Lars Andersson

Årsrapport 2010

Annual Report 2010

Table of content

Exceptional events 2010

- Oxygen conditions were extremely bad in the deep water of the central and northern Baltic Proper.

Summary of the state of the environment

Cold weather dominated the beginning of the year and in southern Sweden there was a great deal of snow. Spring came slowly and the spring flood was relatively weak. Weather conditions were variable during summer with relatively high rainfall and a heat wave in early July. Autumn began normally but the cold returned in November. December was an extreme month, setting records for the lowest average air temperature at many places and with the whitest Christmas for many years.

The ice season 2009/2010 must be classified as severe. Ice cover was extensive, both on the west coast and in the Baltic, causing severe problems for shipping in certain areas. The first sea ice started to develop in early December 2009 and the last melted in the northern Gulf of Bothnia during the last week of May. The maximum ice extent occurred in mid-February.

Fresh water drainage to the Skagerrak was slightly lower than normal during the first months of the year. During the remainder of the year, runoff was at normal levels, except for a short period in early October when there was a peak in the freshwater supply, with flows more than double the normal.
Run off to the Kattegat was also lower than normal at the beginning of the year. Peak

spring run-off occurred in late March / early April and then freshwater supply was at normal levels until the end of July. From August until late November runoff was higher than normal, at times during this period there were sharp peaks with values more than twice normal.
Freshwater supply to the Baltic Proper was below normal during February, but higher than normal during the remainder of the year. Particularly sharp peaks in runoff occurred in early June, during September and late November. During these periods the run-off was more than twice as high as normal.
The Bothnian Sea and Bothnian Bay showed the same pattern of supply. Run-off was at typical levels for most of the year, except for two occasions: in mid-April and during the second half of May. On those occasions supply was about 50% higher than normal.

Hydrography and hydrochemistry

No inflows to the Baltic of any significance took place during the year. A small inflow of about 10 km^3 occurred in late August and the largest, about 15 km^3 in mid-September. In addition, a continuous inflow throughout October and early November took place, but despite the long period of the inflow, the total volume was only 10 km^3. The effect of these inflows could be seen in the Arkona Basin and in parts of the Bornholm Basin and Hanöbukten, but they were not large enough to affect conditions further into the Baltic Sea.

Skagerrak, Kattegat and the Sound

Surface temperature in Skagerrak was much lower than normal in January and February and also in December, while the remainder of the year was normal.
In the Kattegat surface water temperature was also below normal during the beginning and end of the year. In the southern parts, July was warmer than usual, while temperatures during the rest of the year were normal.
An algal bloom was underway already in January and the typical winter nutrient pool was not built up. All the nutrients; nitrogen, phosphorus and silicate, had concentrations well below normal during the first three months. During the rest of the year, concentrations were normal, except for silicate which was lower than normal in the Kattegat during autumn.
In the bottom water, the lowest oxygen content was 1.9 ml/l, corresponding to a 29% oxygen saturation. This was measured during September in the central part of the Sound. In the open Kattegat, at Anholt E, the concentrations at this time were 2.32 ml/l, equivalent to a saturation of 35%.
In the open Skagerrak there is normally no shortage of oxygen in the deep water. The lowest value in 2010 was found at the station Släggö, in the mouth of the Gullmar fjord, where concentrations fell to 1.3 ml / l in October.

An extensive diatom bloom started late autumn 2009 and continued to the end of February before collapsing. The diversity was high, and the potentially toxic diatom *Pseudo-nitzschia* exceeded its critical limits (> one million cells per liter) at several

stations in January and February. The ichtyotoxic (ichty=fish) genus *Chrysochromulina* was abundant at one station in the Kattegat and one in the Skagerrak during March.
The flagellate *Emiliania huxleyi* bloomed in late May and early June. The species is harmless, but colours the sea a beautiful shade of turquoise.
During summer phytoplankton numbers and volume, and chlorophyll a concentration, were lower than during previous years.
A chlorophyll peak was observed at the Kattegat station Anholt E in August, and phytoplankton cell numbers were relatively high. In late summer and autumn chlorophyll concentrations were close to or slightly below normal for the season.

Baltic Proper

Surface water temperatures were at normal levels during the main part of the year. However in February and March they were slightly lower in the southern part and during July well above normal in the whole area. In the case of nutrients, phosphate and silicate showed elevated levels during the first months in the south, while nutrient concentrations in other respects remained at normal levels. The spring bloom occurred in March / April and thereafter nitrogen concentrations remained below the detection limit until early October.

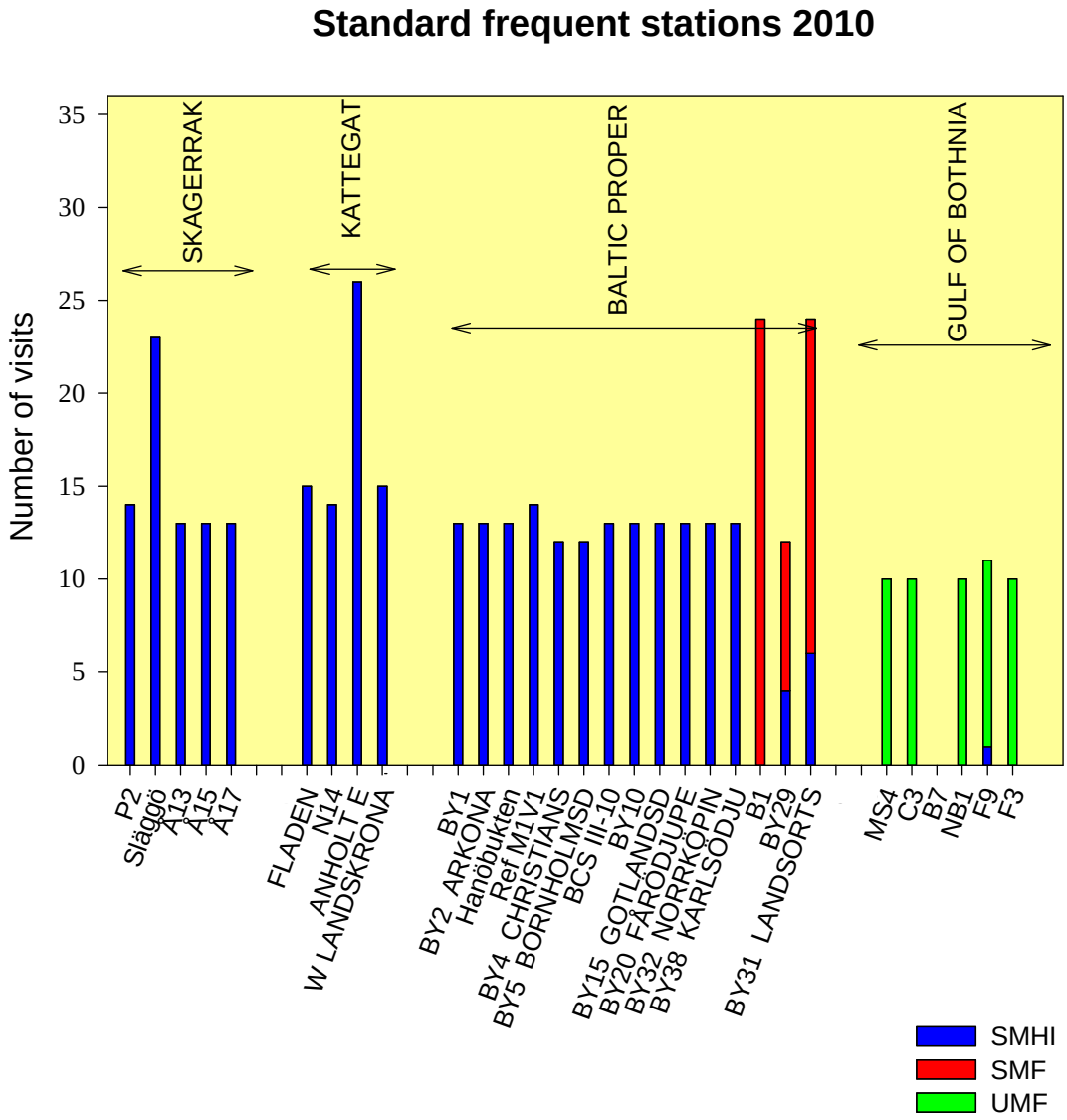
Hydrogen sulphide was present in the bottom water of the Bornholm Basin between July and October. Low oxygen levels (<2ml/l) were measured in the Arkona Basin during late summer and in the south-eastern Baltic Proper throughout the year.
The oxygen situation in the deep water of the Baltic Proper continues to be serious. About one sixth (~17%) of the bottom area in the Baltic Proper is affected by anoxia (oxygen free, with toxic hydrogen sulphide present) corresponding to ~10% of the water volume. Acute oxygen deficiency, with concentrations <2ml/l, affects about 28% of the bottom area, or about 20% of the volume. This is the largest affected volume measured since 1960. North of Öland, hydrogen sulphide was already present from depths exceeding 45 meters. Anoxic conditions at these shallow depths have never been observed before in this area. In the south-west, in the Arkona Basin and in parts of the Bornholm Basin, oxygen conditions were good due to some smaller inflows during August and September.

