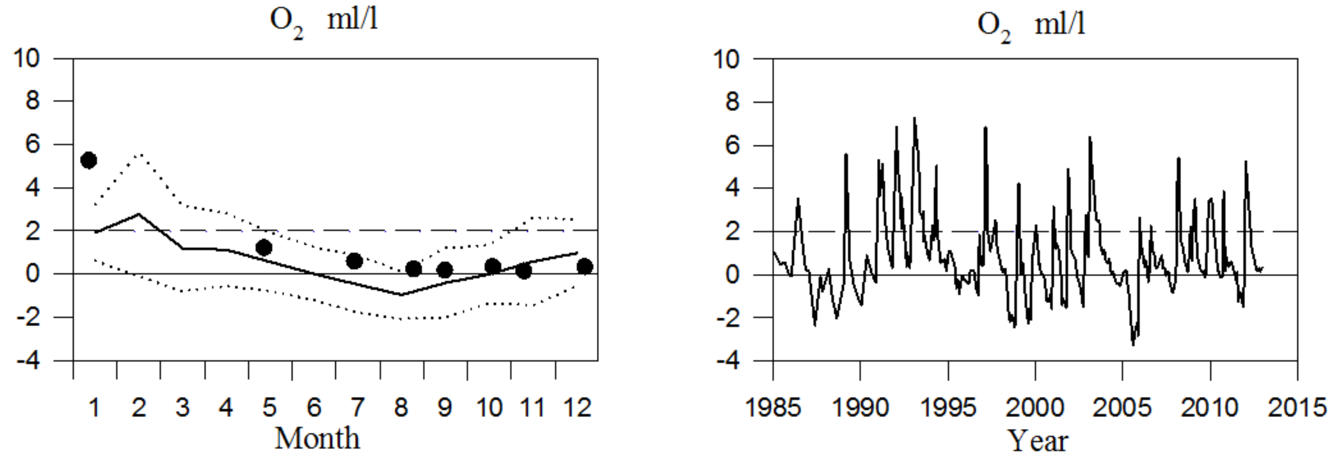
STATION BY4 SURFACE WATER

Annual Cycles

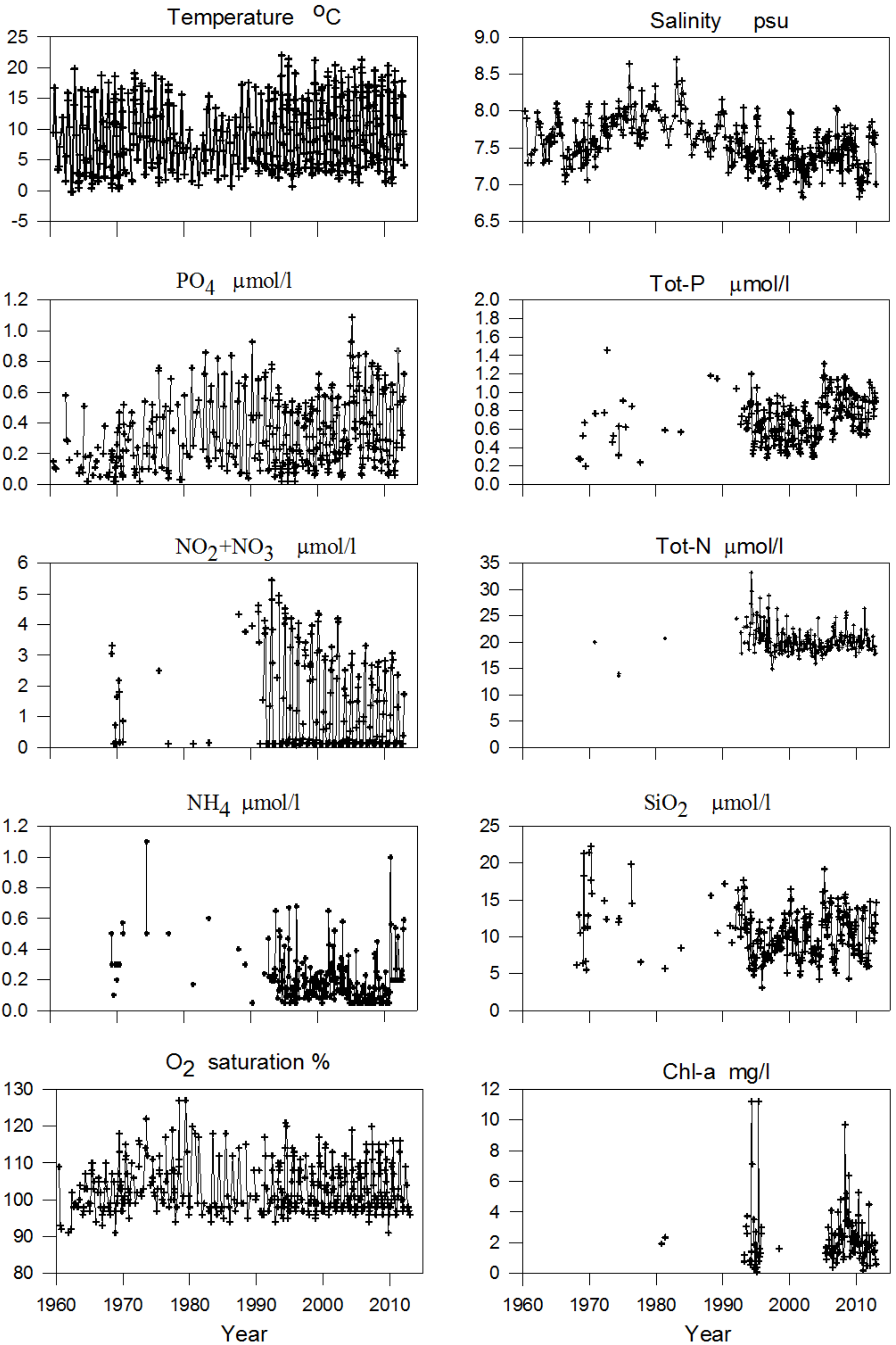
Mean 1995-2004 St.Dev. ● 2012



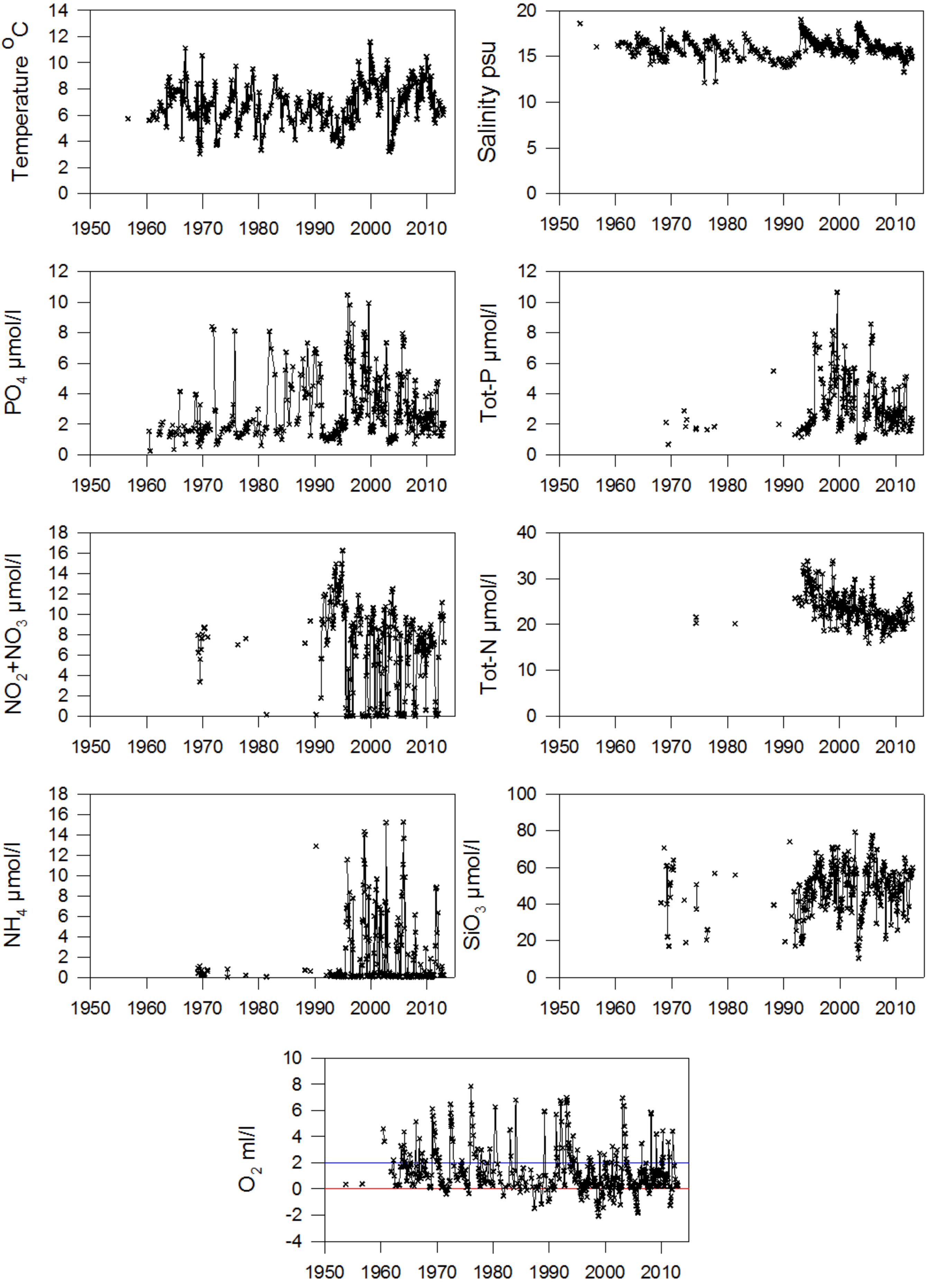
OXYGEN IN BOTTOM WATER



STATION BY4 SURFACE WATER

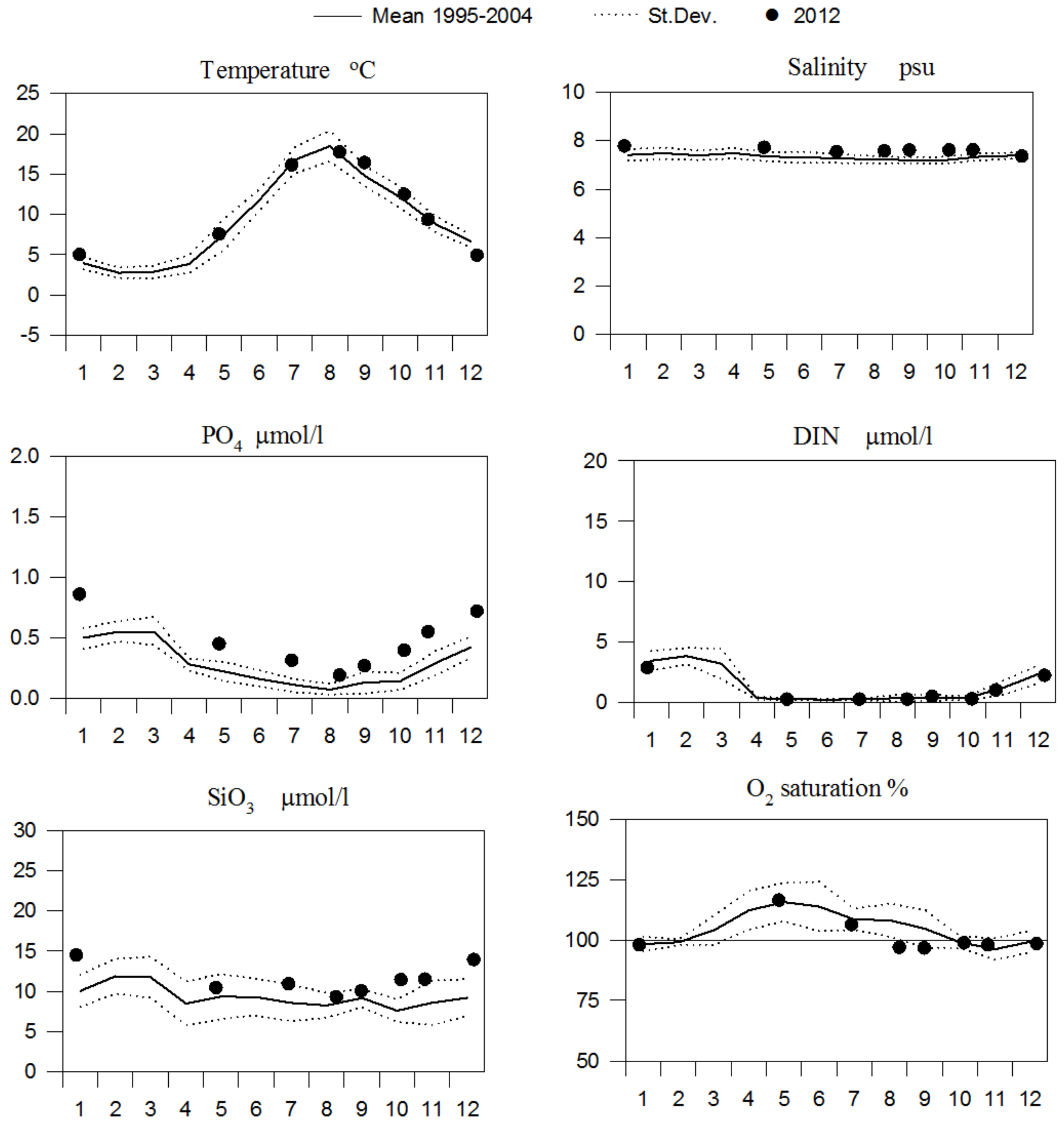


STATION BY4 DEEP WATER (80m)