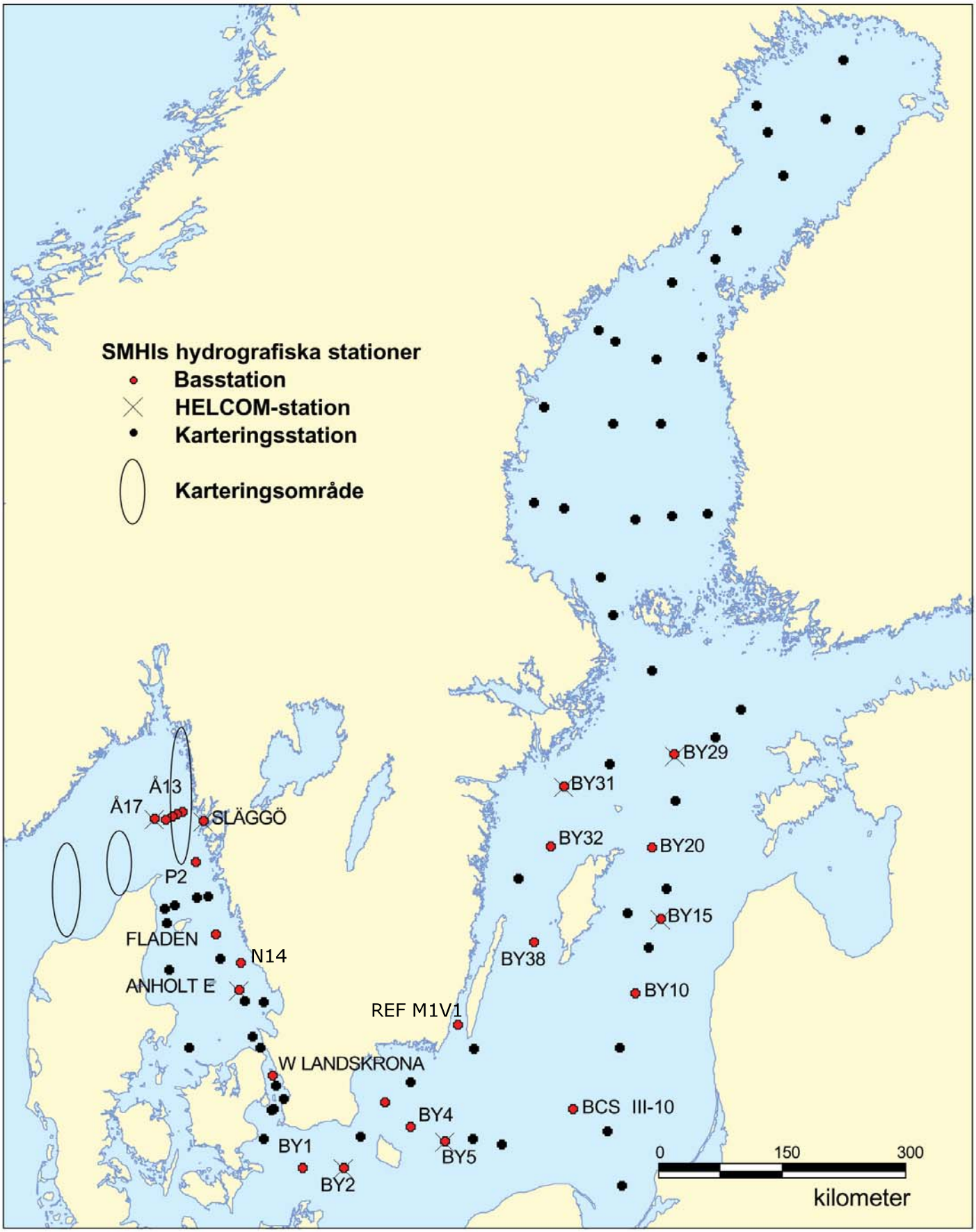
The beginning of the spring bloom was observed in the southern Baltic in the middle of March. The diatom *Skeletonema marinoi* was numerous and other diatoms were abundant as well. In April, spring bloom was ongoing at all Baltic Proper stations, and chlorophyll concentrations and cell numbers were high.
The warm and calm weather situation caused the cyanobacteria bloom to begin already by the end of June. The bloom was still extensive at the time of the July monitoring expedition. By the middle of August the surface accumulations were gone, but cyanobacteria were still abundant, albeit mixed down in the water column.
Small flagellated species common in the Baltic dominated during the autumn. The ichtyotoxic species *Chrysochromulina* cf. *polylepis* was observed west of Gotland in

October and had increased in cell numbers and locations by November. By the December cruise, *C.* cf. *polylepis* was gone.

Gulf of Bothnia

Number of visits at standard frequent stations



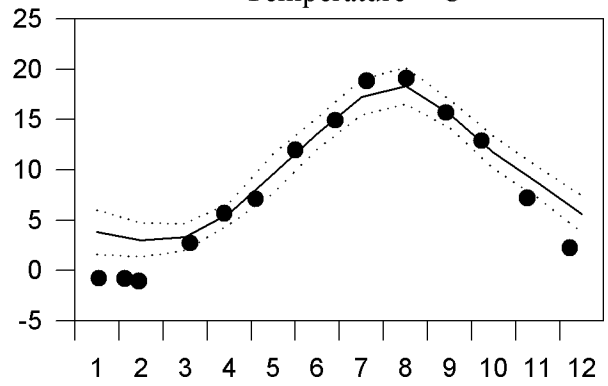

SMHIs hydrografiska stationer
Basstation
HELCOM-station
Karteringsstation
Karteringsområde
Å13
Å17
SLÄGGÖ
P2
FLADEN
N14
ANHOLT E
W LANDSKRONA
BY1
BY2
BY4
BY5
REF M1V1
BY38
BY29
BY31
BY32
BY20
BY15
BY10
BCS III-10
0
150
300
kilometer