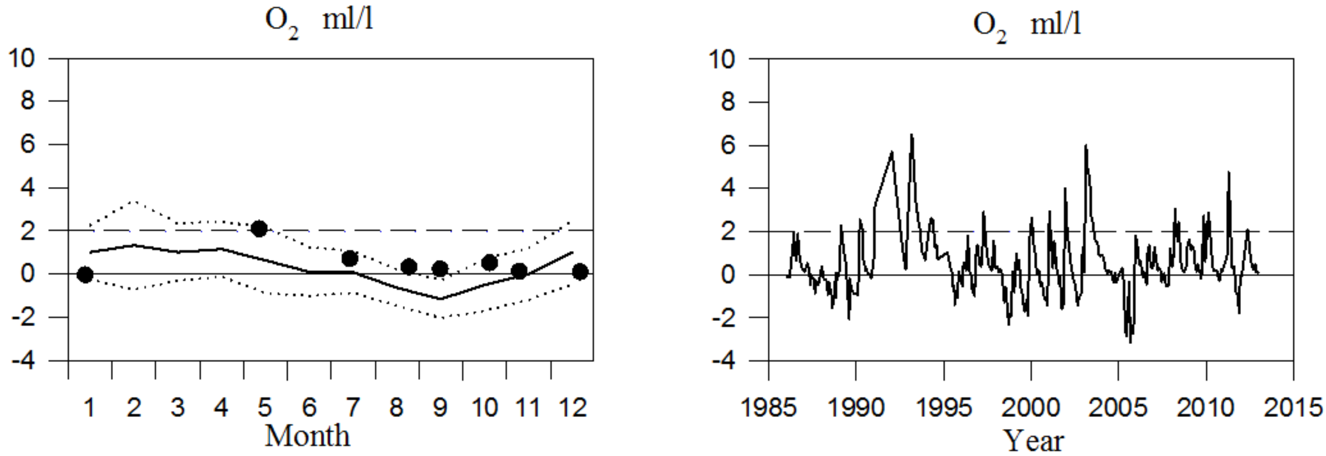


STATION BY5 SURFACE WATER

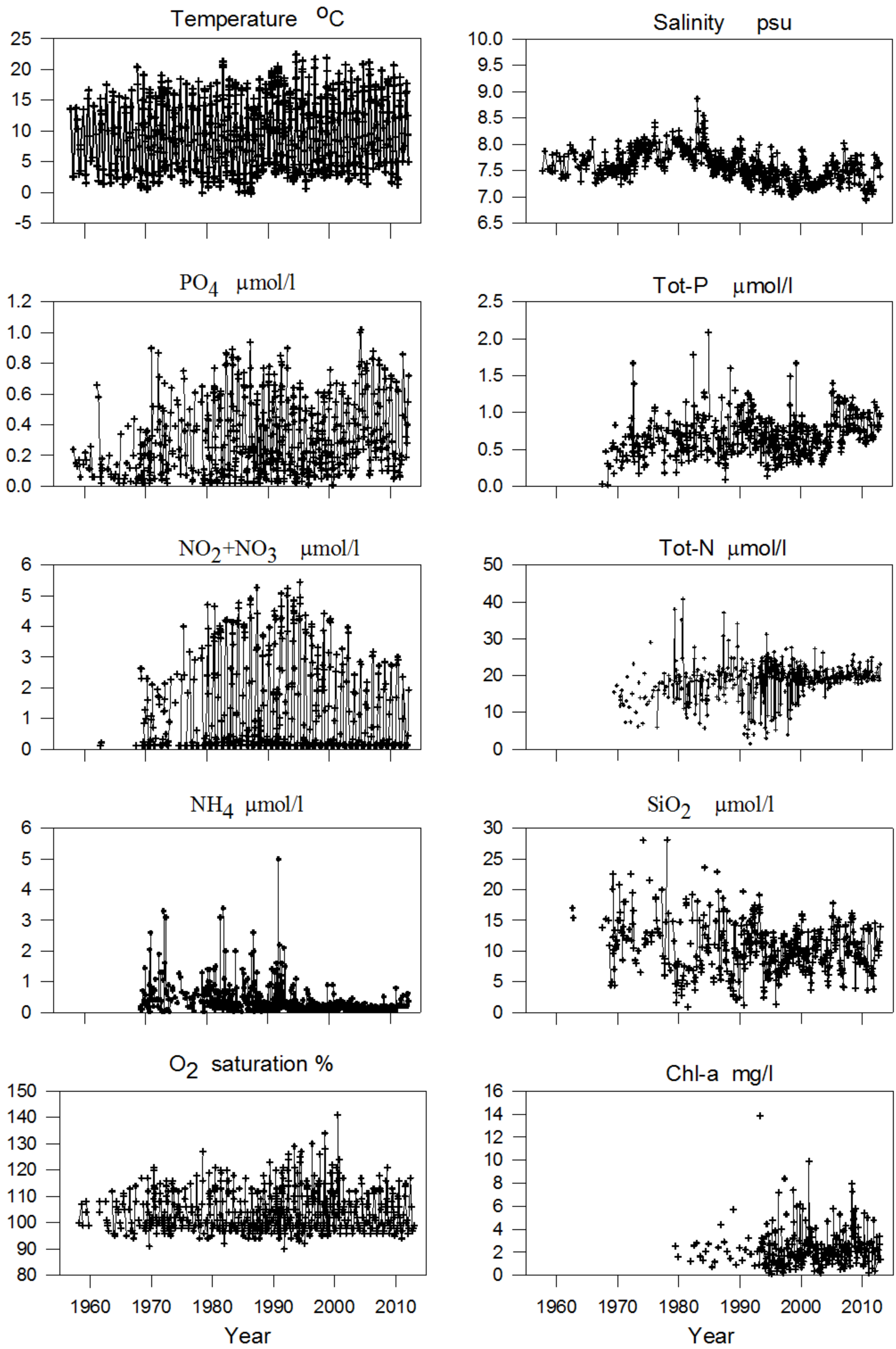
Annual Cycles



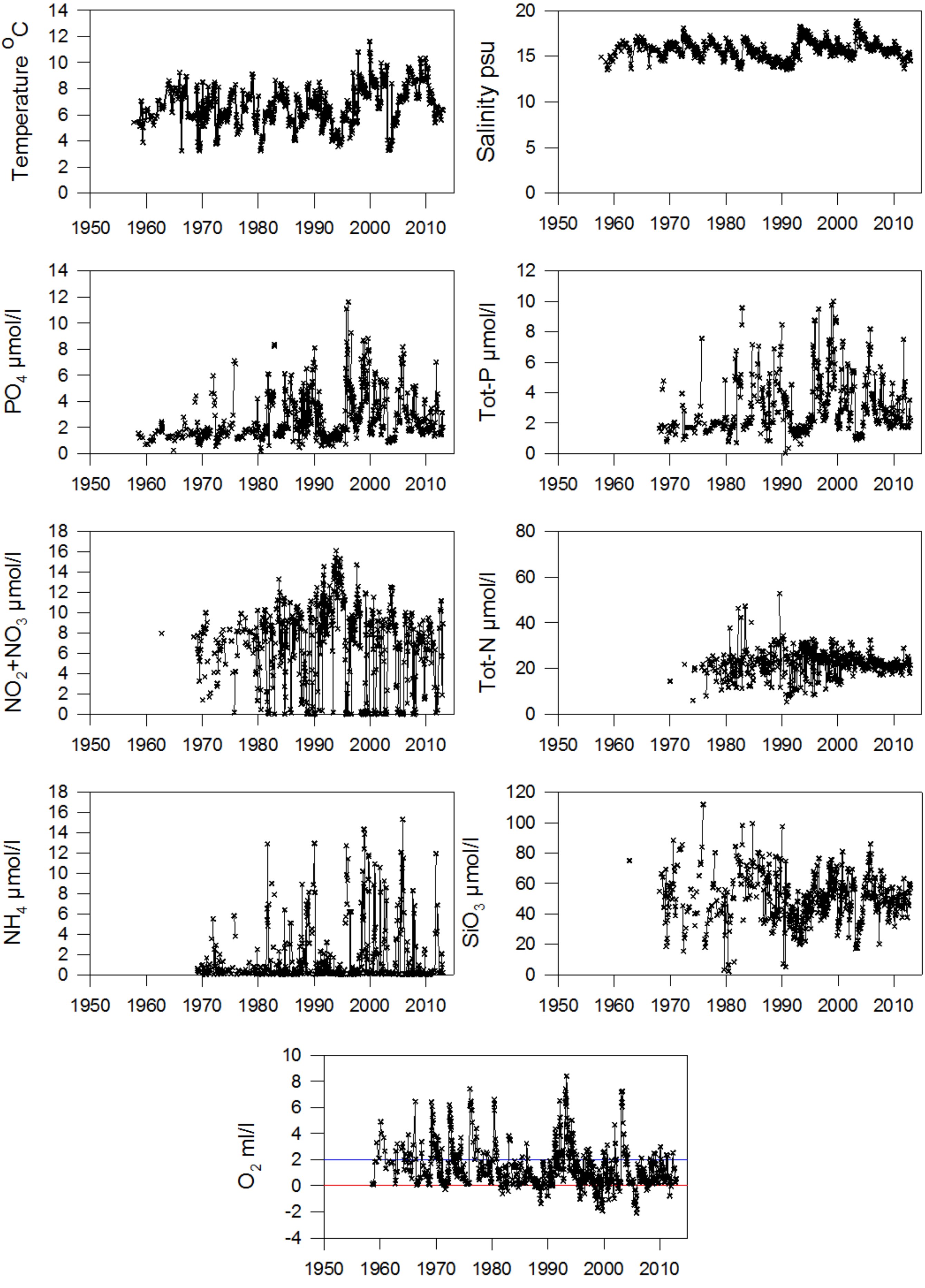
OXYGEN IN BOTTOM WATER



STATION BY5 SURFACE WATER

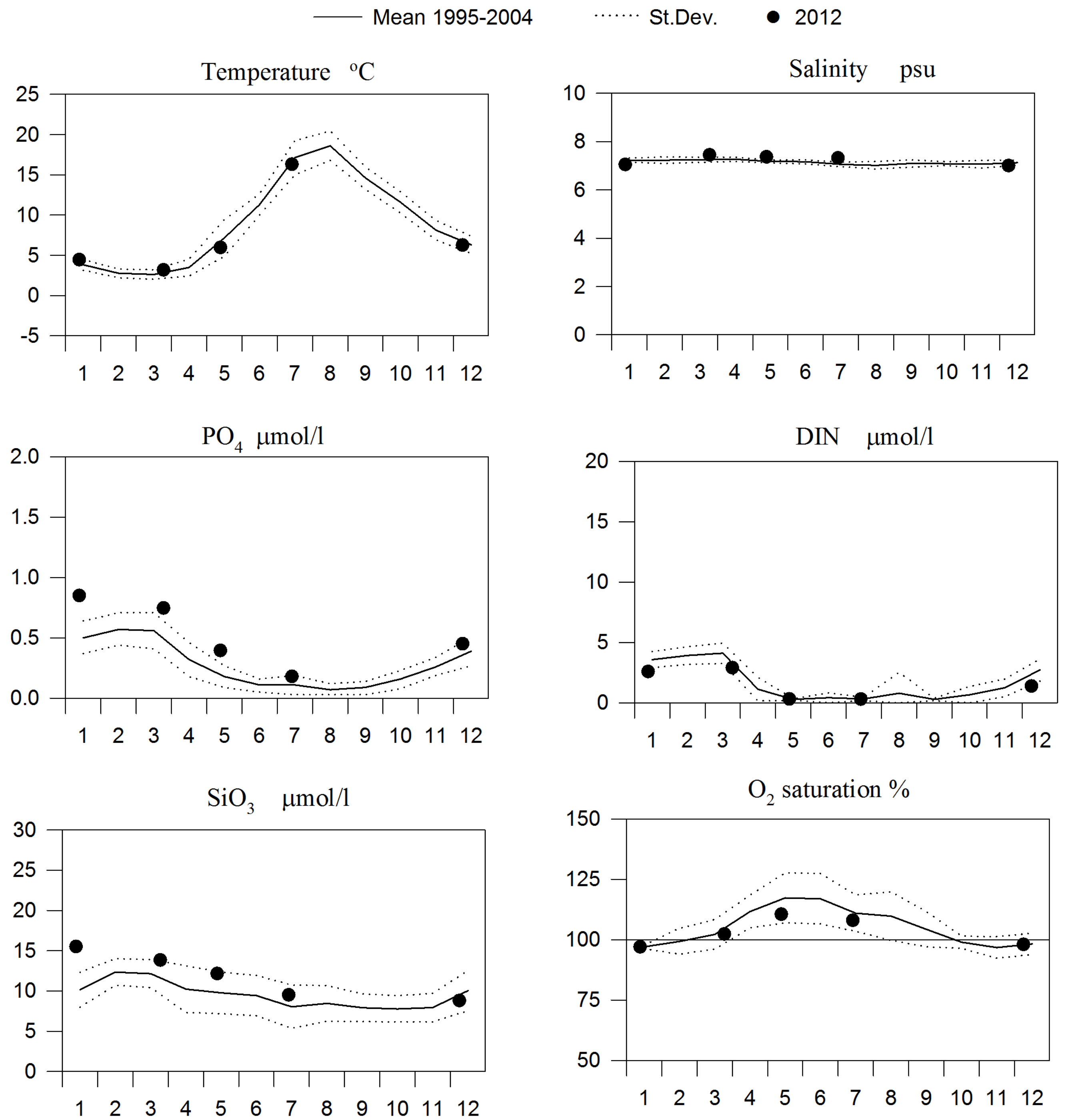


STATION BY5 DEEP WATER (80m)

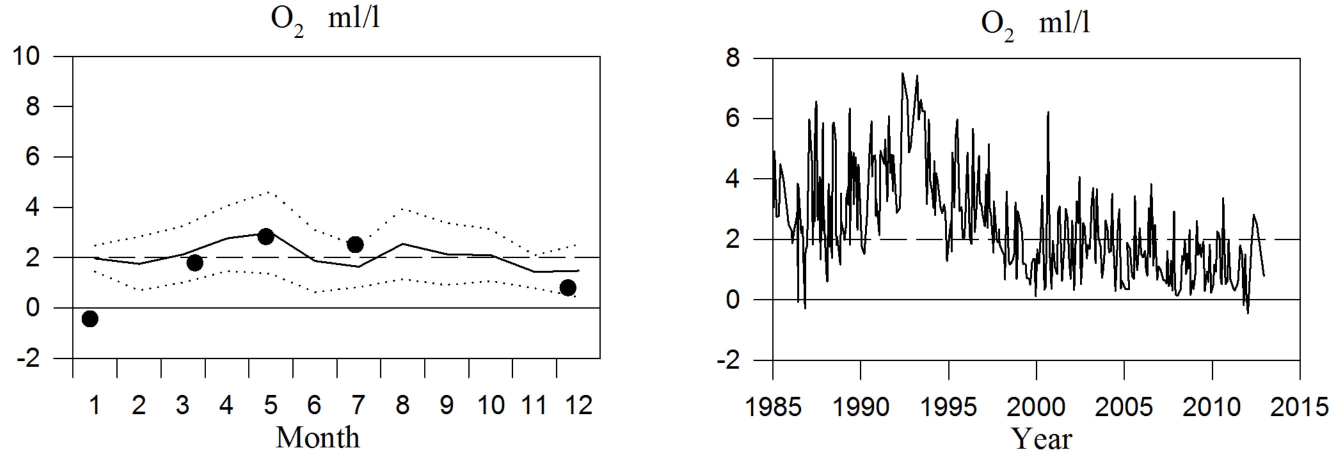


STATION BCS III-10 SURFACE WATER

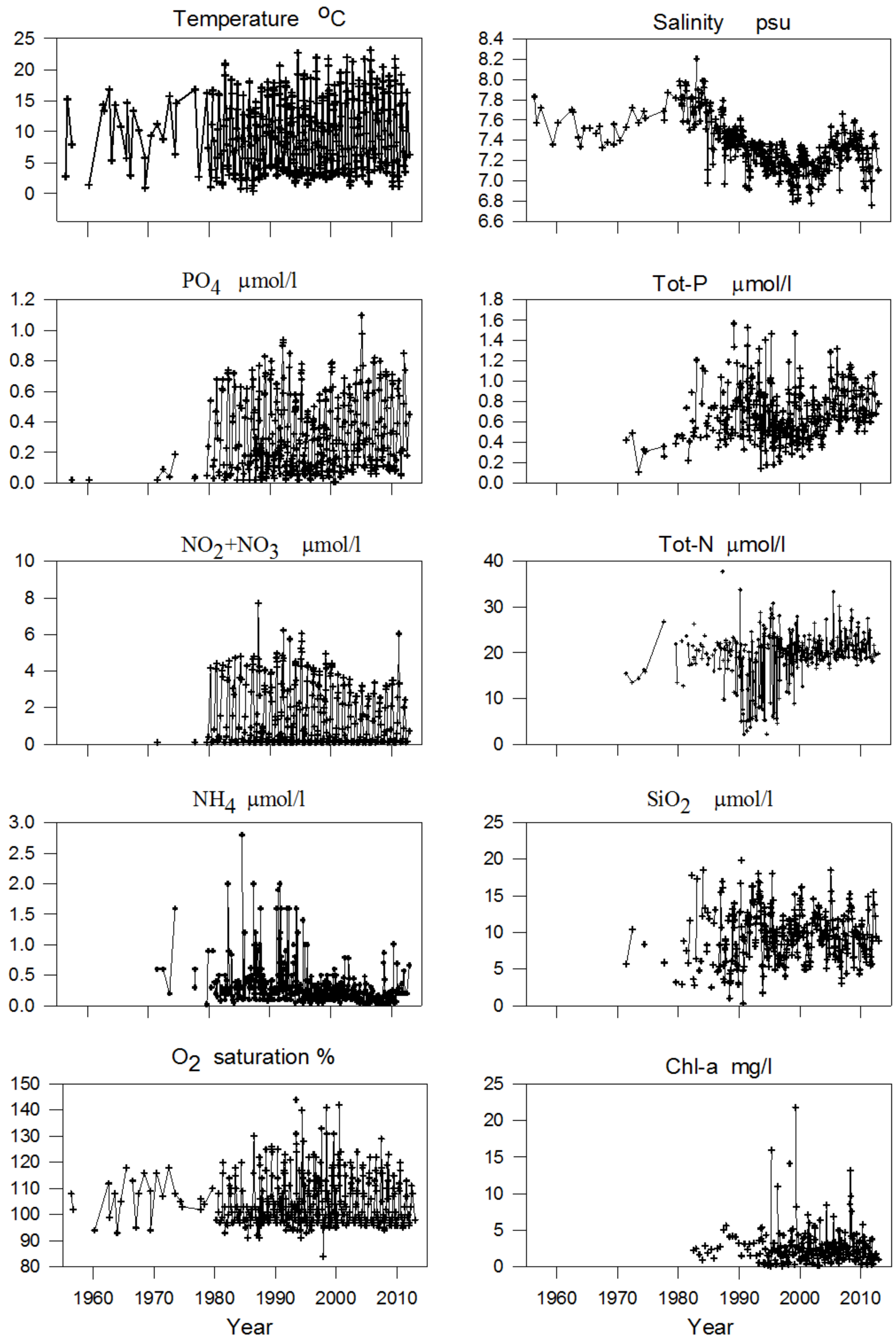
Annual Cycles



OXYGEN IN BOTTOM WATER



STATION BCS III-10 SURFACE WATER



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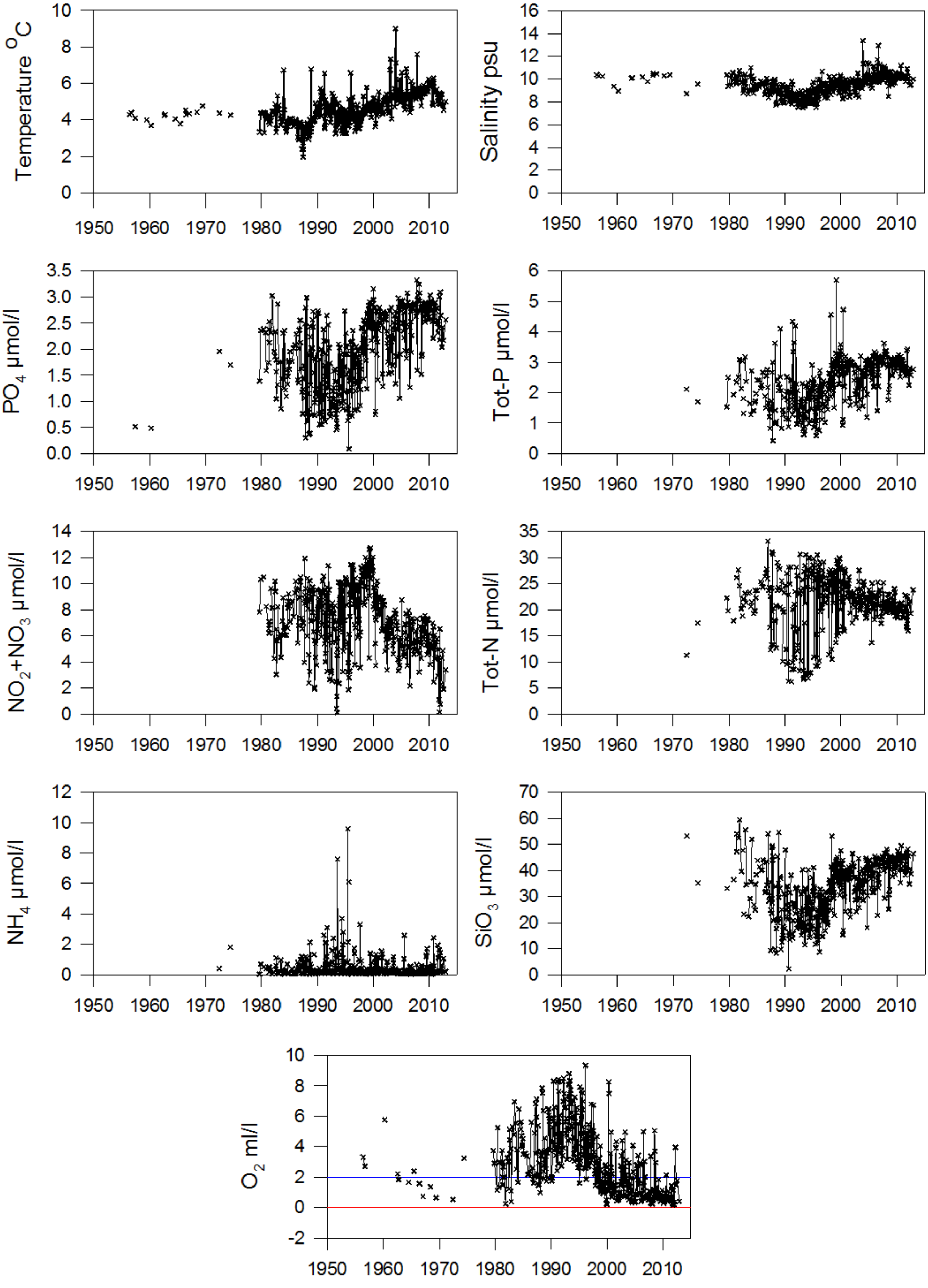
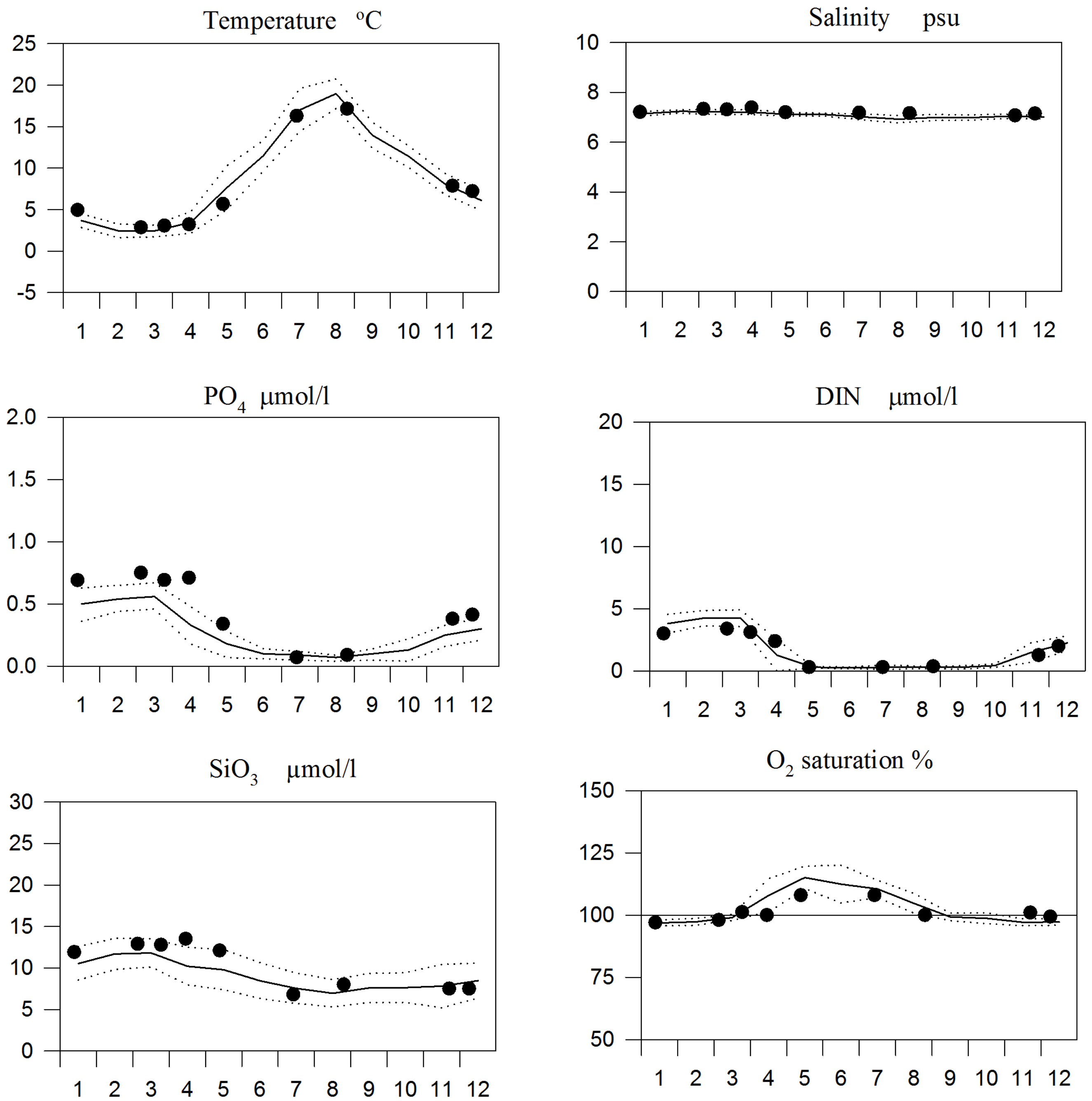
STATION BCS III-10 DEEP WATER (80m)