STATION P2 SURFACE WATER

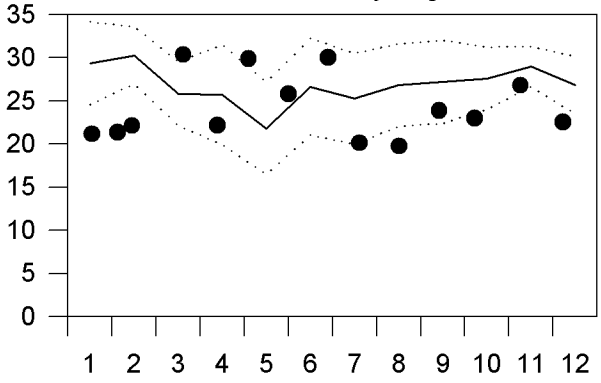
Annual Cycles

Mean 1995-2004 ····· St.Dev. ● 2010

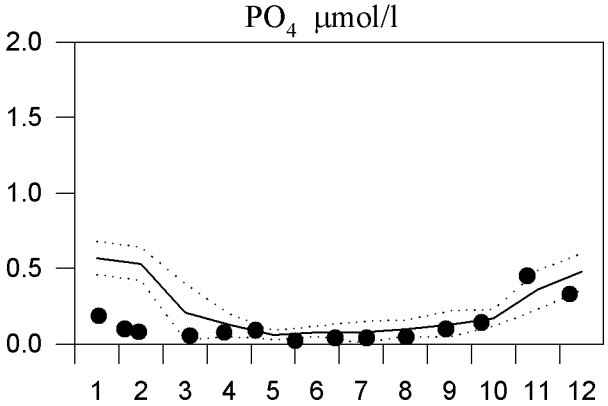
Temperature °C



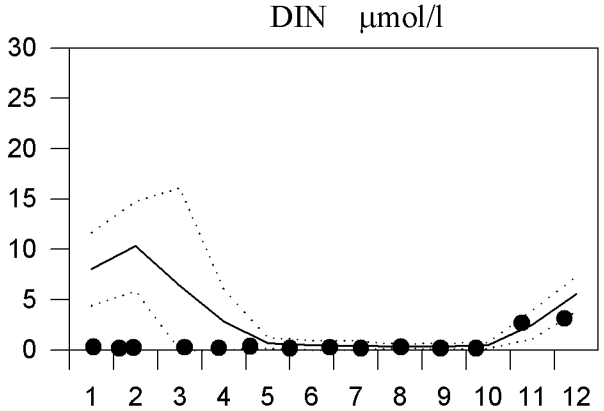
Salinity psu



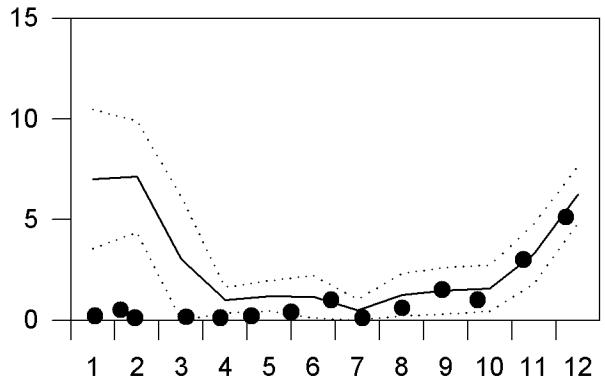
PO_4 µmol/l



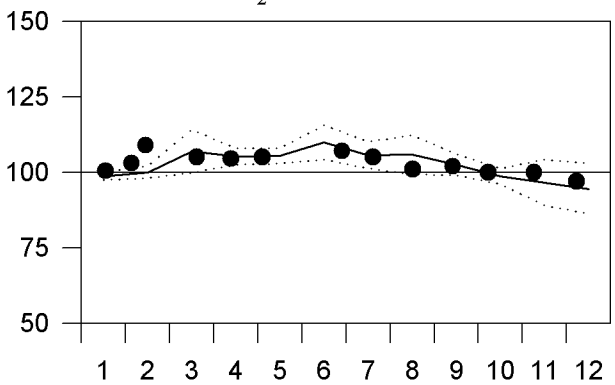
DIN µmol/l



SiO_3 µmol/l

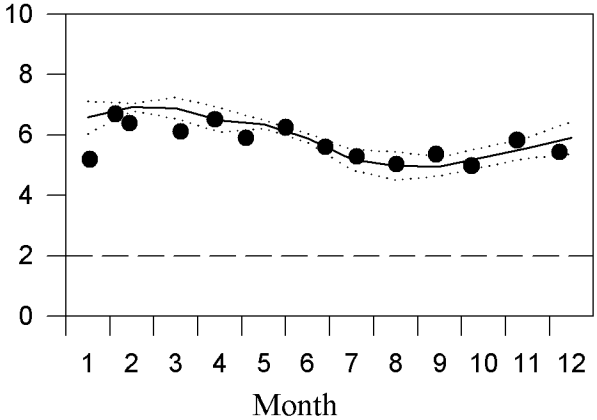


O_2 saturation %

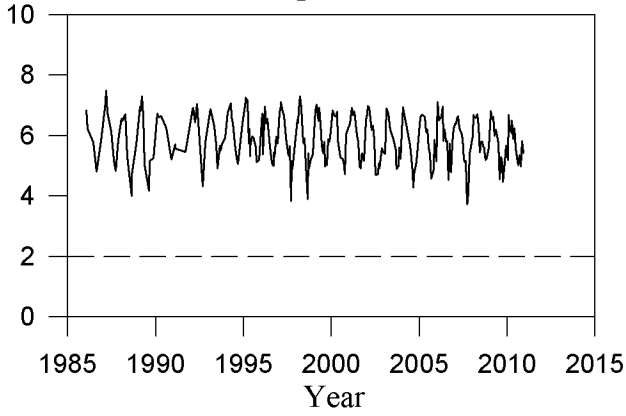


OXYGEN IN BOTTOM WATER

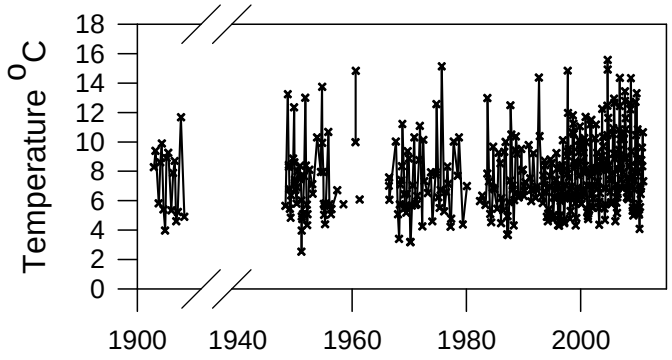
O_2 ml/l

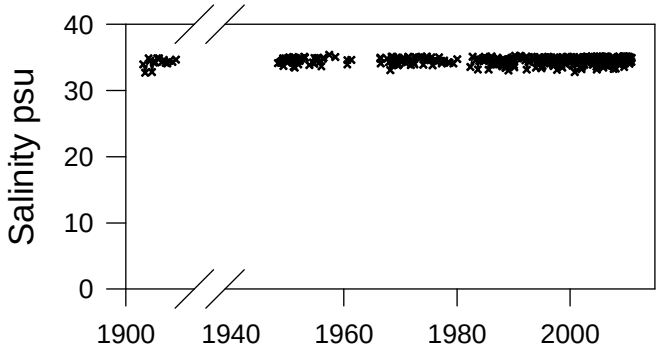


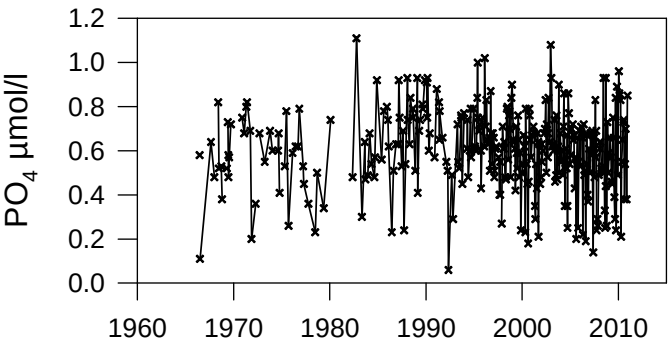
O_2 ml/l

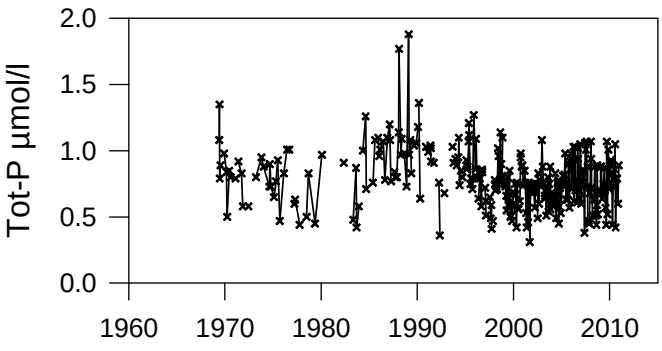


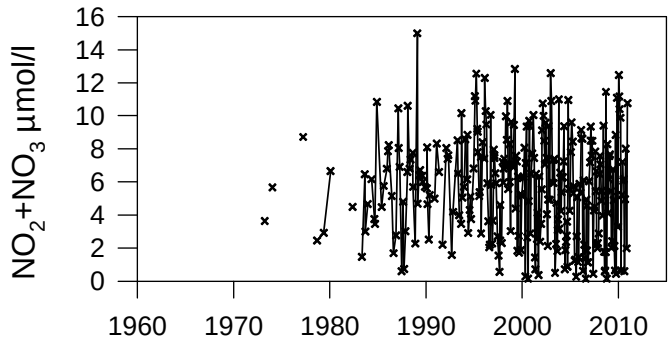
STATION P2 DEEP WATER (75m)