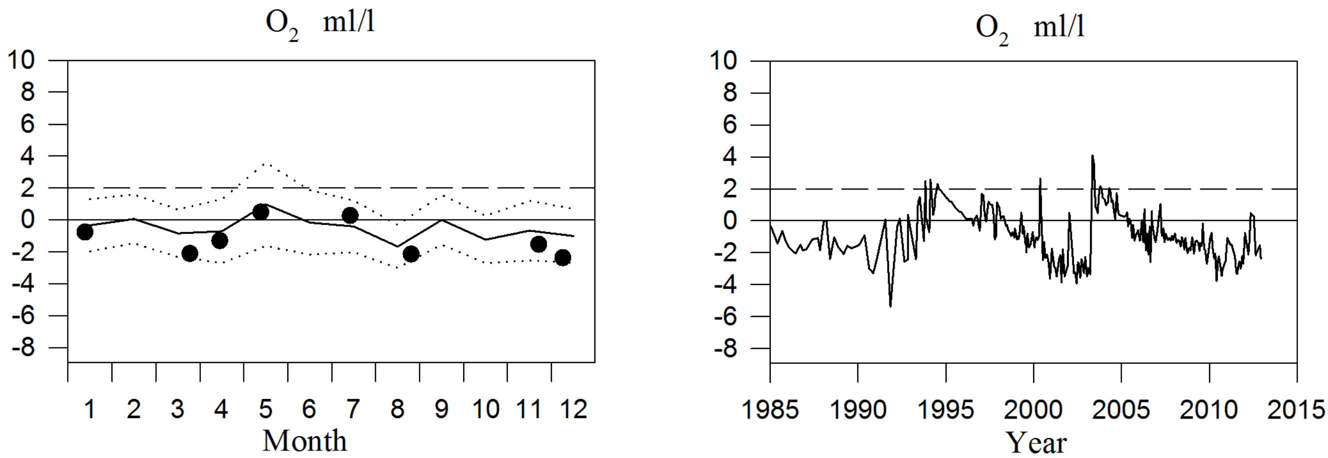
STATION BY10 SURFACE WATER

Annual Cycles

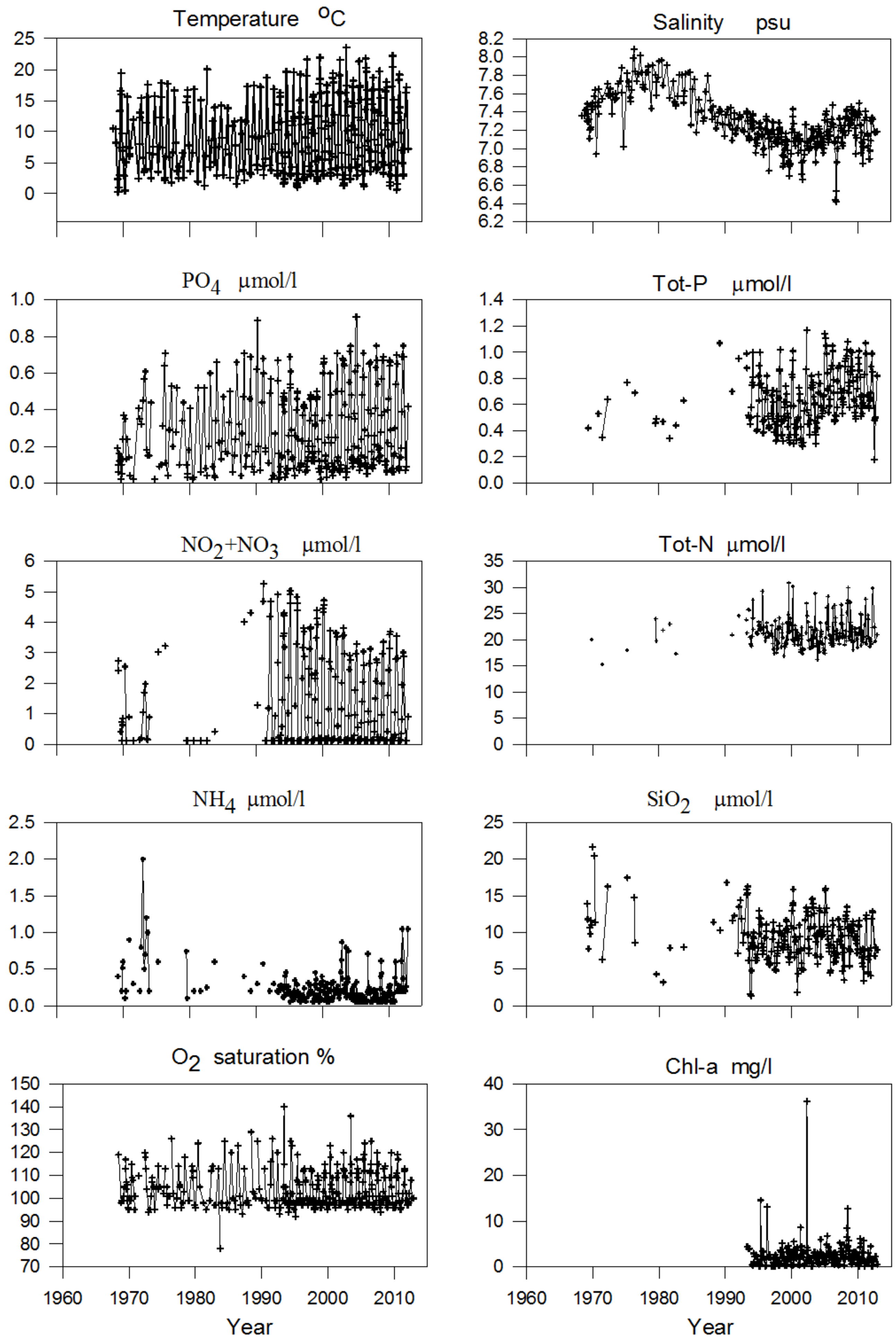
Mean 1995-2004 St.Dev. 2012



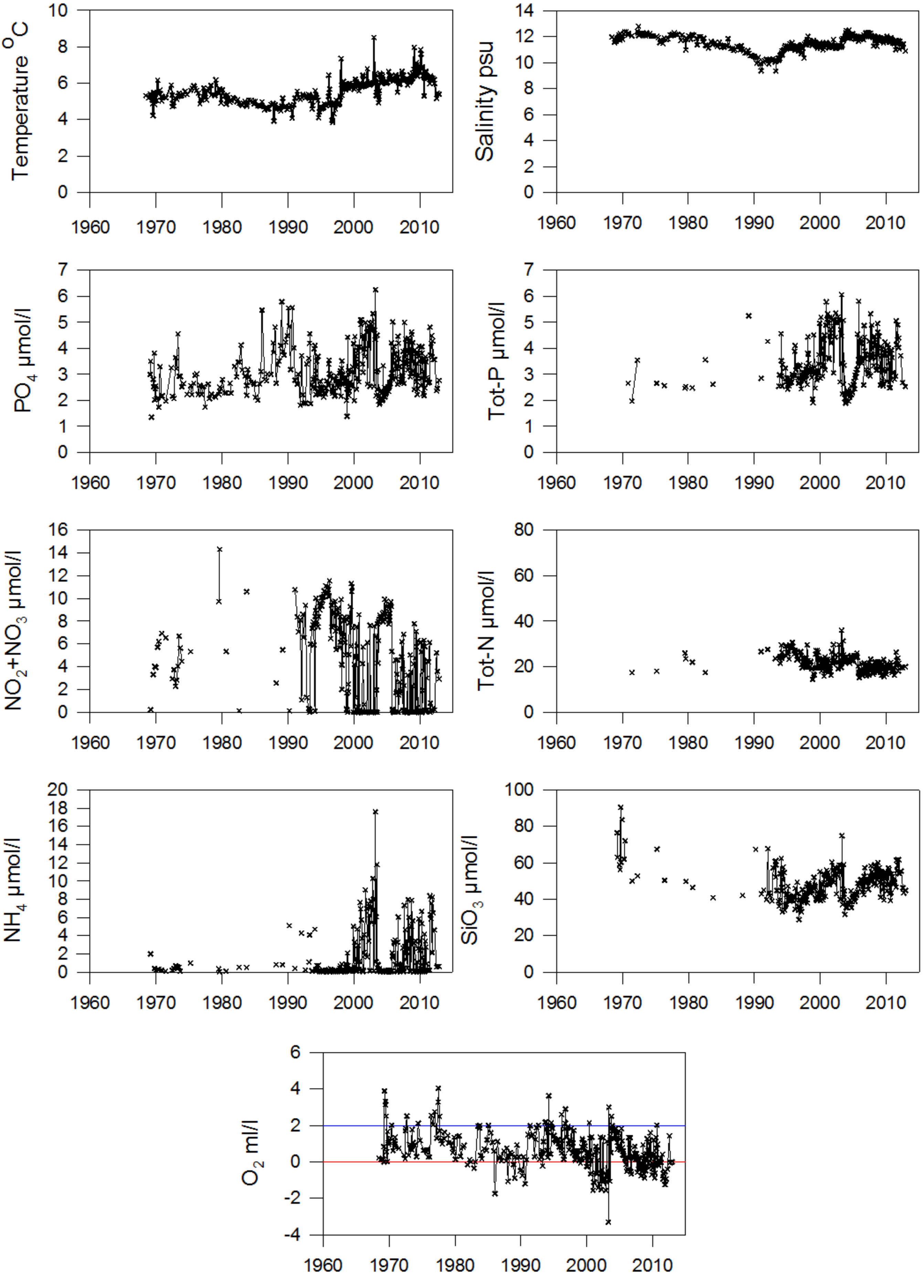
OXYGEN IN BOTTOM WATER



STATION BY10 SURFACE WATER



STATION BY10 DEEP WATER (125m)

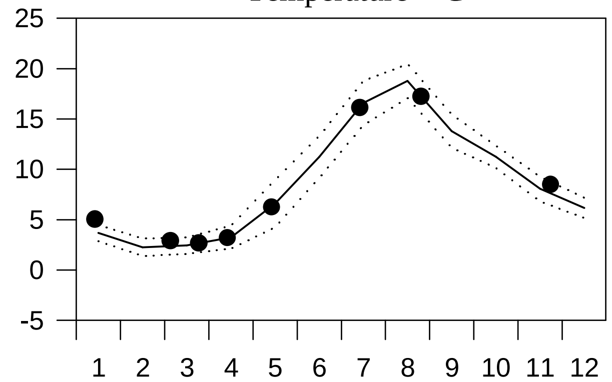


STATION BY15 SURFACE WATER

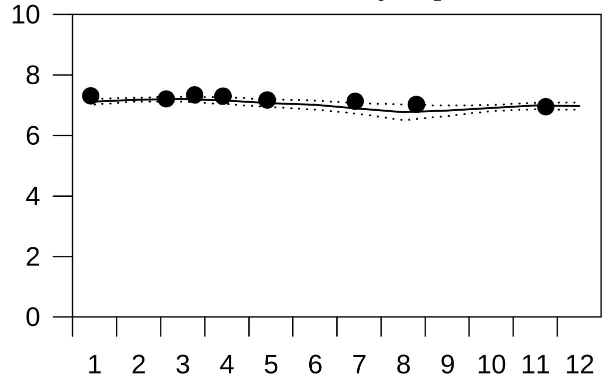
Annual Cycles

Mean 1995-2004 St.Dev. 2012

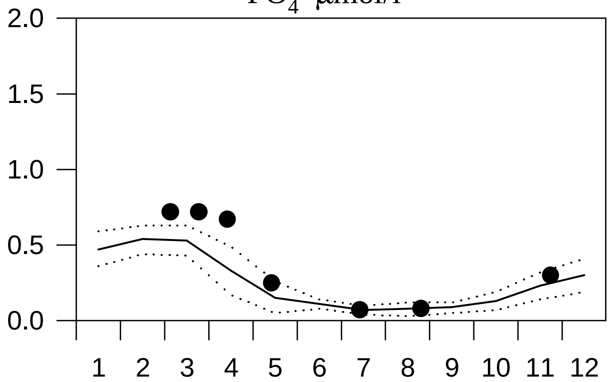
Temperature °C



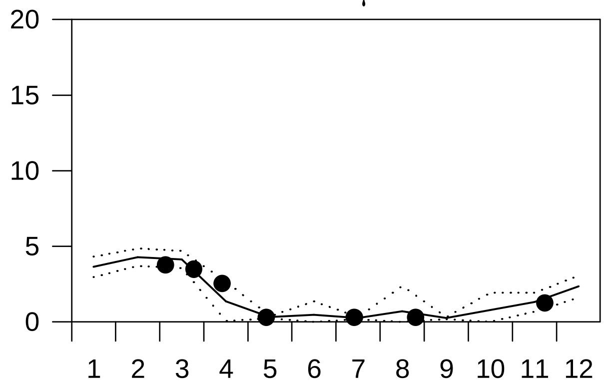
Salinity psu



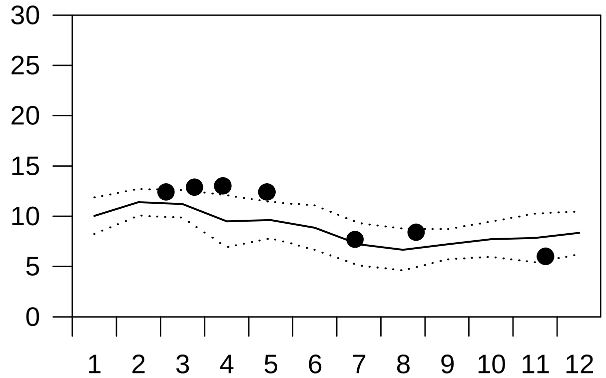
PO_4 µmol/l



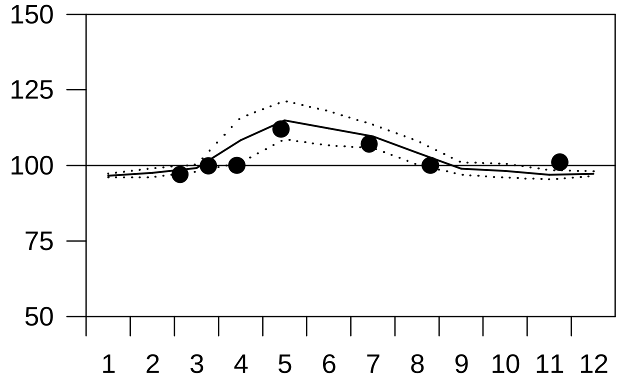
DIN µmol/l



SiO_3 µmol/l

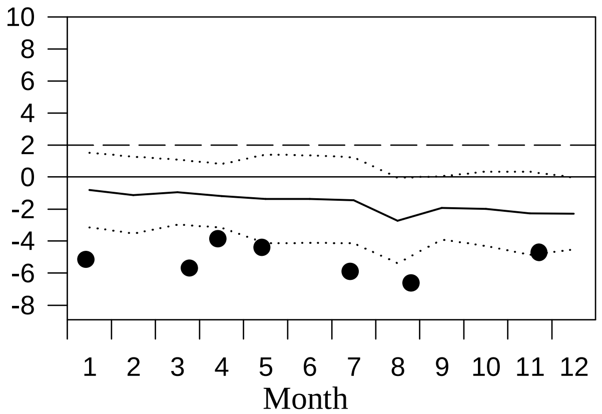


O_2 saturation %

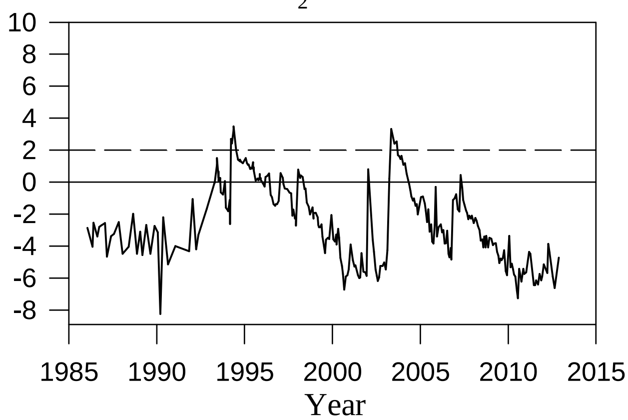


OXYGEN IN BOTTOM WATER

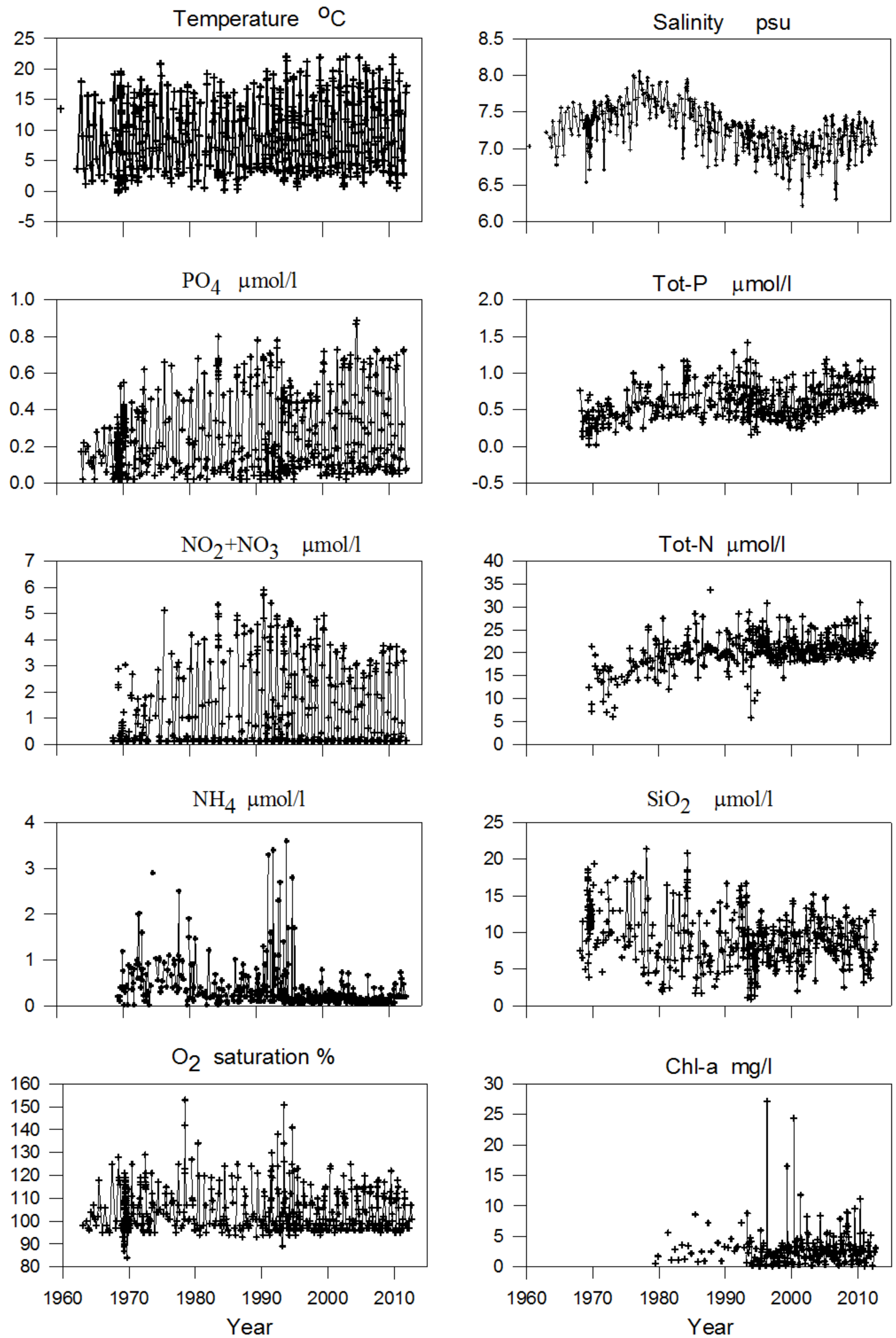
O_2 ml/l



O_2 ml/l



STATION BY15 SURFACE WATER



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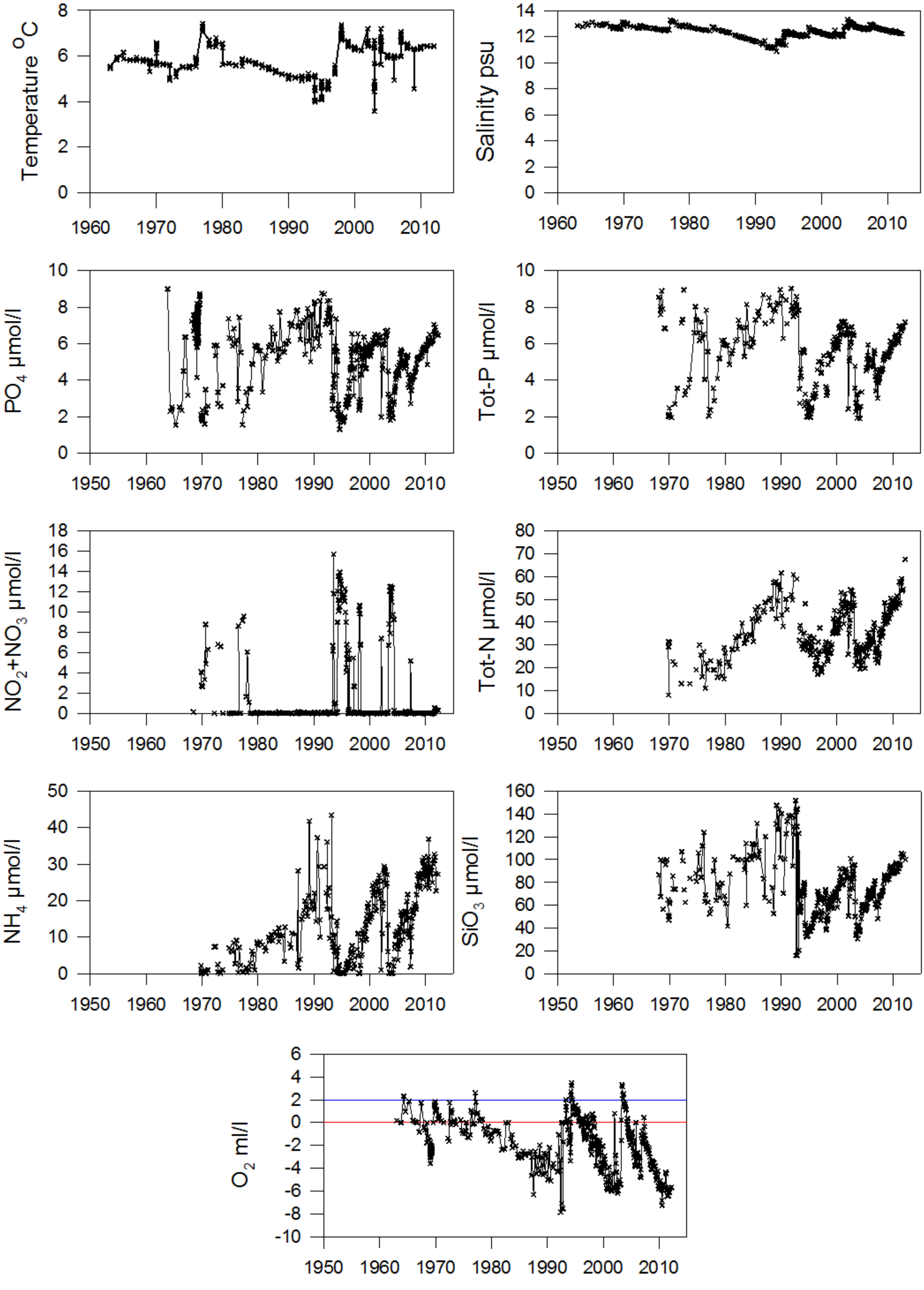
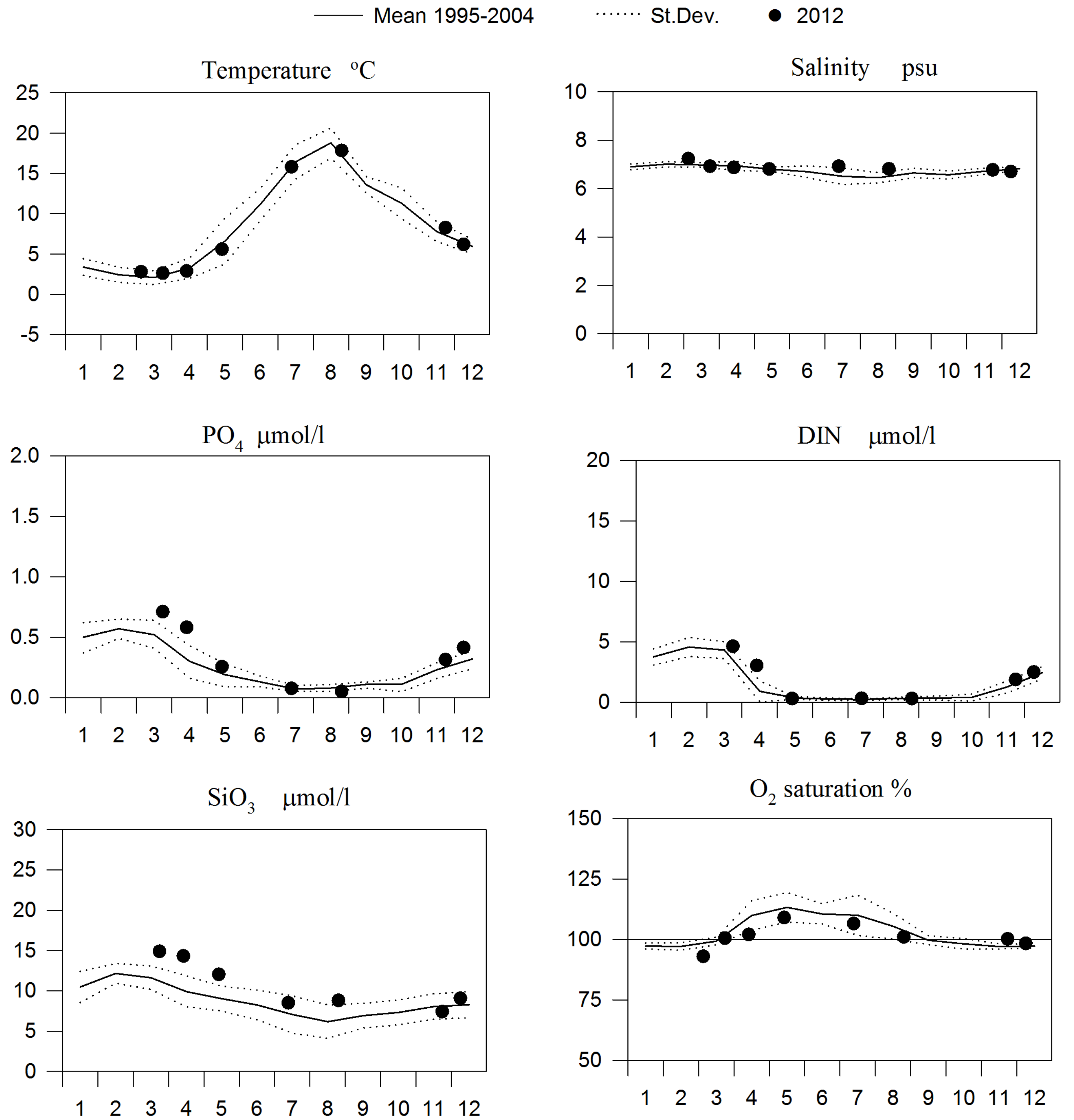
STATION BY15 DEEP WATER (240m)

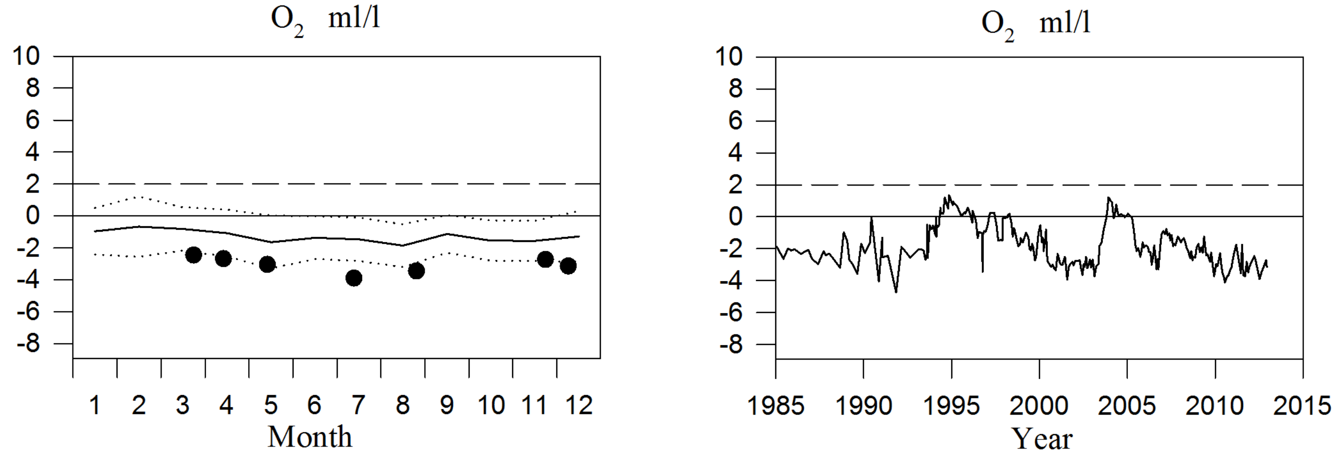


STATION BY20 SURFACE WATER

Annual Cycles



OXYGEN IN BOTTOM WATER



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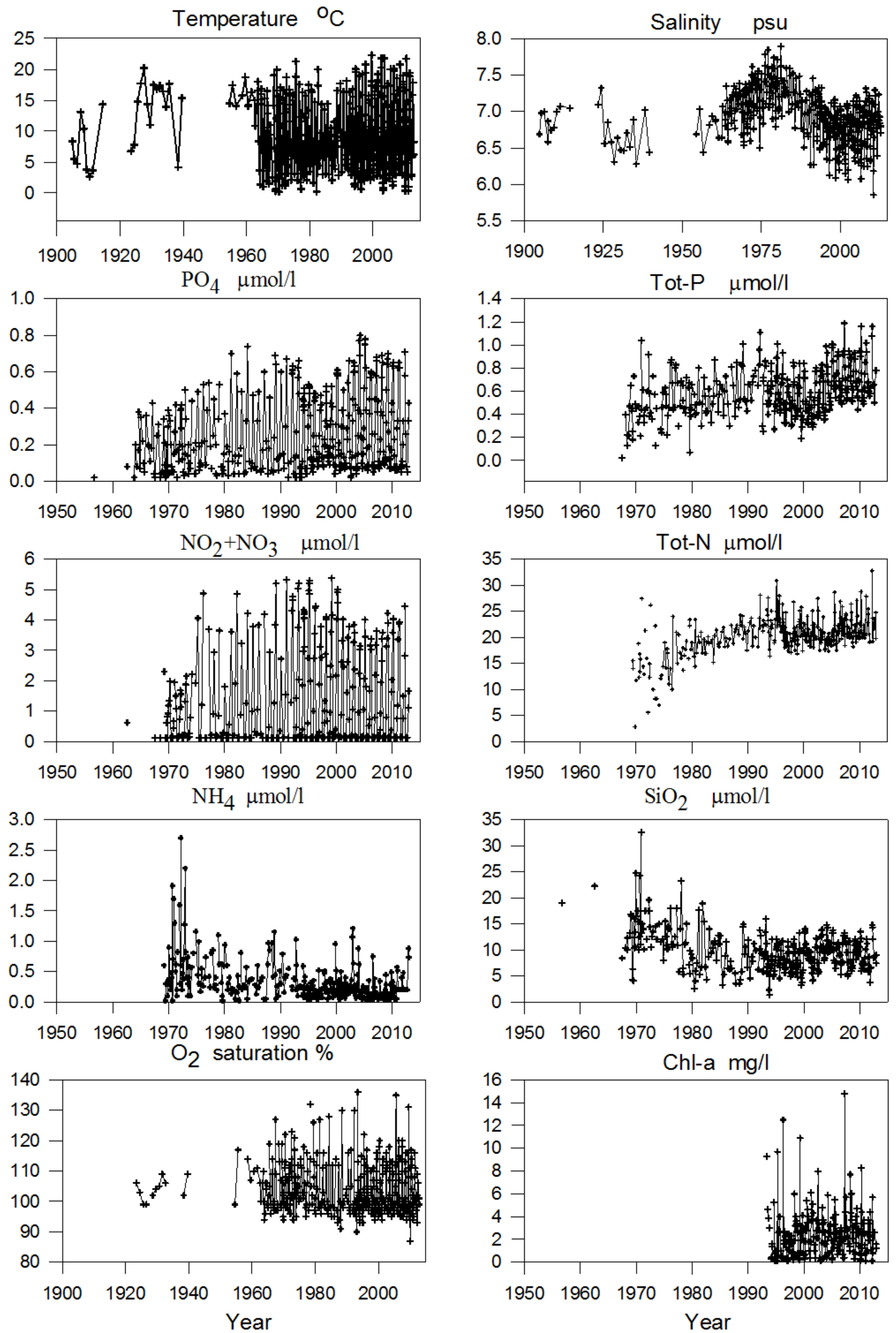
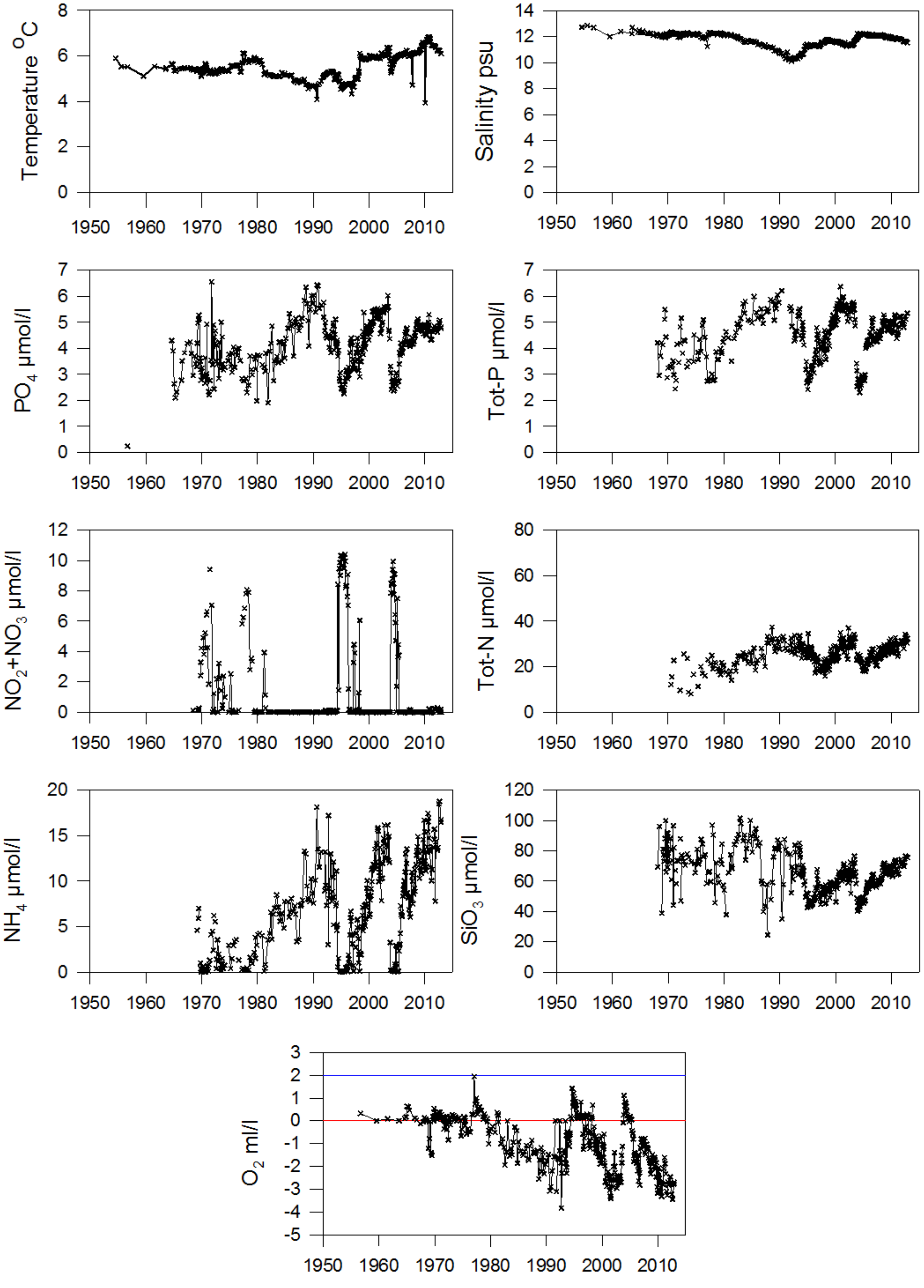
STATION BY20 SURFACE WATER