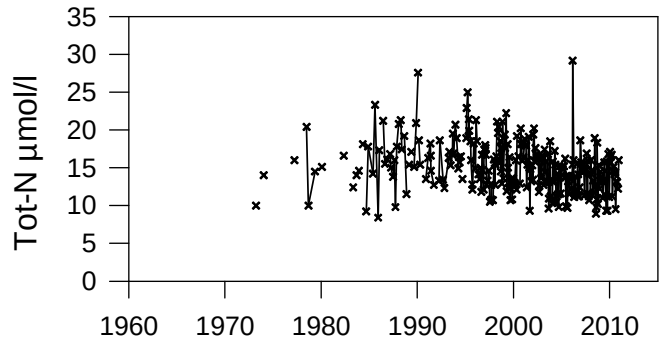


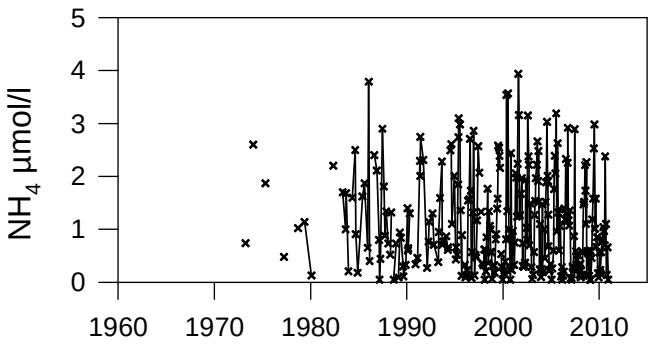


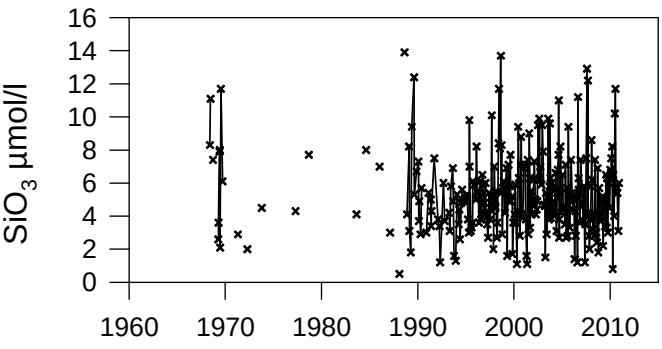


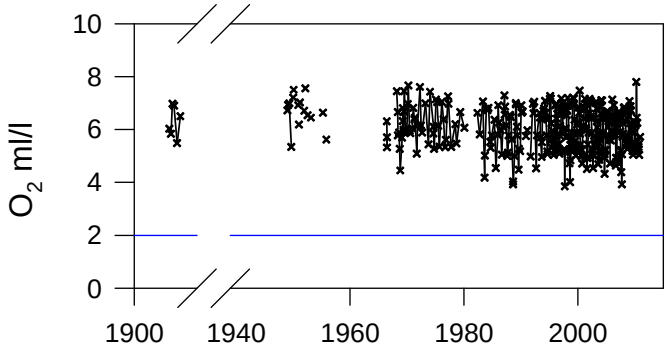










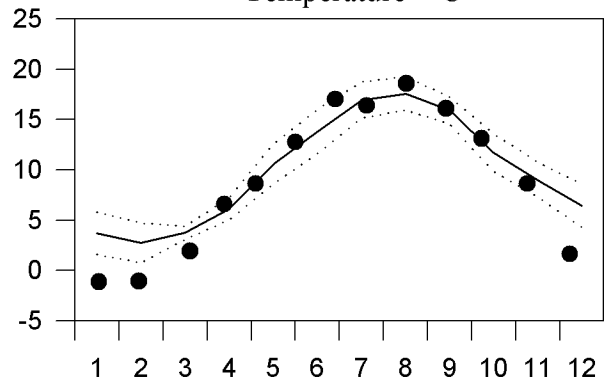


STATION Å13 SURFACE WATER

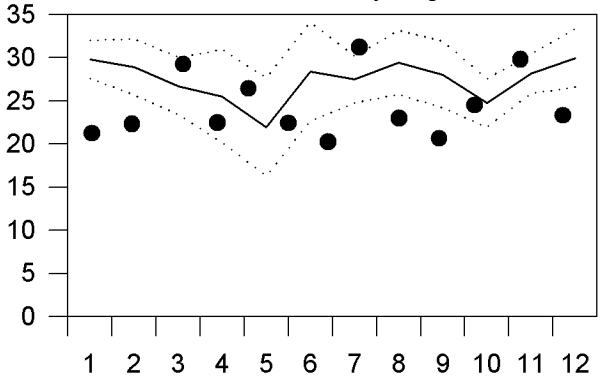
Annual Cycles

Mean 1995-2004 ····· St.Dev. ● 2010

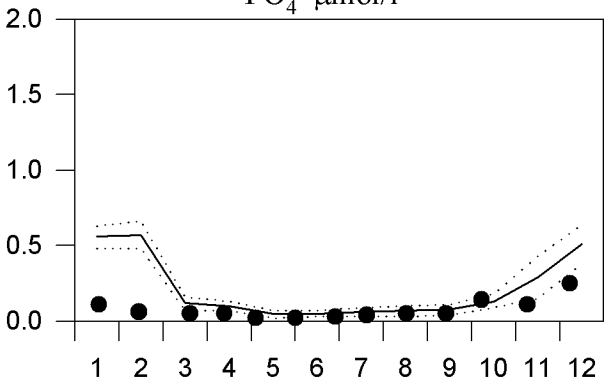
Temperature °C



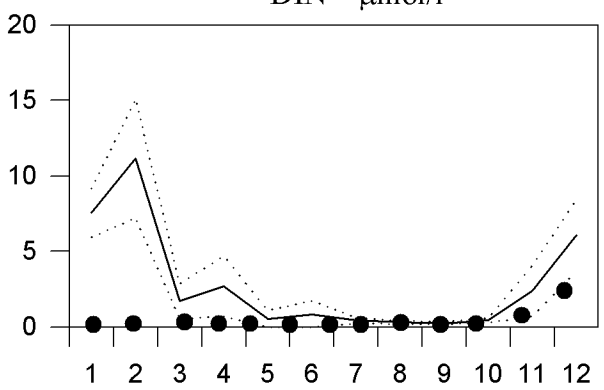