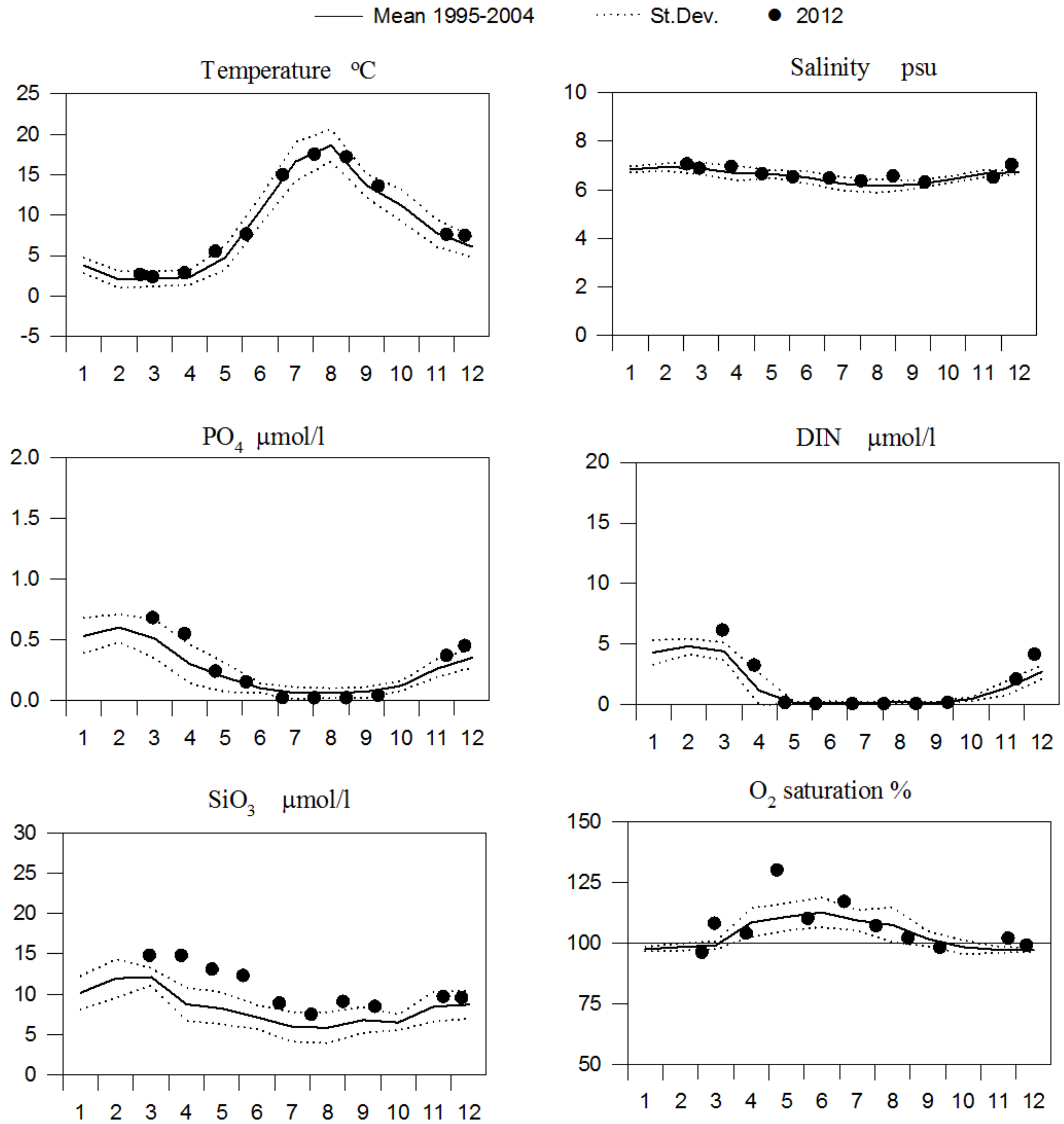


STATION BY20 DEEP WATER (175m)

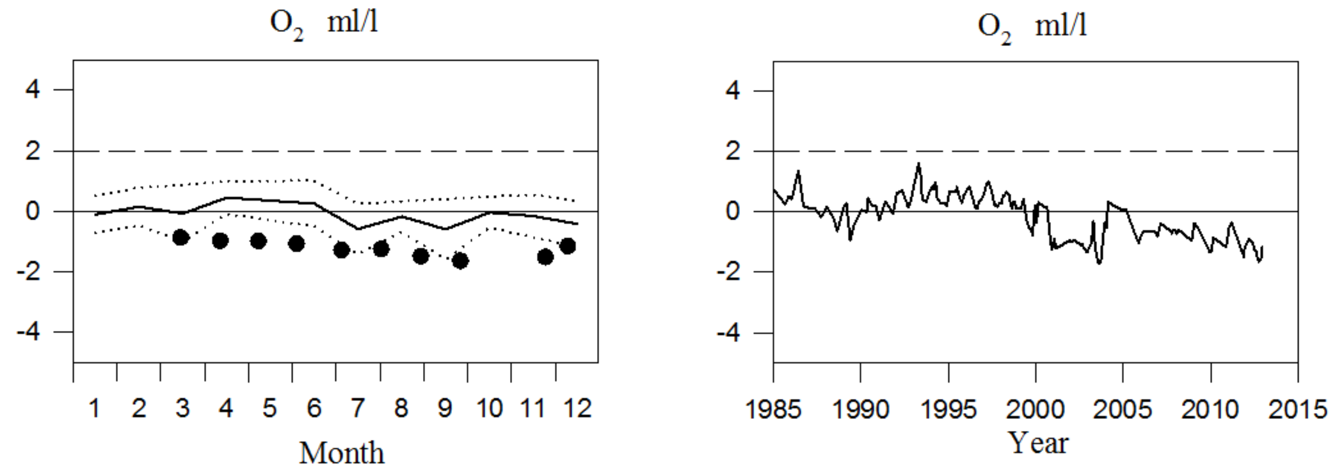


STATION BY29 SURFACE WATER

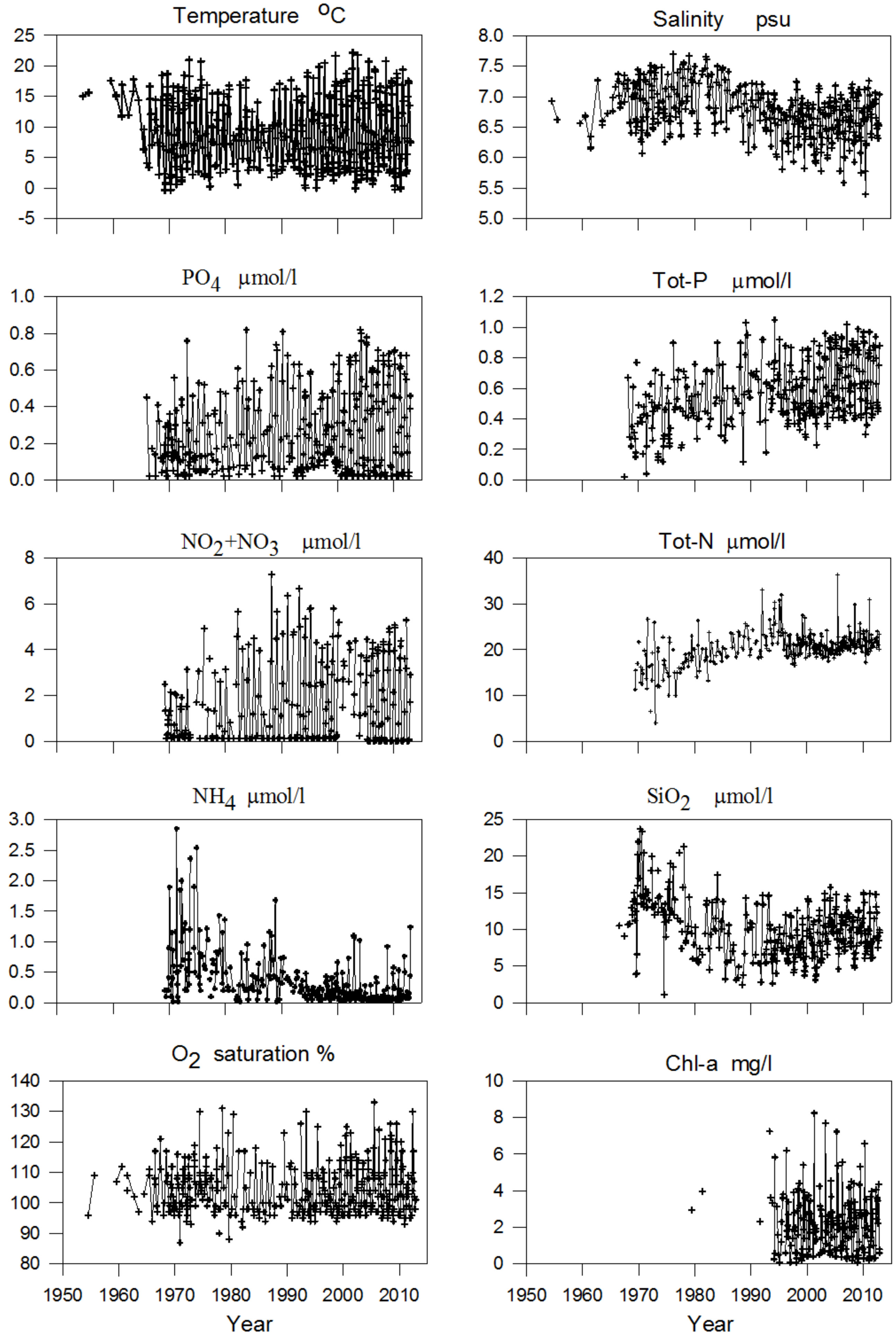
Annual Cycles



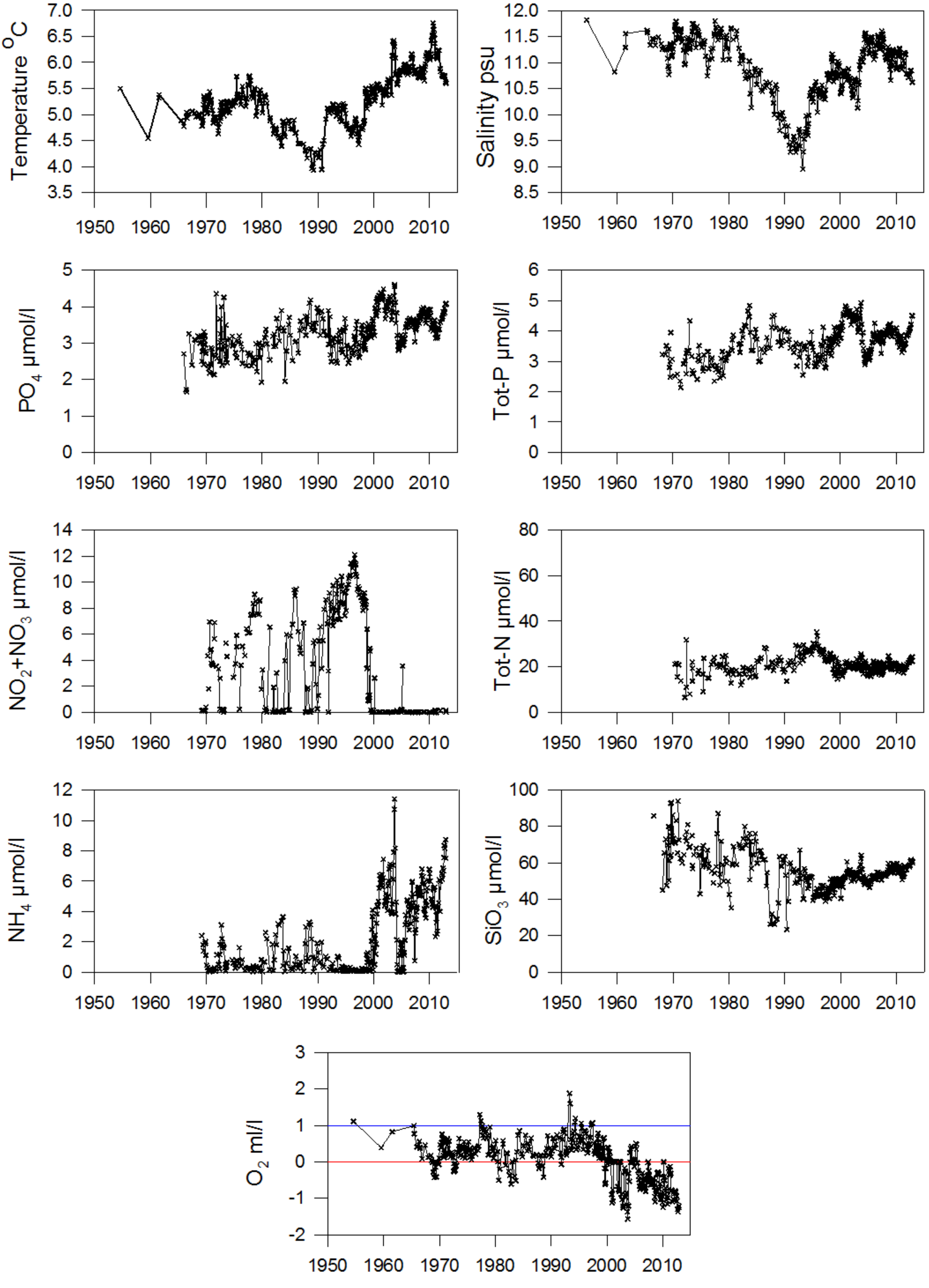
OXYGEN IN BOTTOM WATER



STATION BY29 SURFACE WATER

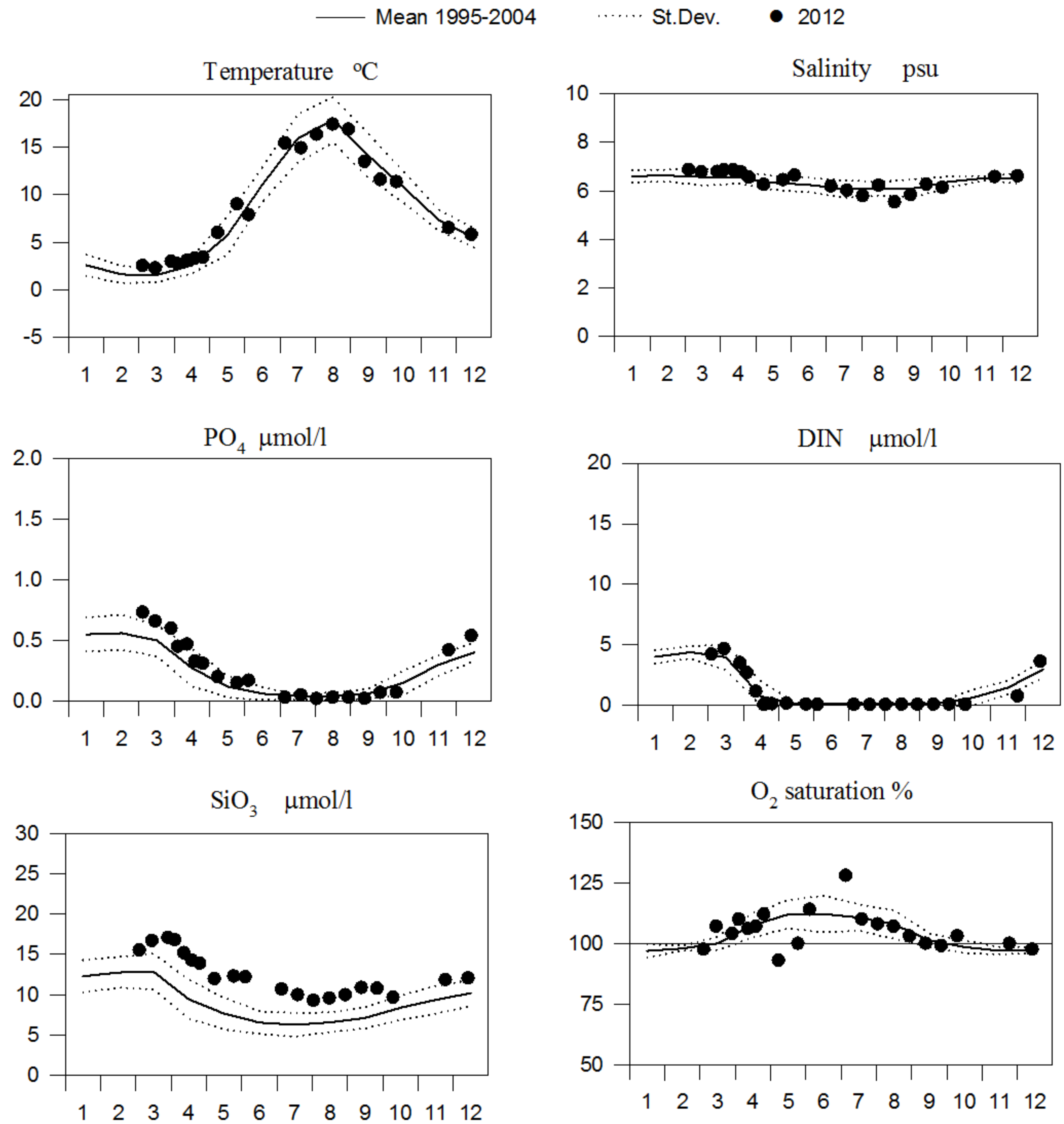


STATION BY29 DEEP WATER (150m)