Salinity psu



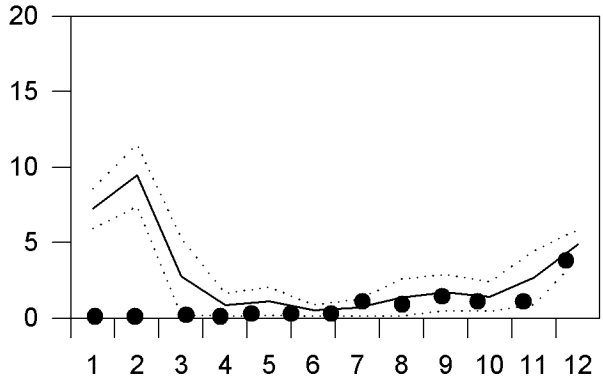
PO_4 µmol/l



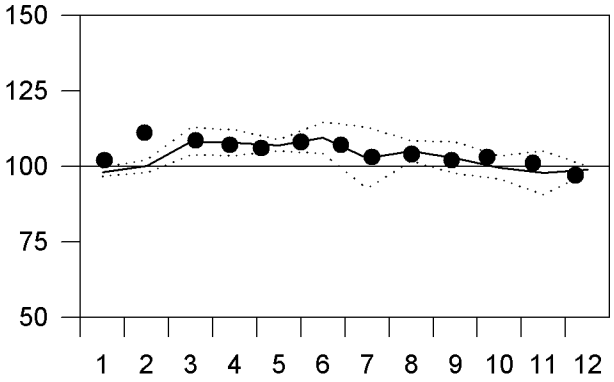
DIN µmol/l



SiO_3 µmol/l

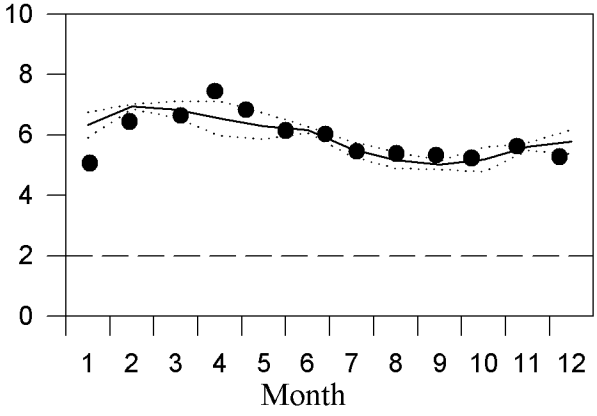


O_2 saturation %

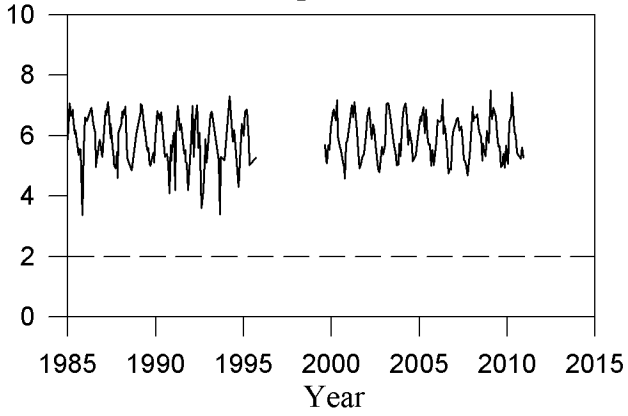


OXYGEN IN BOTTOM WATER

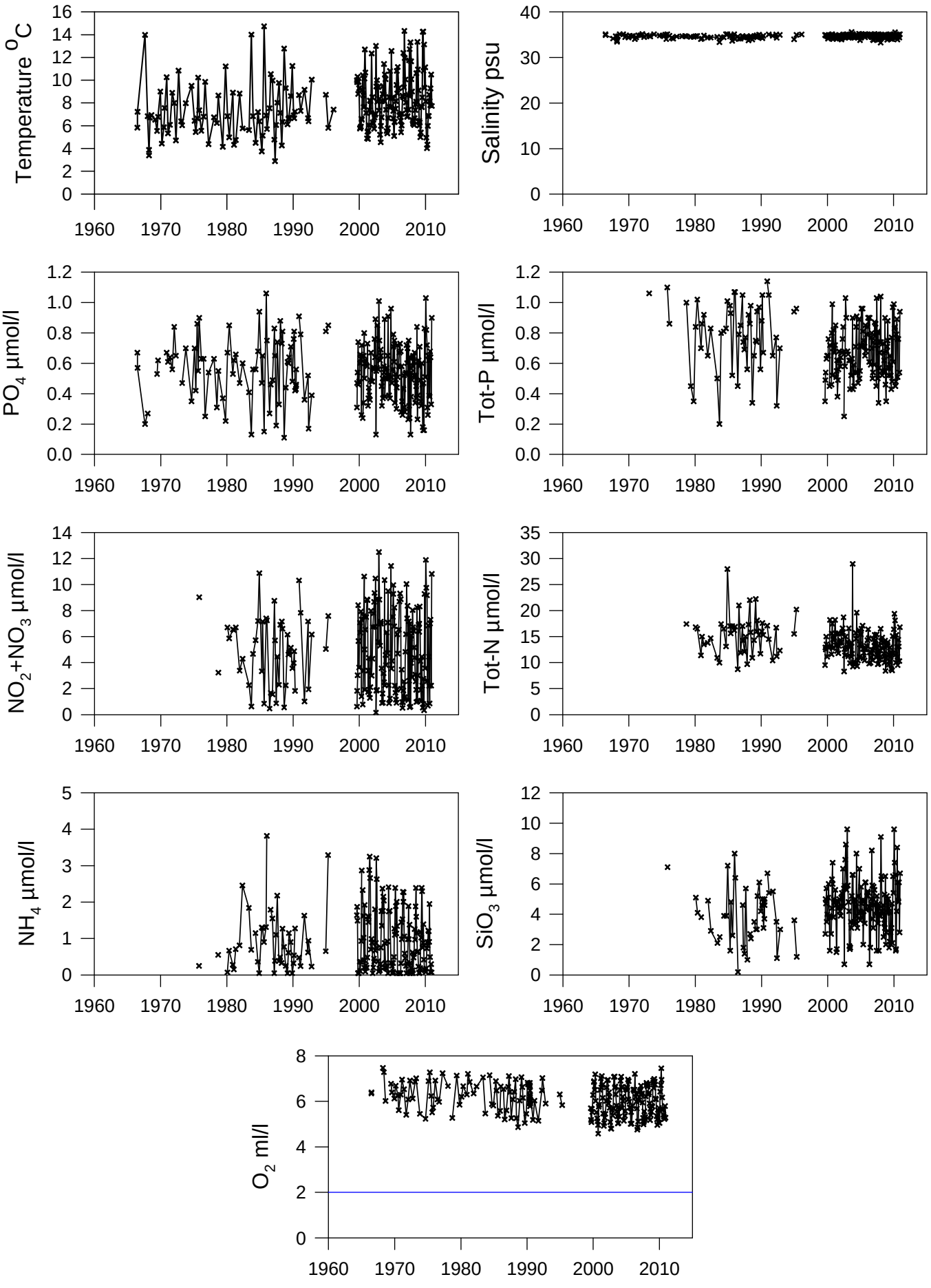
O_2 ml/l



O_2 ml/l



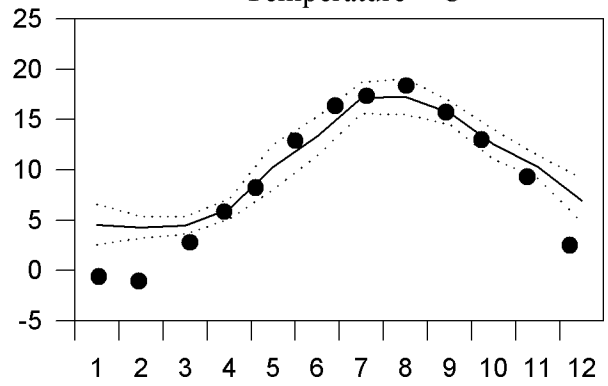
STATION Å13 DEEP WATER (75m)