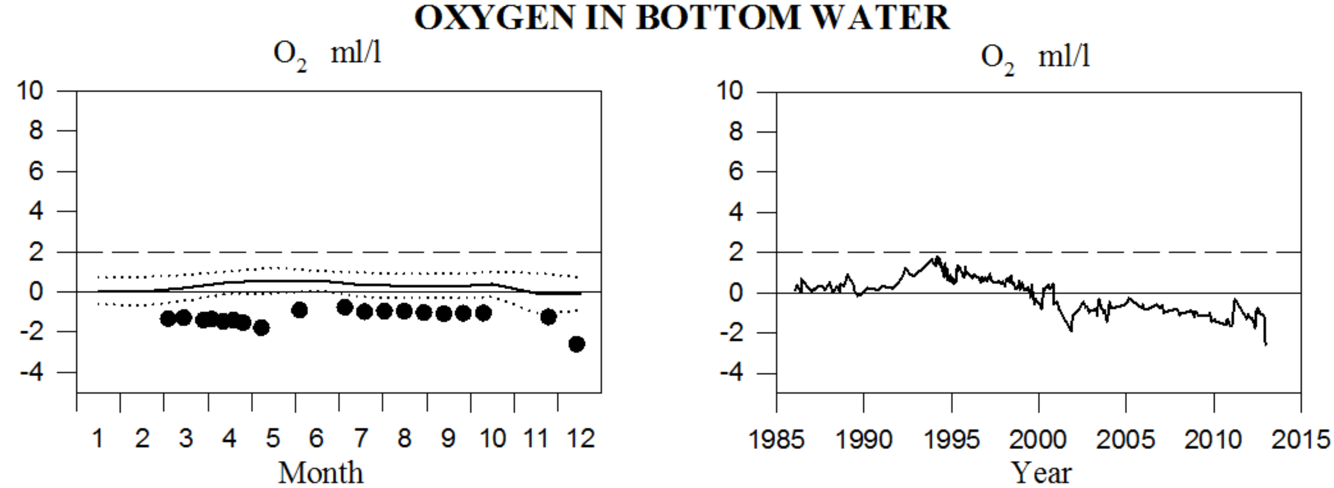


STATION BY31 SURFACE WATER

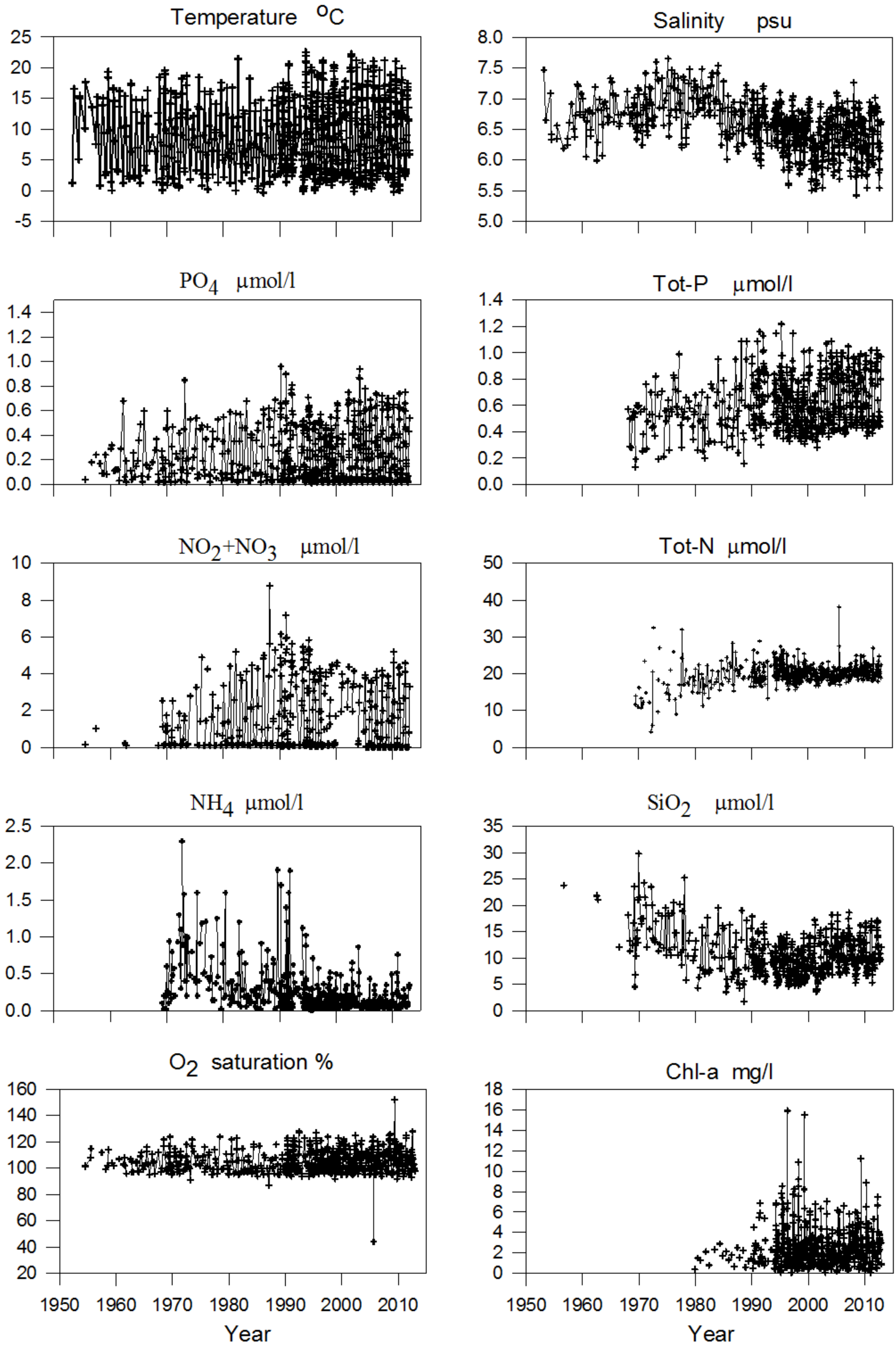
Annual Cycles



OXYGEN IN BOTTOM WATER



STATION BY31 SURFACE WATER



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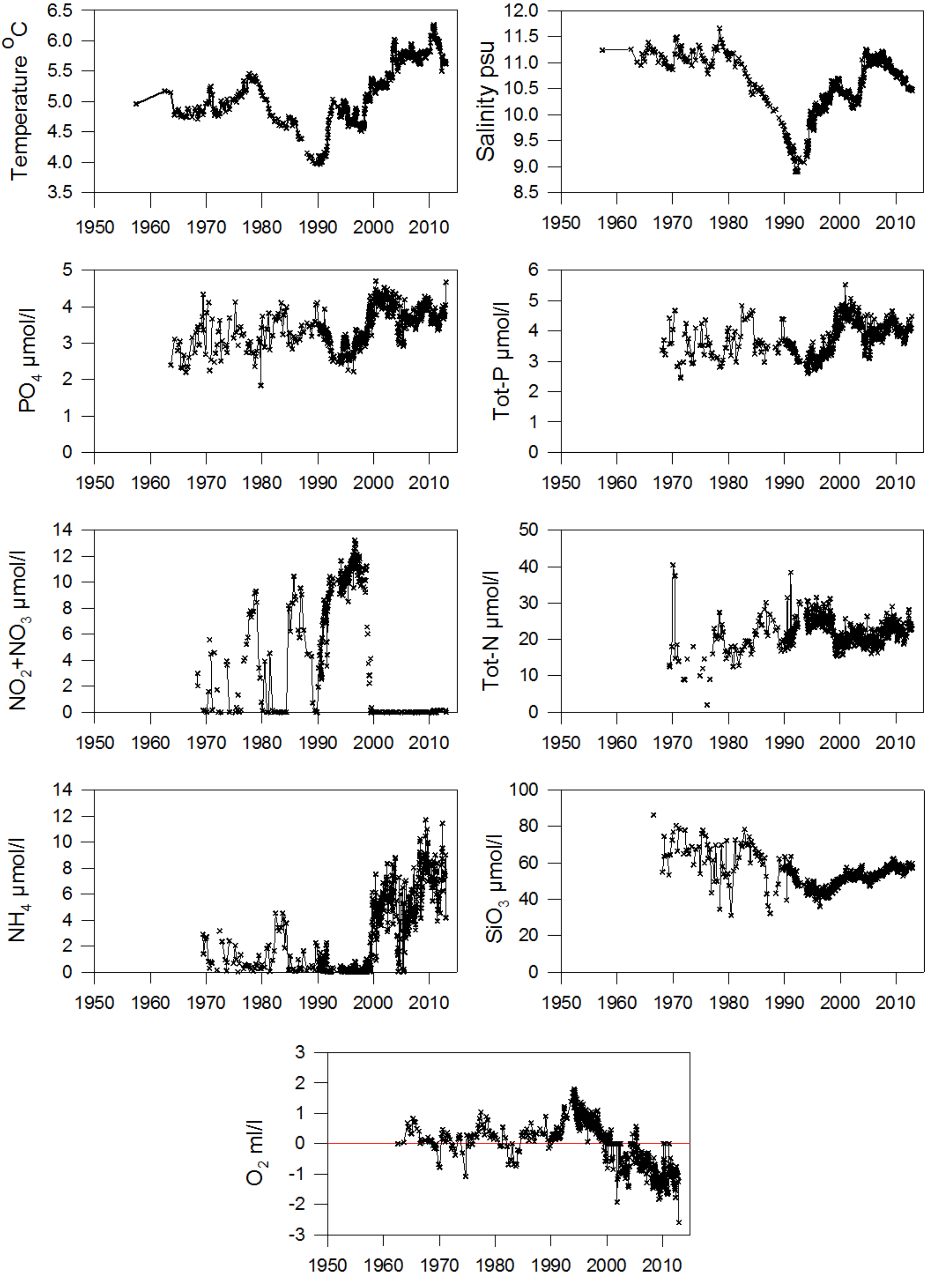
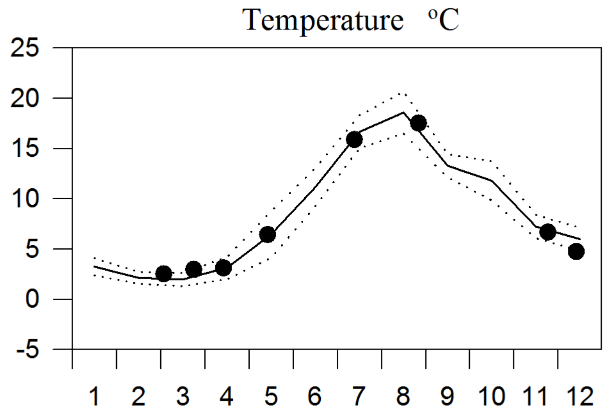
STATION BY31 DEEP WATER (440m)

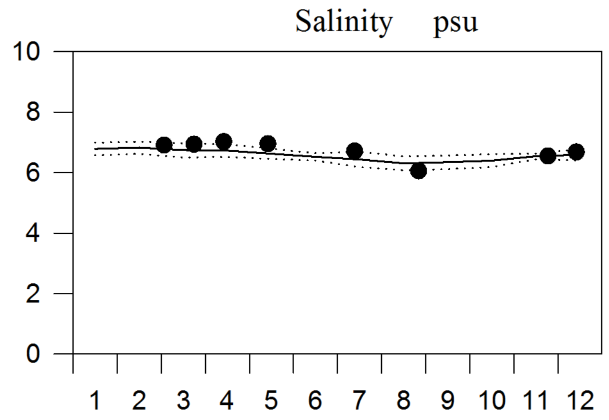


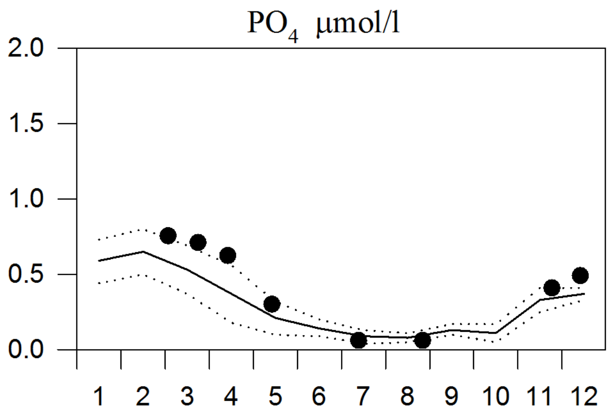
STATION BY32 SURFACE WATER

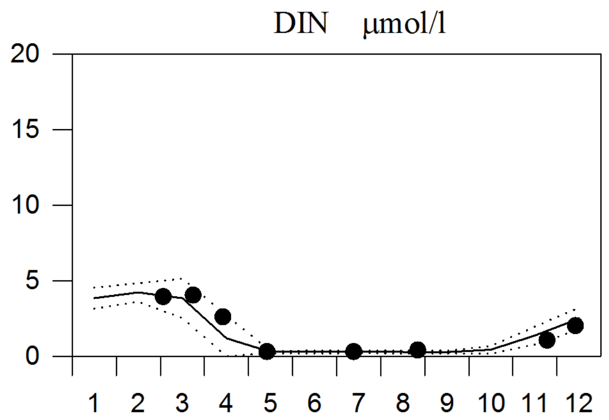
Annual Cycles

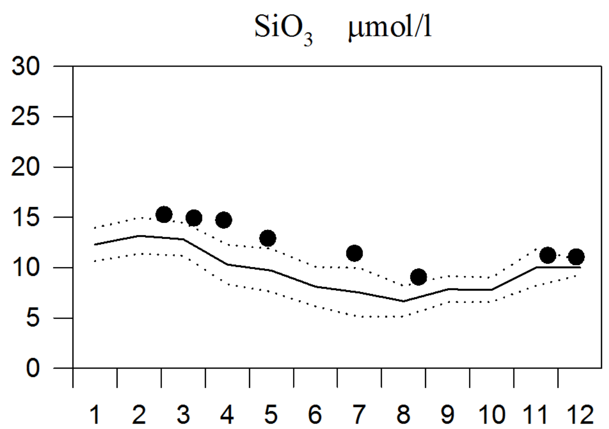
Mean 1995-2004 ⋯⋯ St.Dev. ● 2012

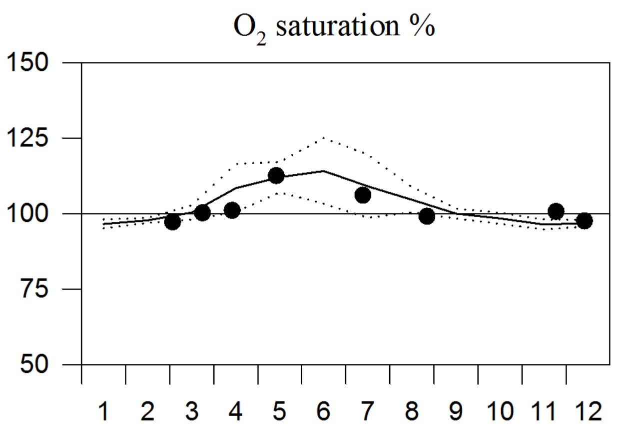




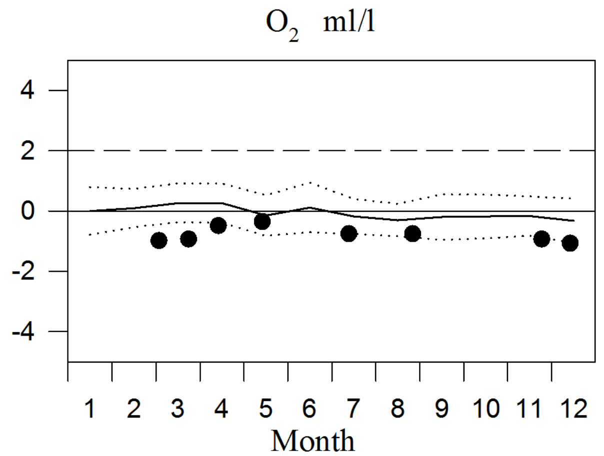


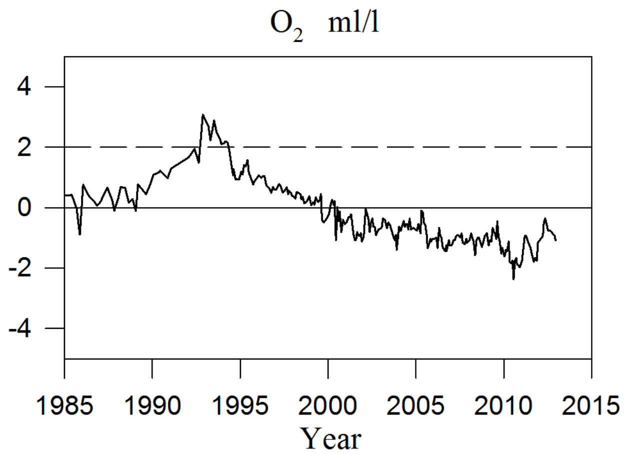




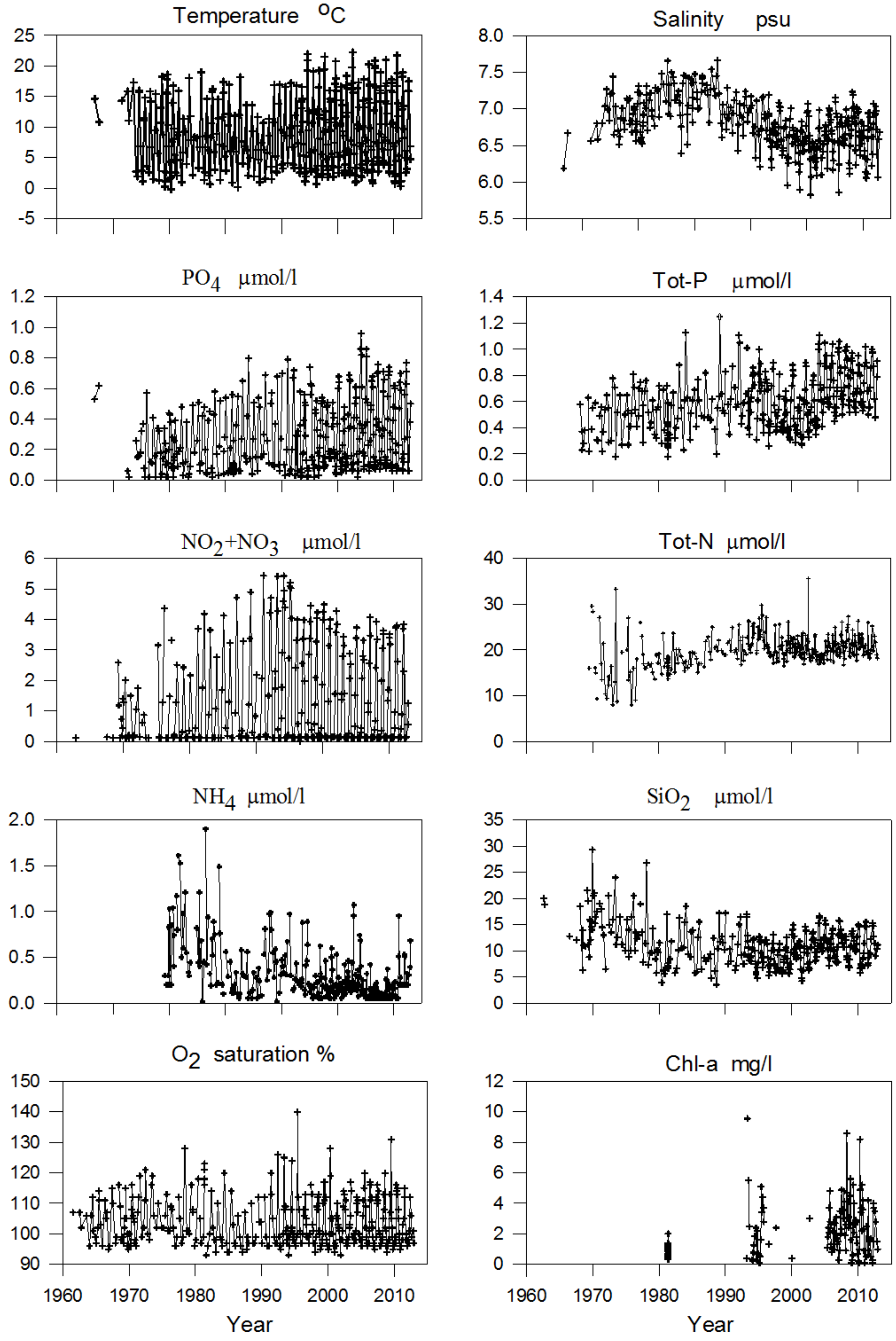


OXYGEN IN BOTTOM WATER





STATION BY32 SURFACE WATER



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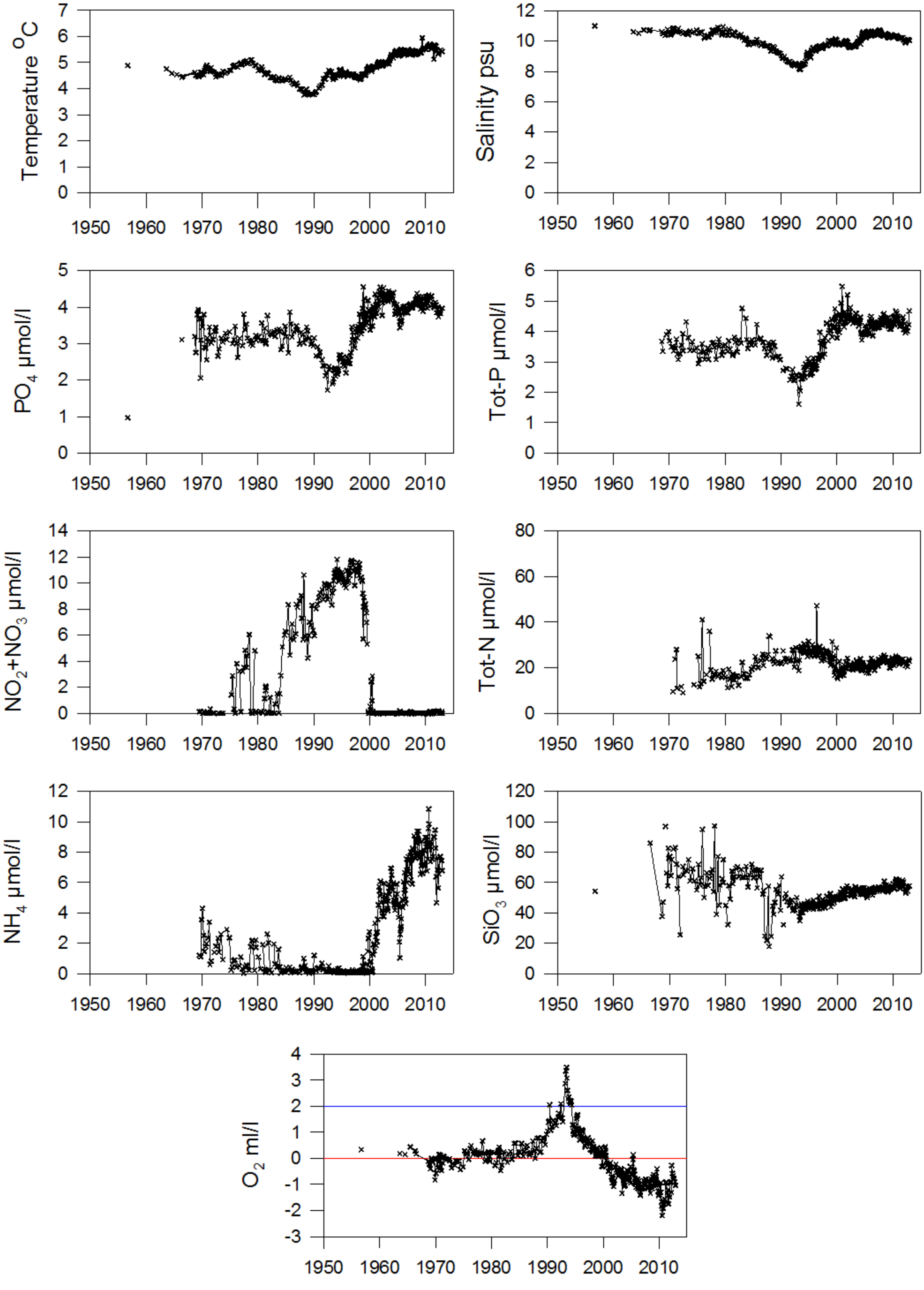
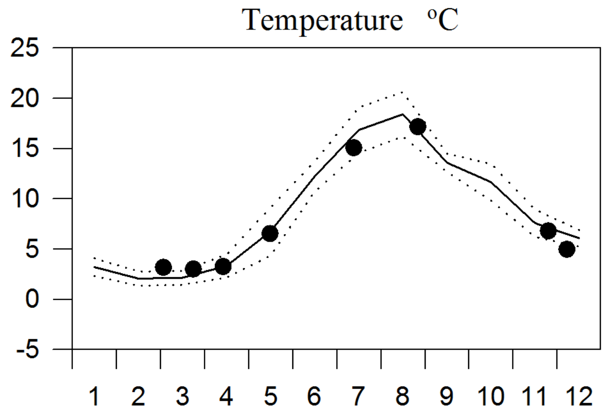
STATION BY32 DEEP WATER (175m)

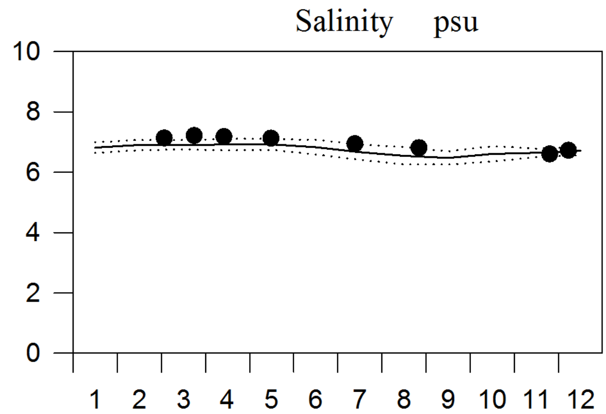


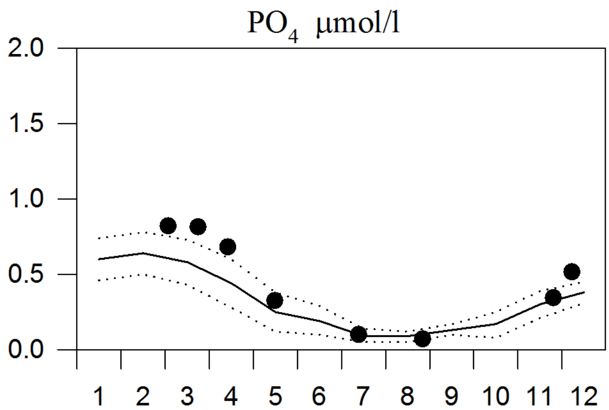
STATION BY38 SURFACE WATER

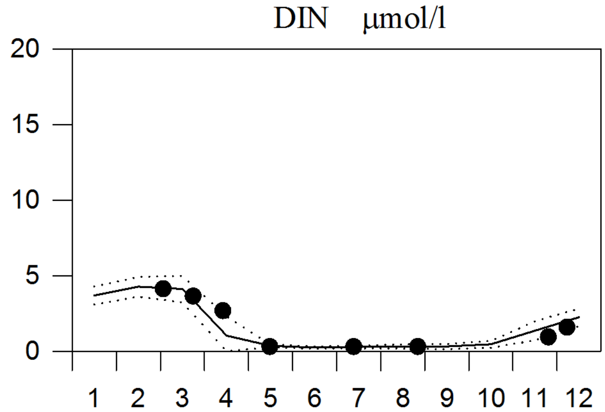
Annual Cycles

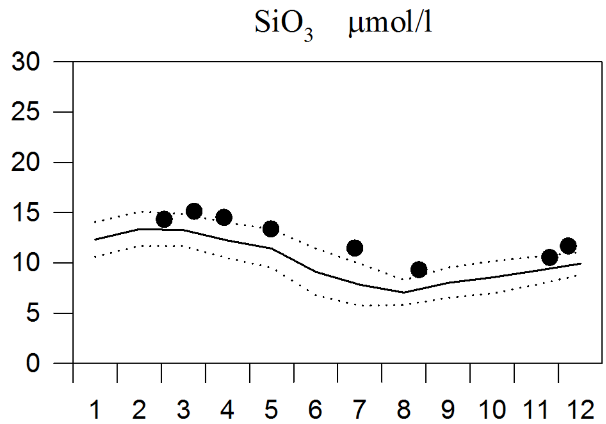
—— Mean 1995-2004 ⋯⋯ St.Dev. ● 2012

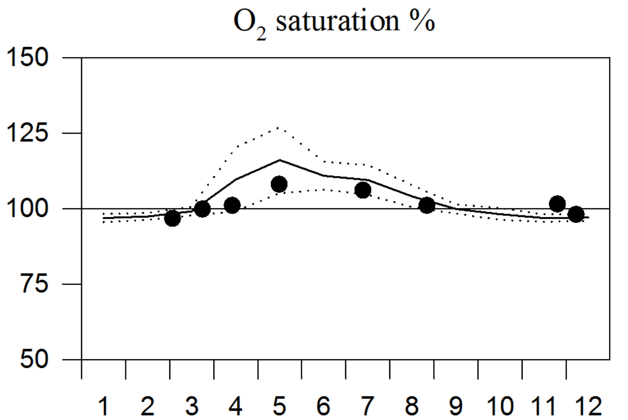




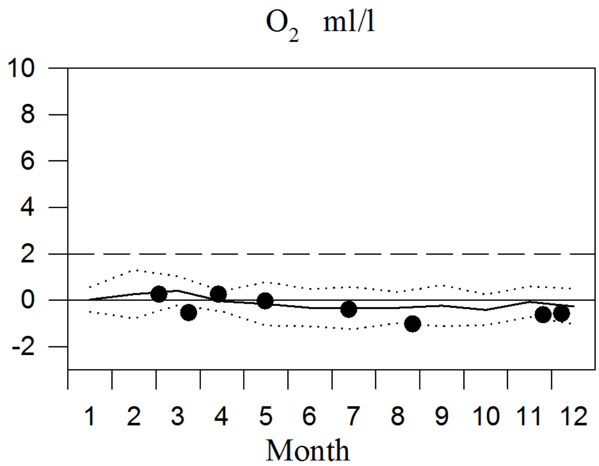


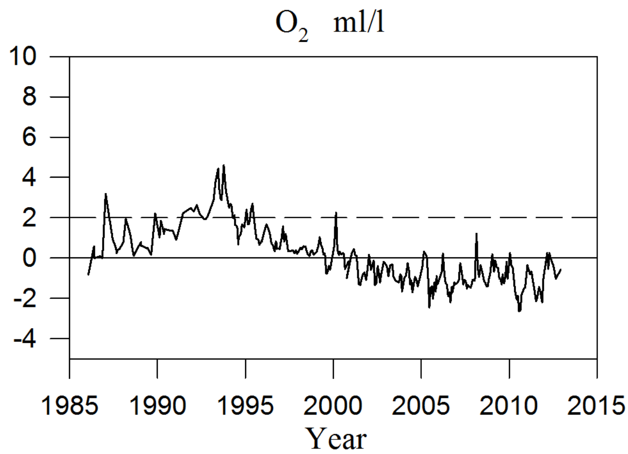




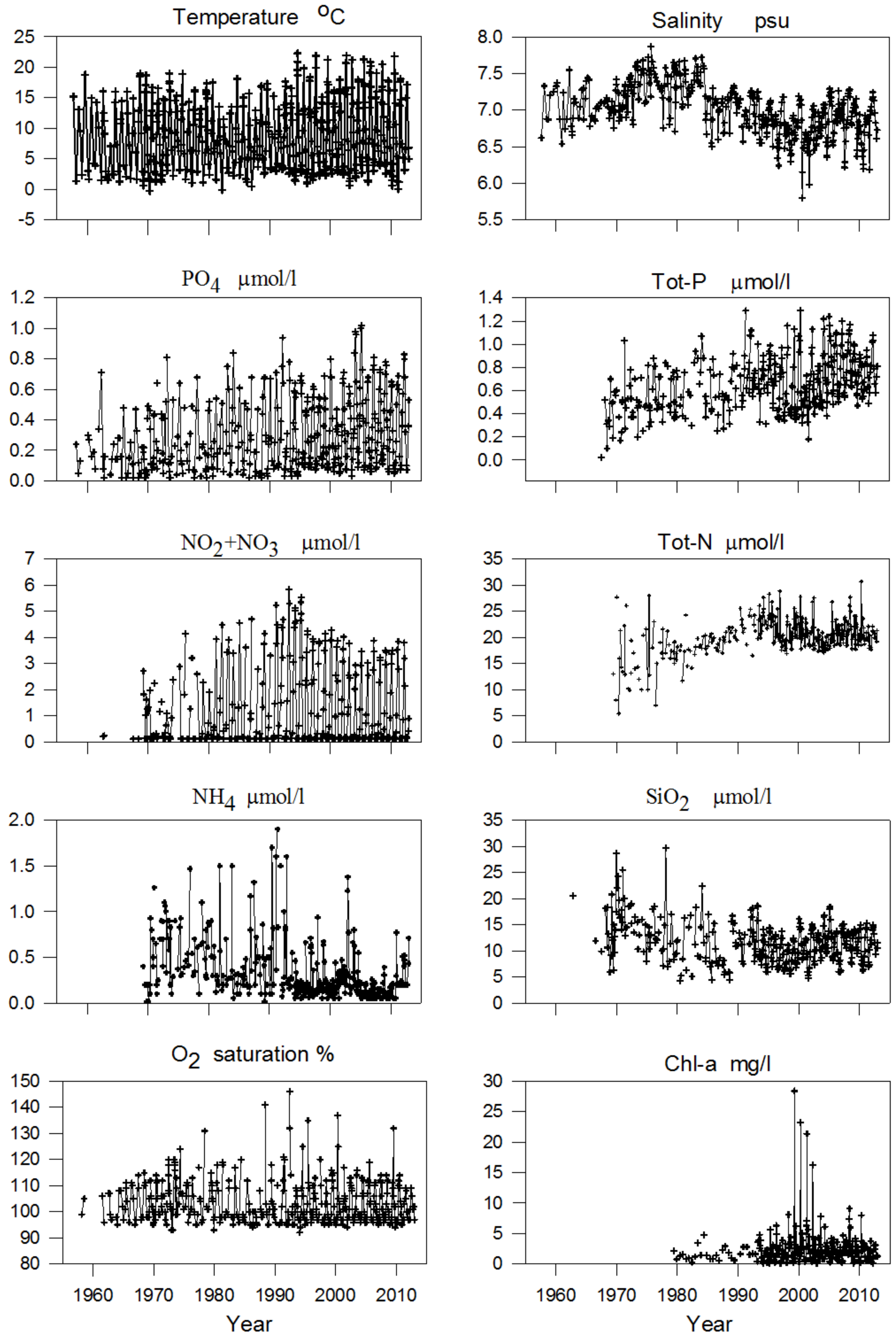


OXYGEN IN BOTTOM WATER



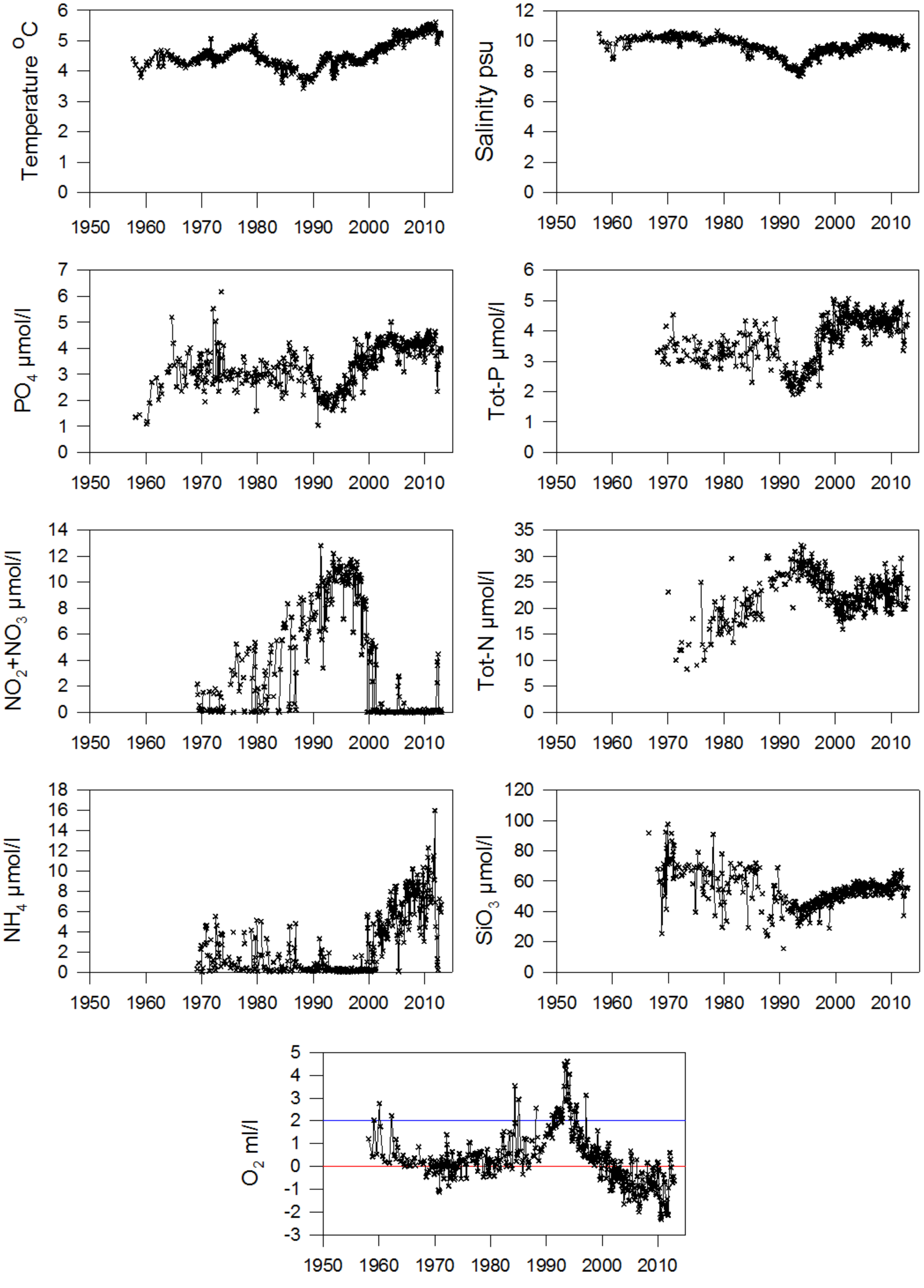


STATION BY38 SURFACE WATER



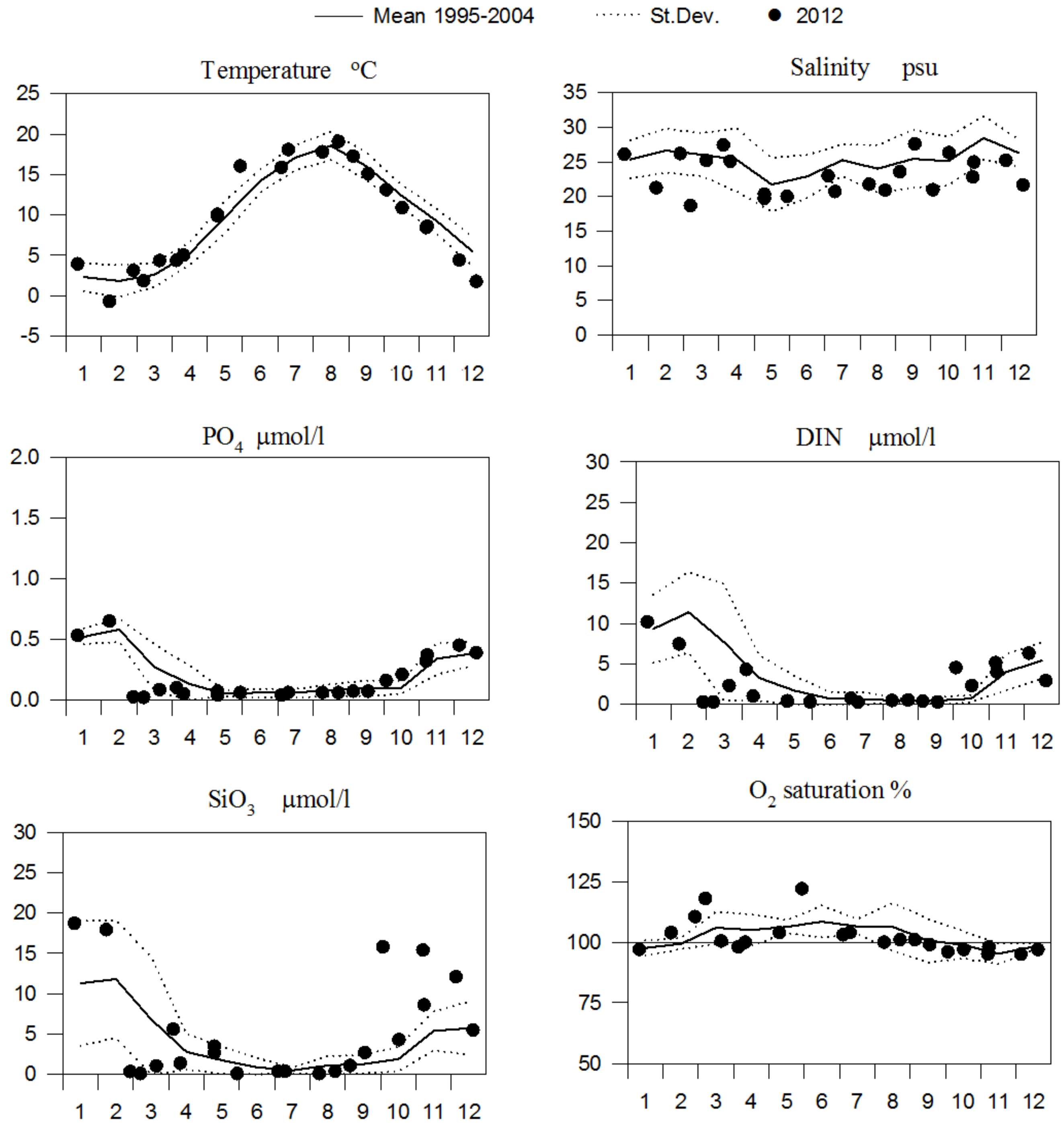
SMHI

STATION BY38 DEEP WATER (100m)