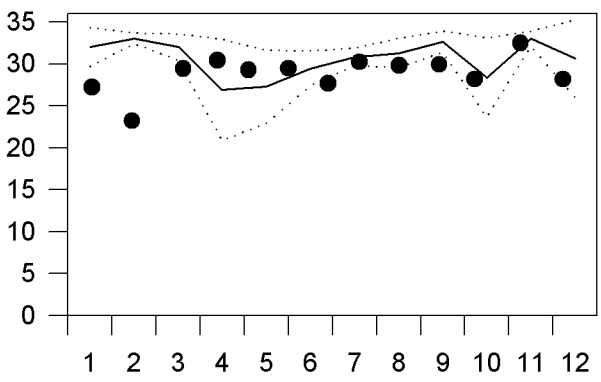
STATION Å17 SURFACE WATER

Annual Cycles

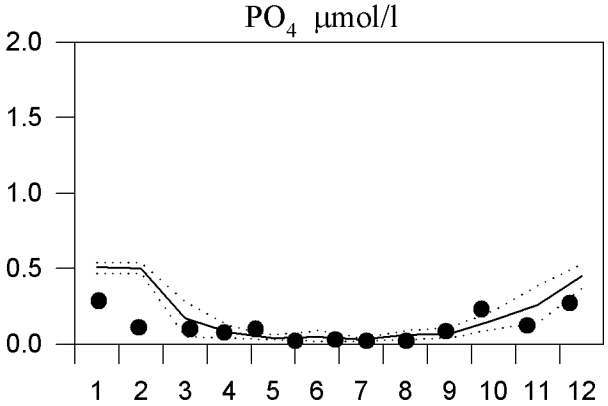
Temperature °C



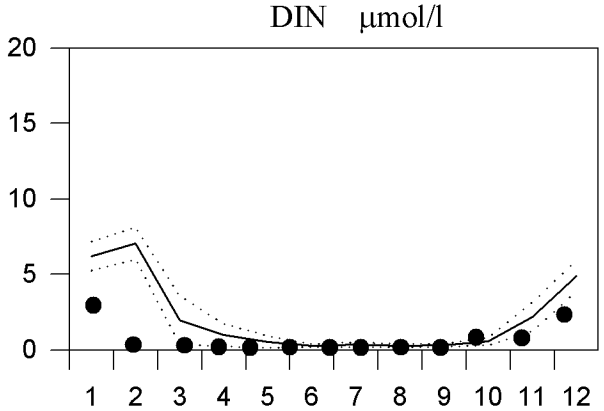
Salinity psu



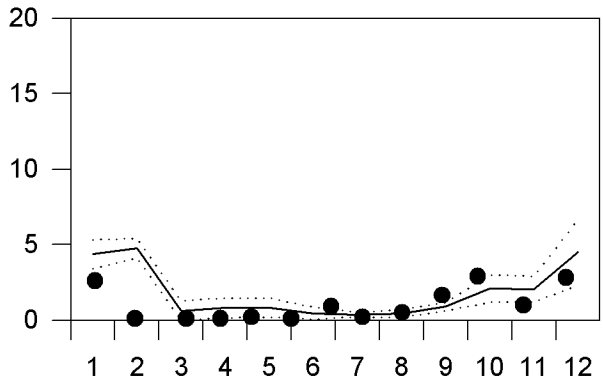
PO_4 µmol/l



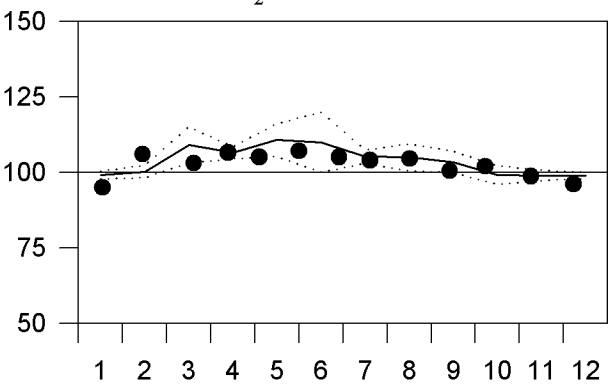
DIN µmol/l



SiO_3 µmol/l

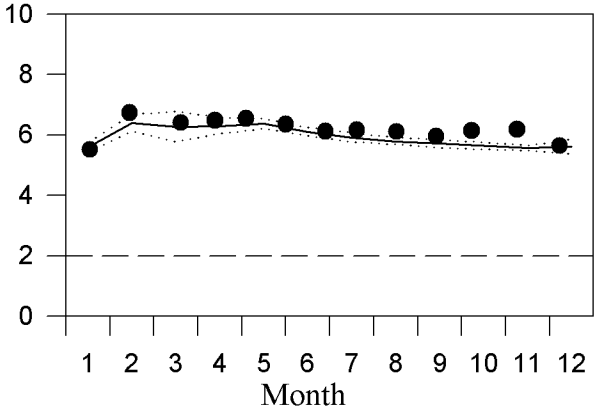


O_2 saturation %

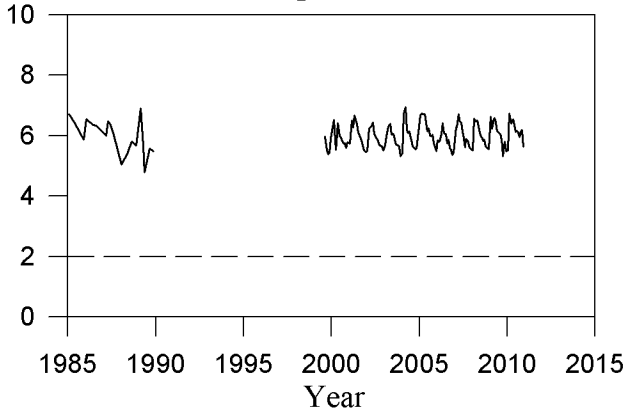


OXYGEN IN BOTTOM WATER

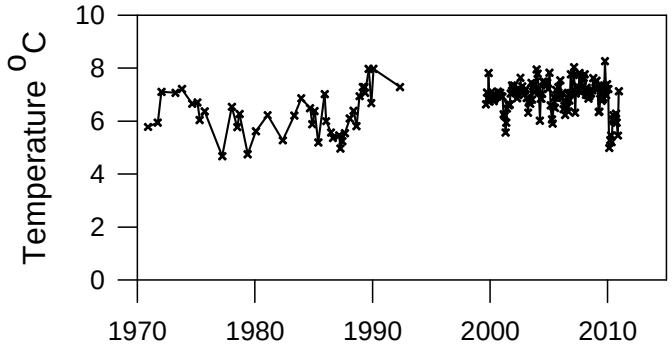
O_2 ml/l

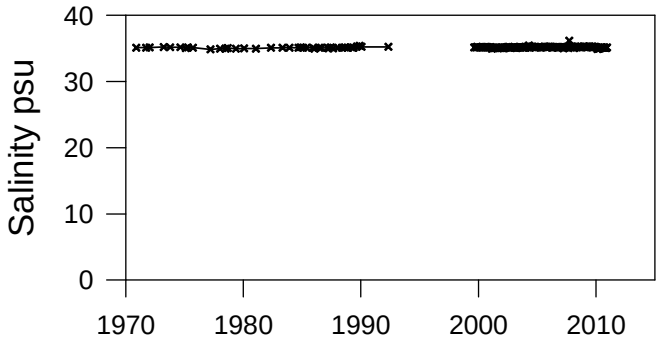


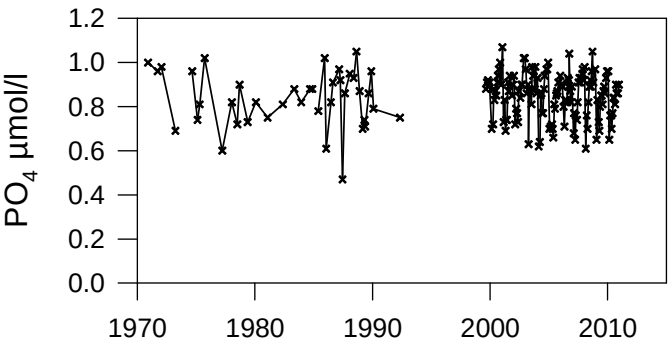
O_2 ml/l

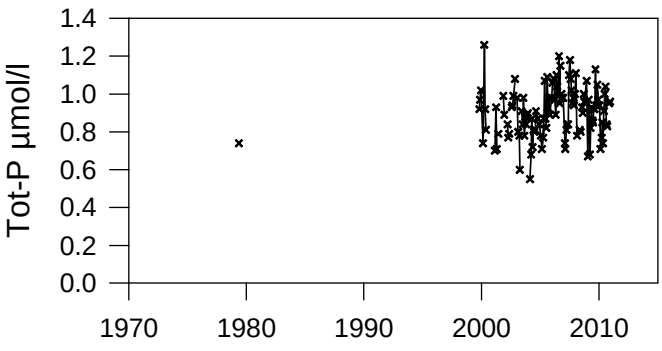


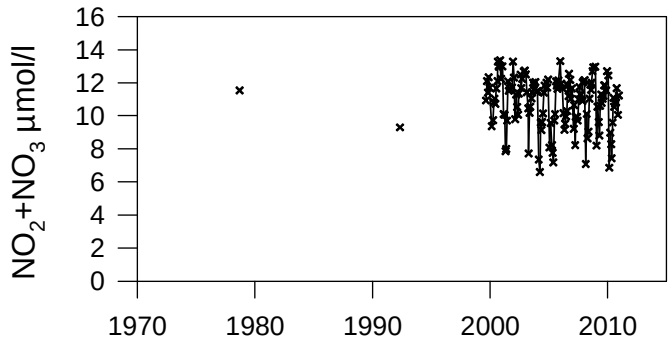
STATION Å17 DEEP WATER (300m)