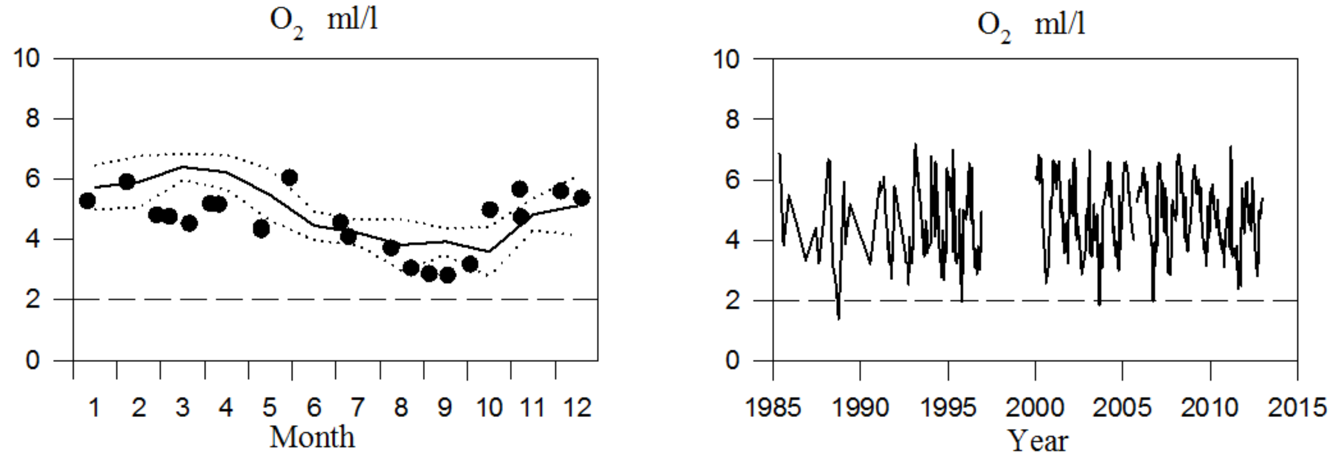


STATION SLÄGGÖ SURFACE WATER

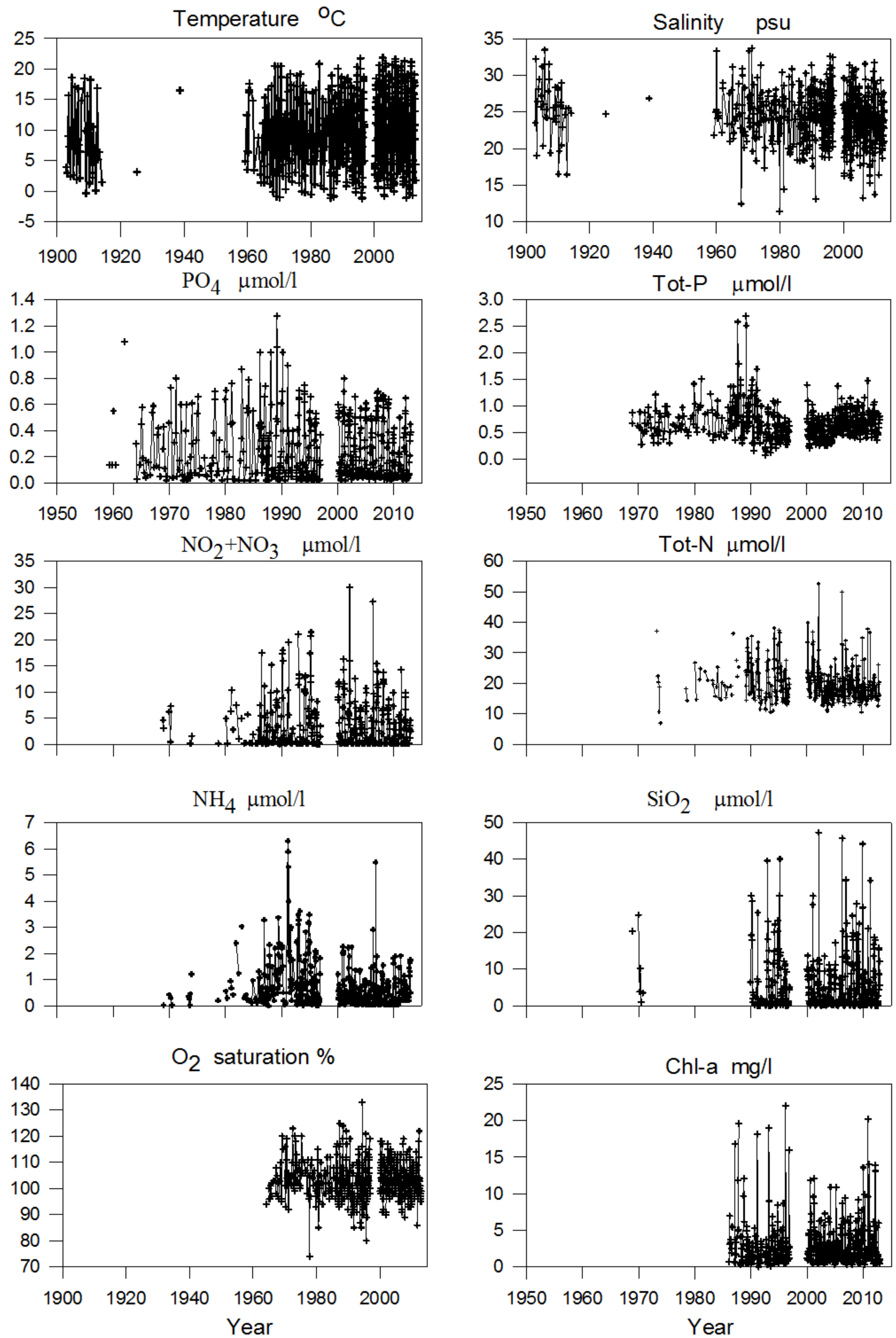
Annual Cycles



OXYGEN IN BOTTOM WATER

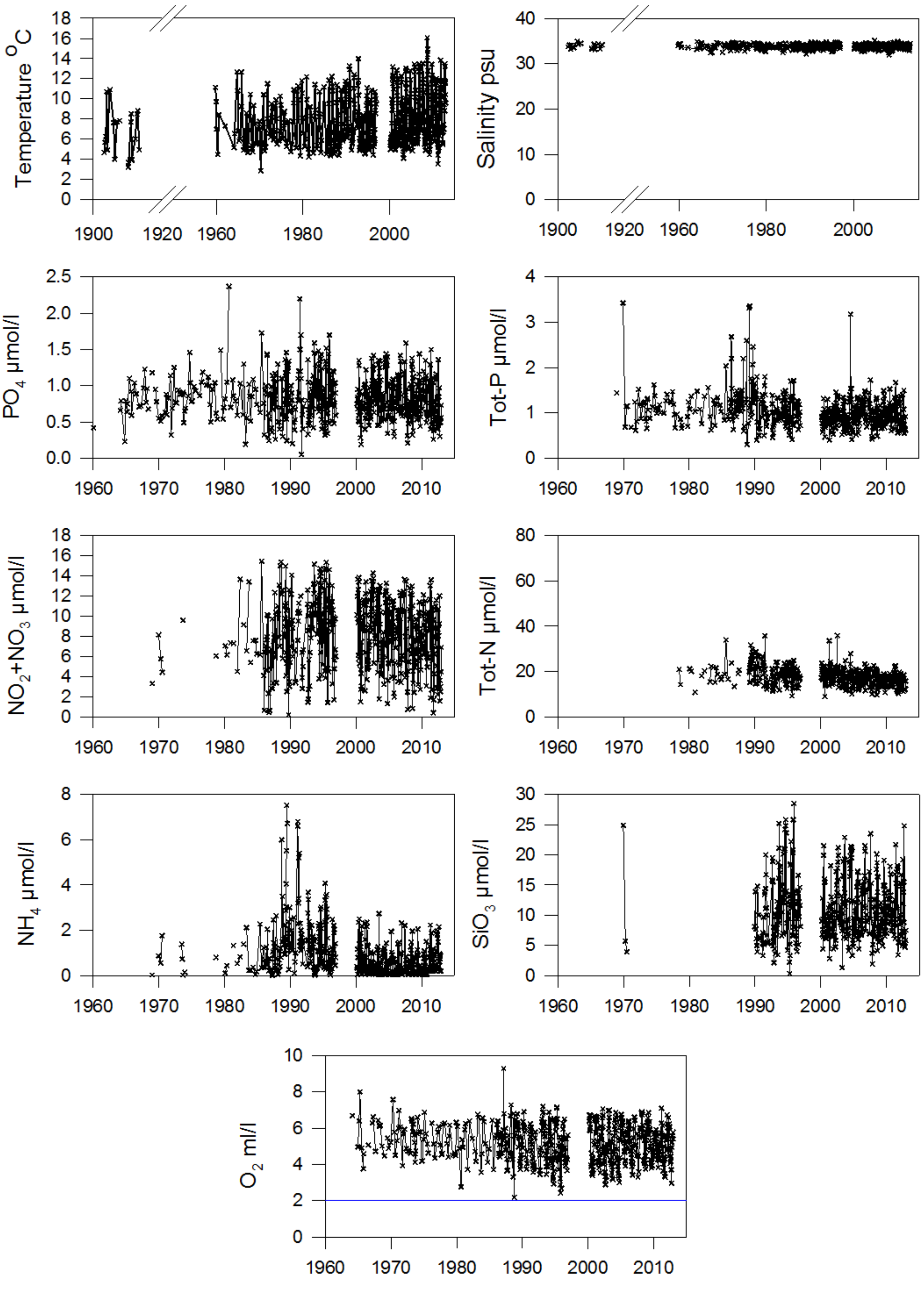


STATION SLÄGGÖ SURFACE WATER



SMHI

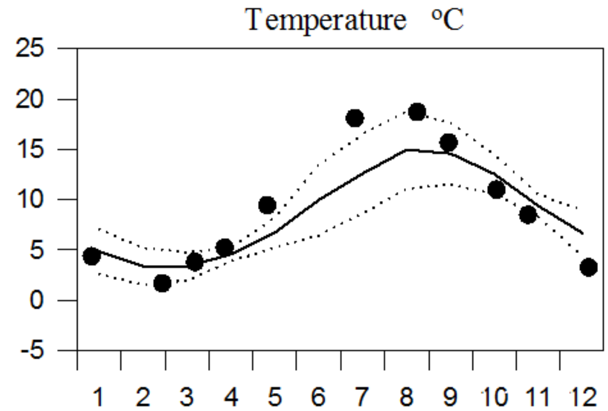
STATION SLÄGGÖ DEEP WATER (50m)

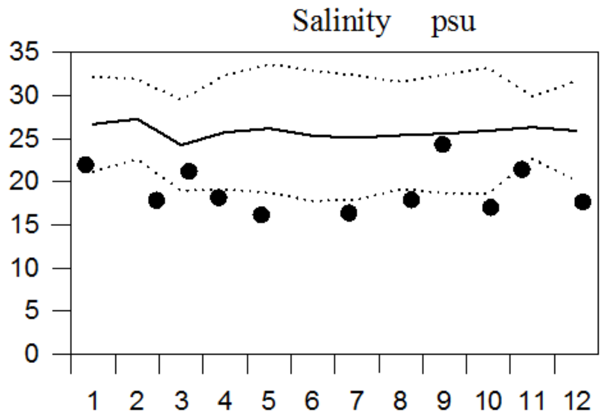


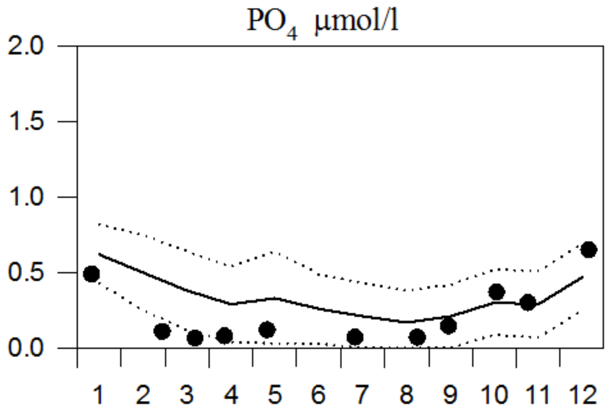
STATION N14 Falkenberg SURFACE WATER

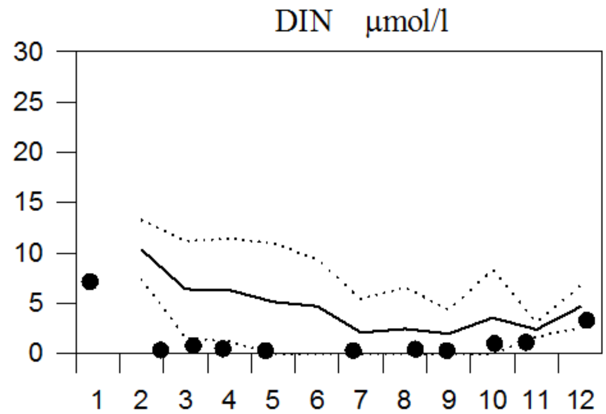
Mean 1995-2001 St.Dev. **Annual Cycles** ● 2012

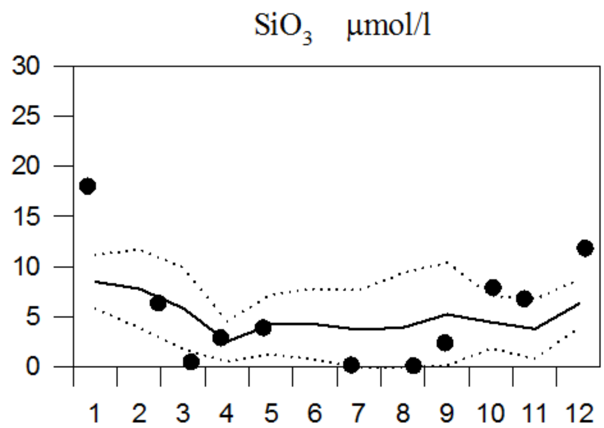
Mean and st.dev. based on data
from other source than SMHI.

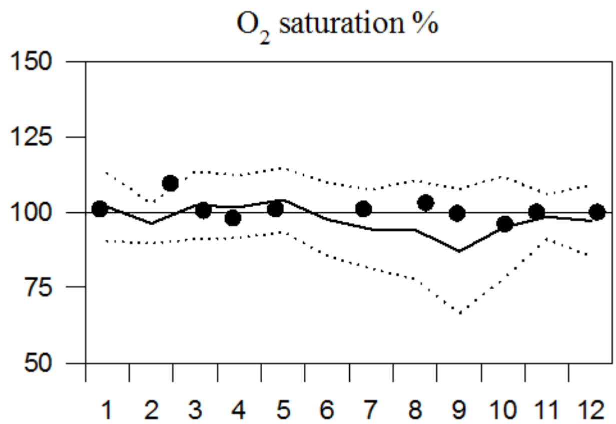




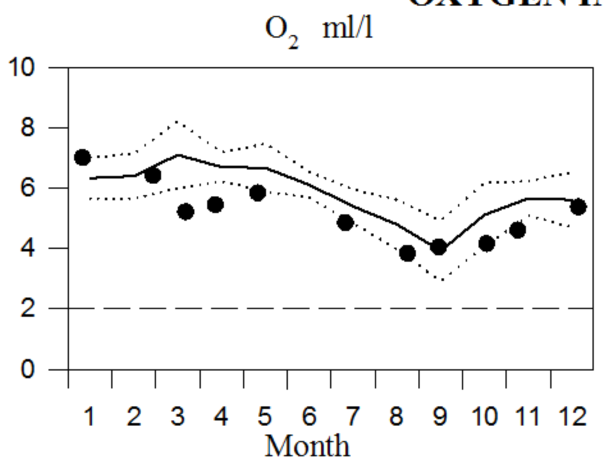


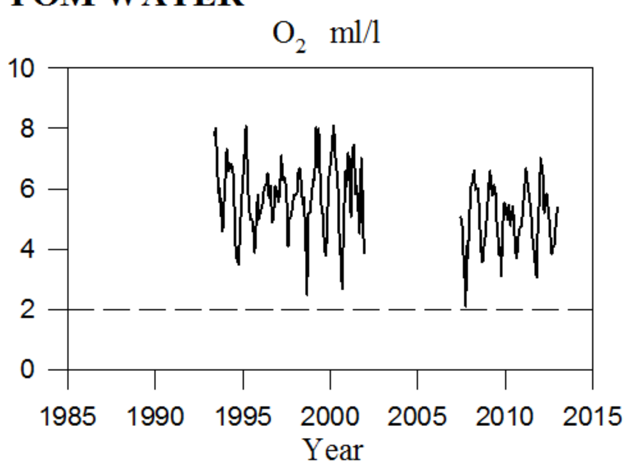






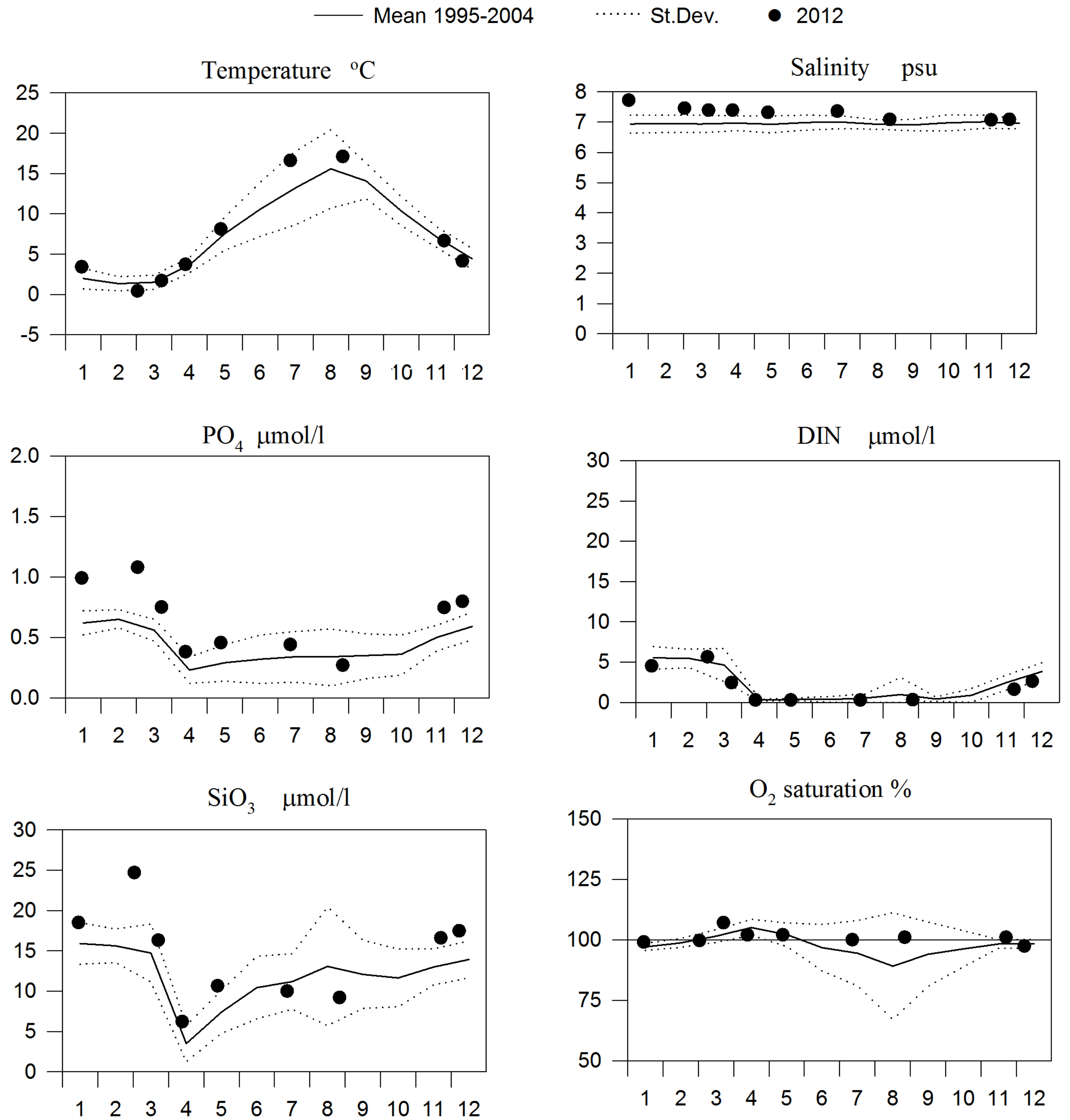
OXYGEN IN BOTTOM WATER





STATION REF M1V1 SURFACE WATER

Annual Cycles



OXYGEN IN BOTTOM WATER