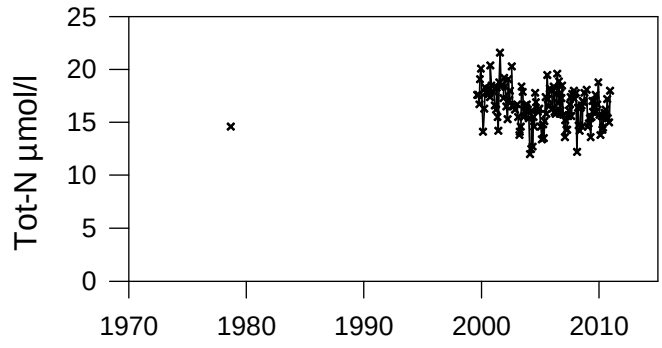


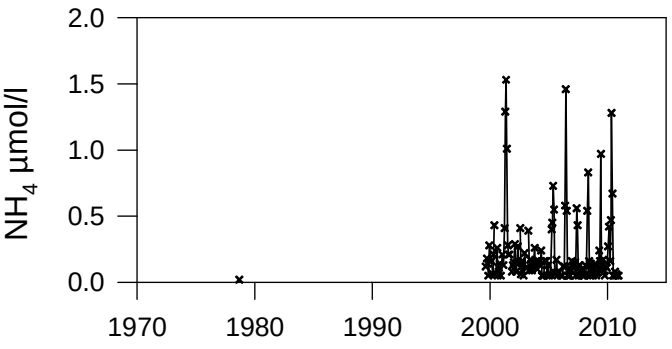


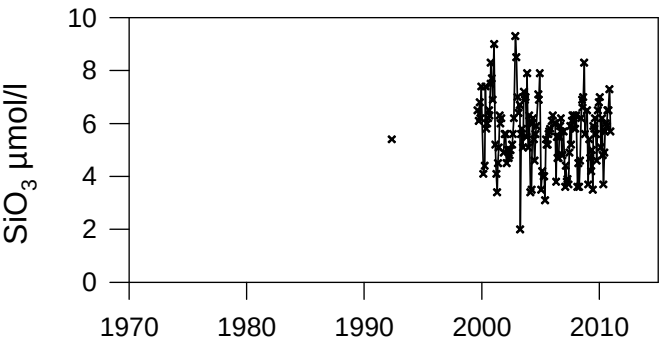


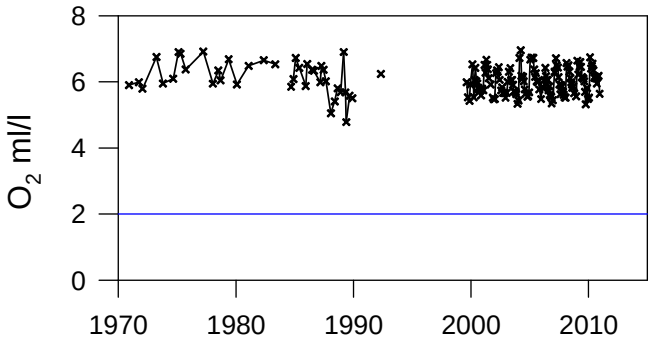










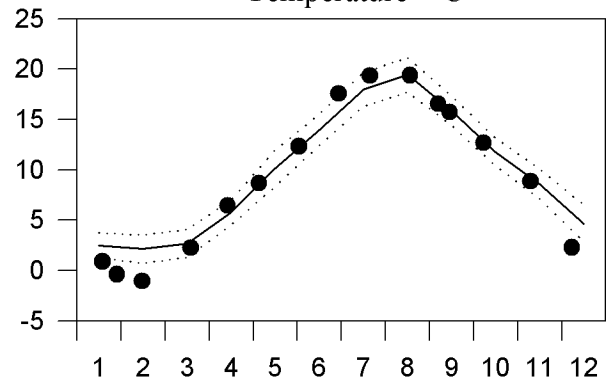


STATION FLADEN SURFACE WATER

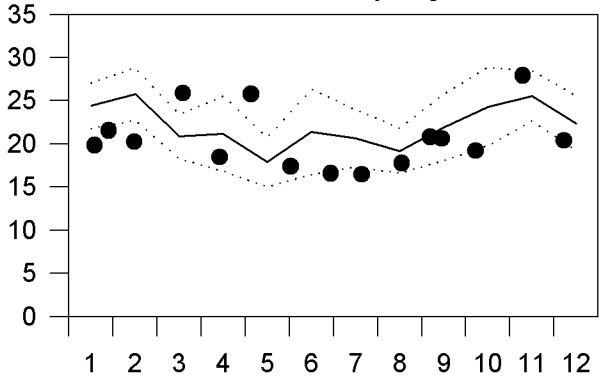
Annual Cycles

Mean 1995-2004 ····· St.Dev. ● 2010

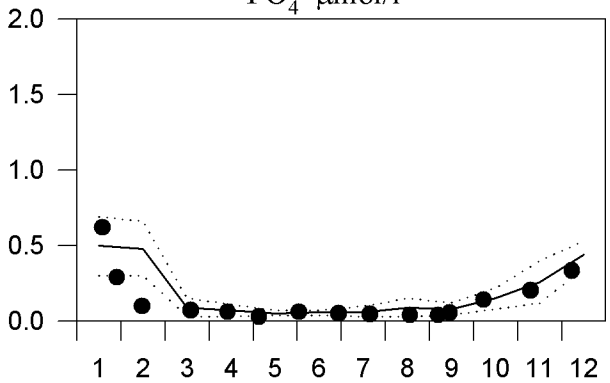
Temperature °C



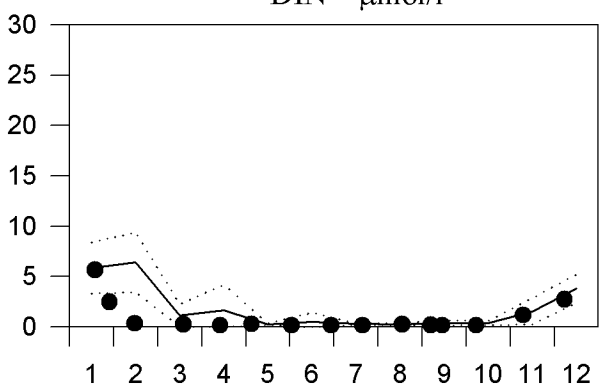
Salinity psu



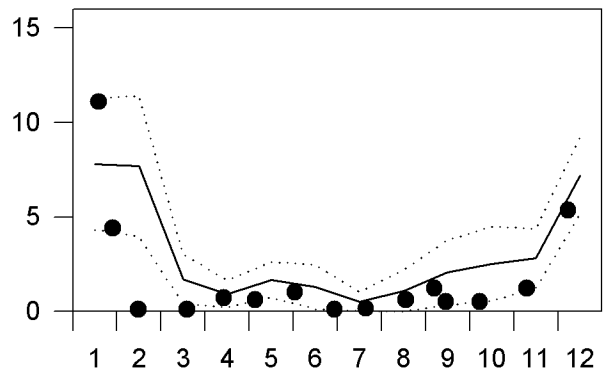
PO_4 µmol/l



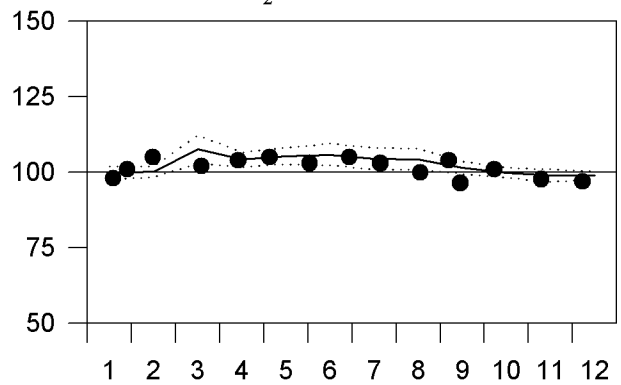
DIN µmol/l



SiO_3 µmol/l

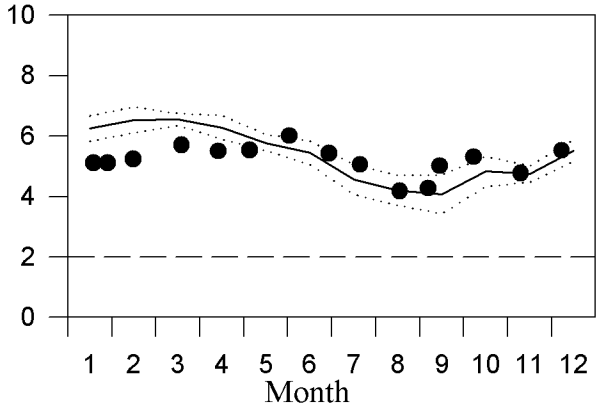


O_2 saturation %

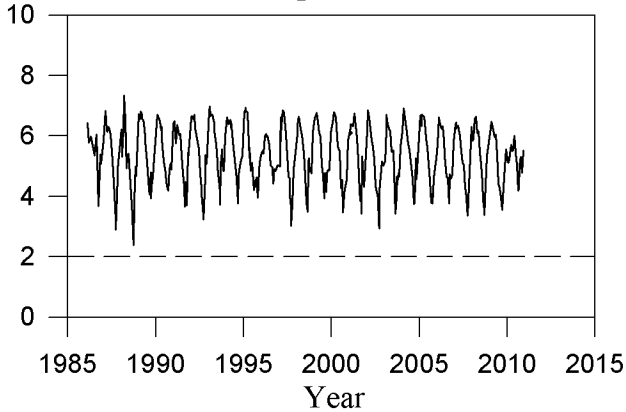


OXYGEN IN BOTTOM WATER

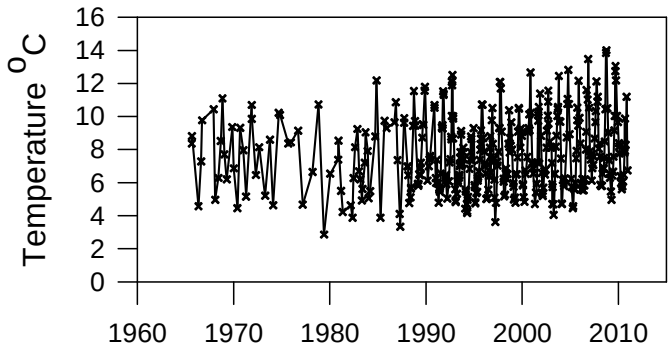
O_2 ml/l

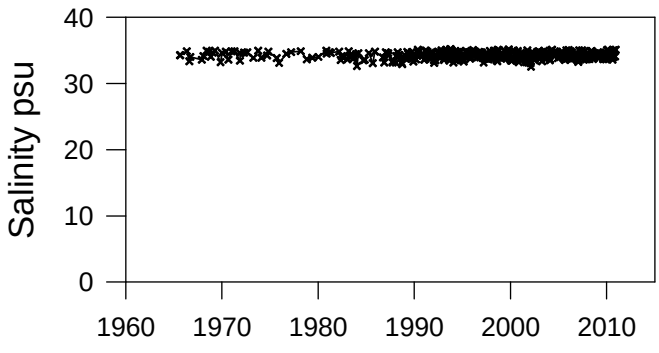


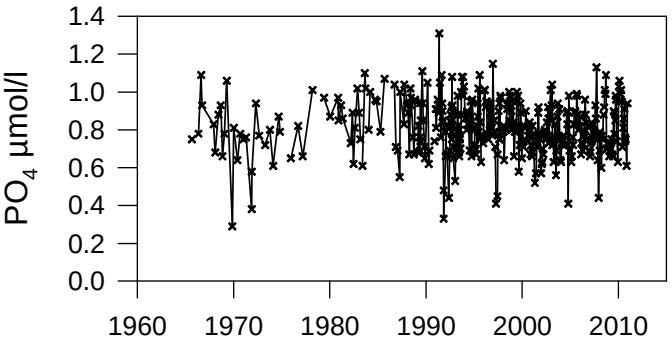
O_2 ml/l

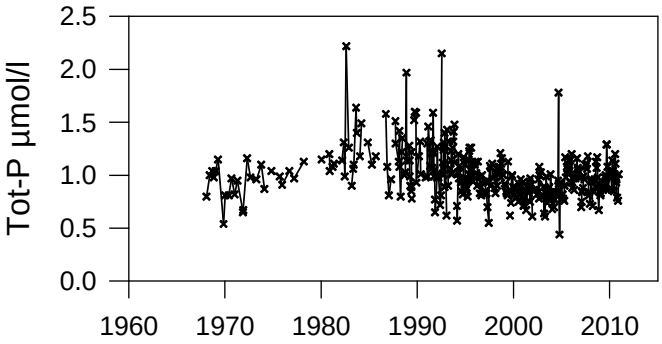


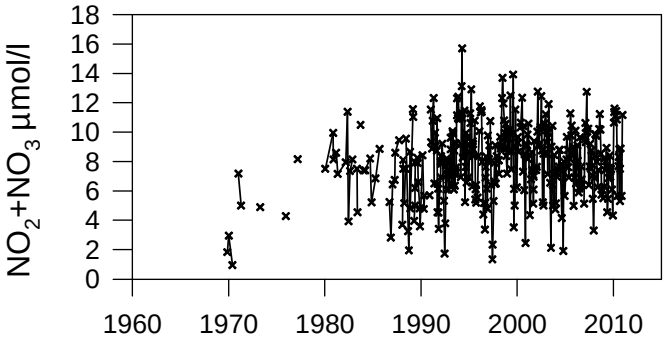
STATION FLADEN DEEP WATER (70m)

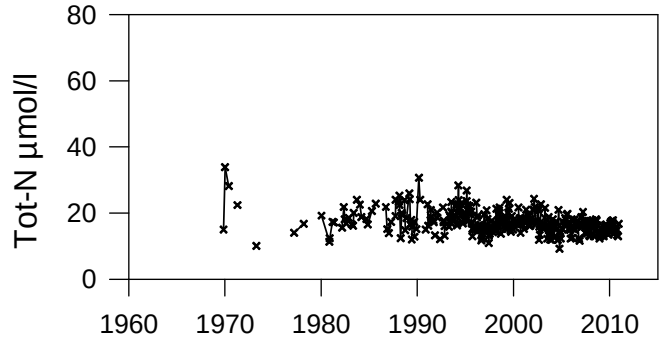


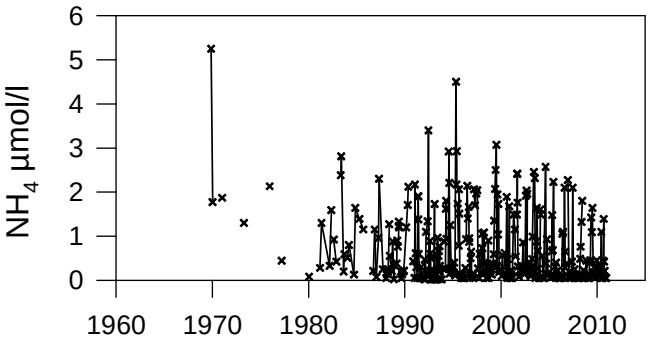


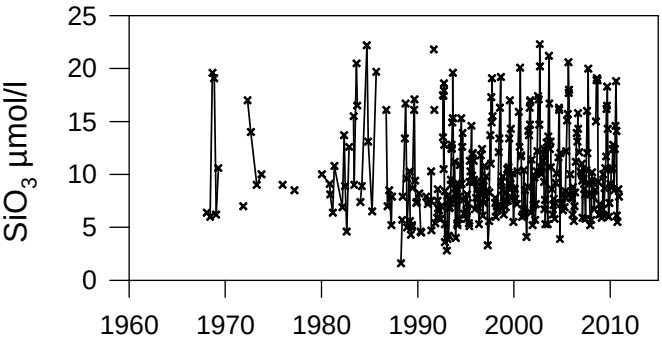


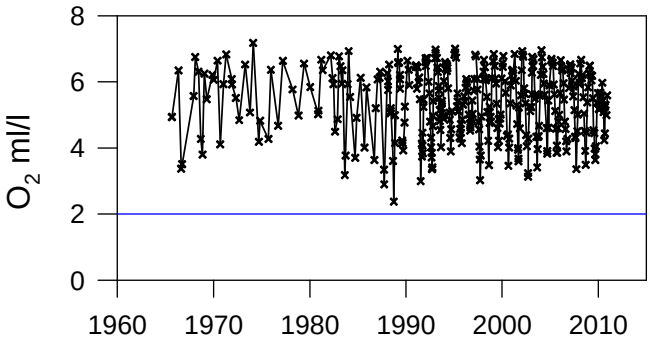










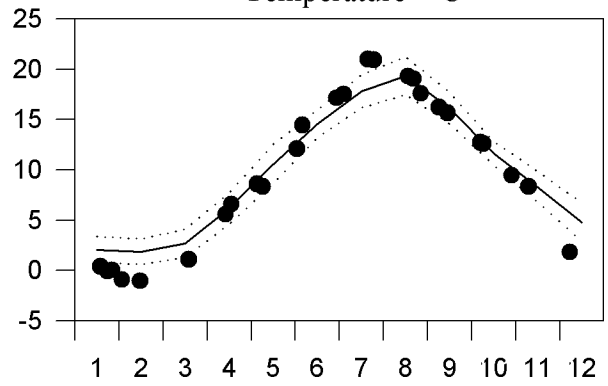


STATION ANHOLT E SURFACE WATER

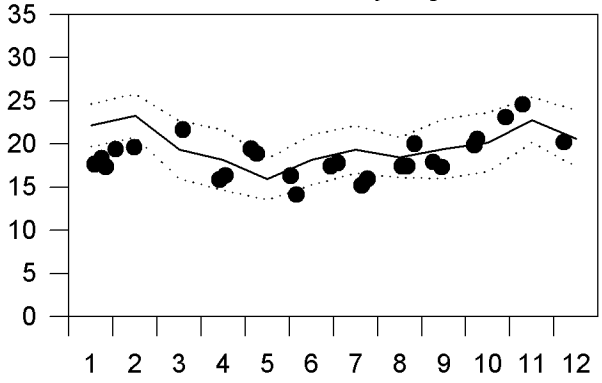
Annual Cycles

Mean 1995-2004 ····· St.Dev. ● 2010

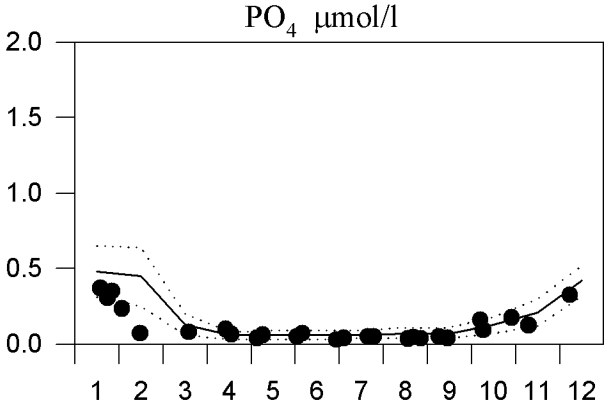
Temperature °C



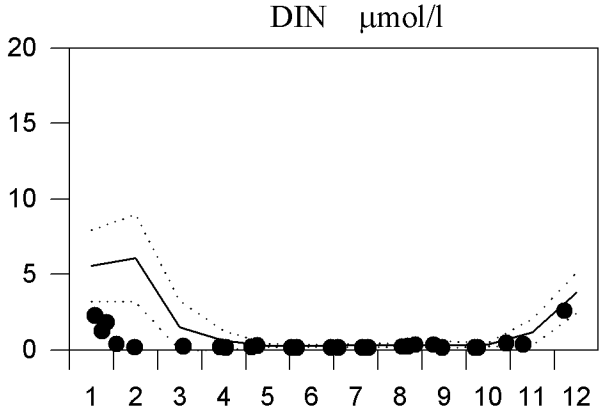
Salinity psu



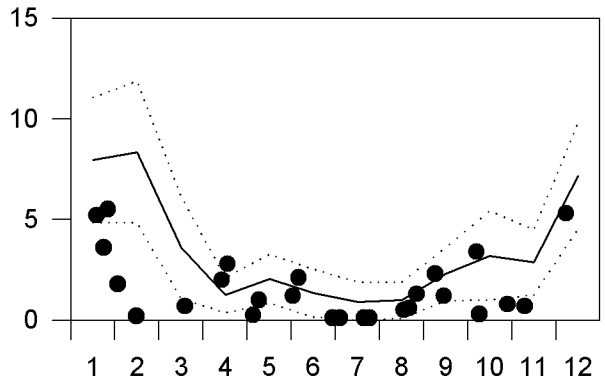
PO_4 µmol/l



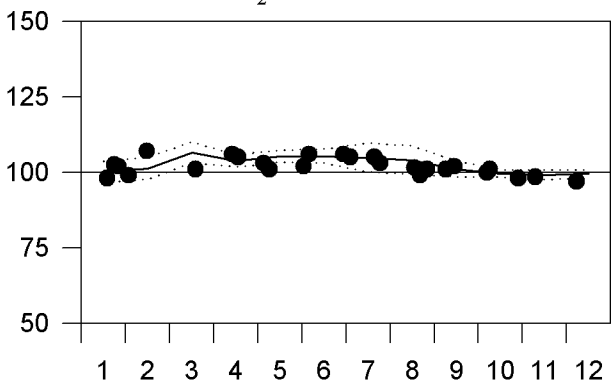
DIN µmol/l



SiO_3 µmol/l

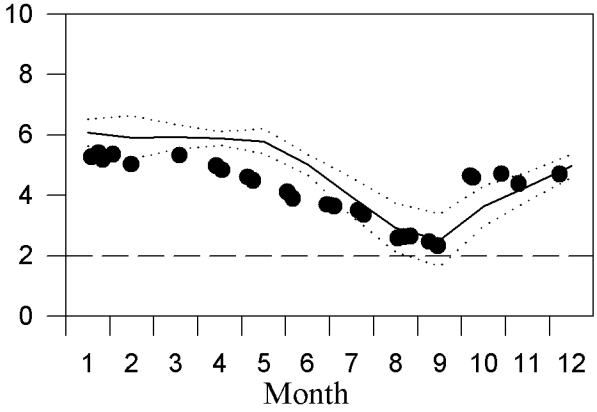


O_2 saturation %

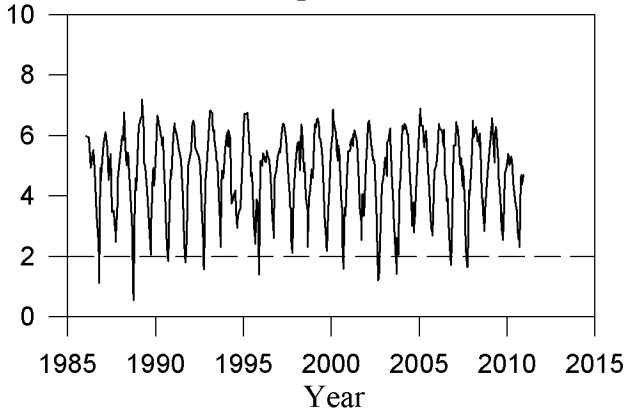


OXYGEN IN BOTTOM WATER

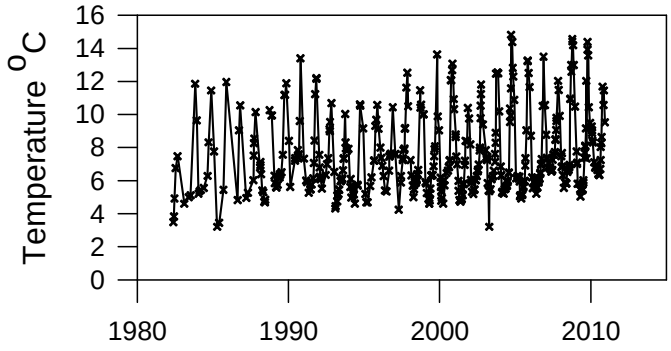
O_2 ml/l

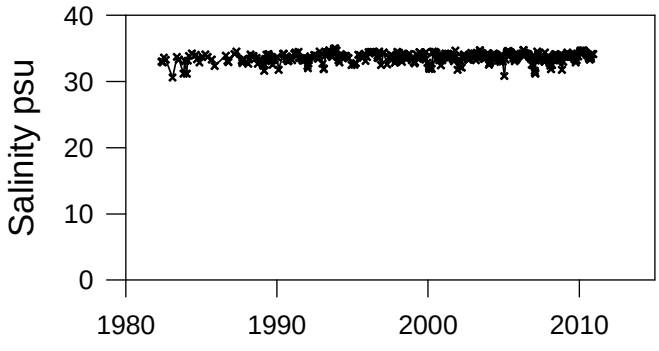


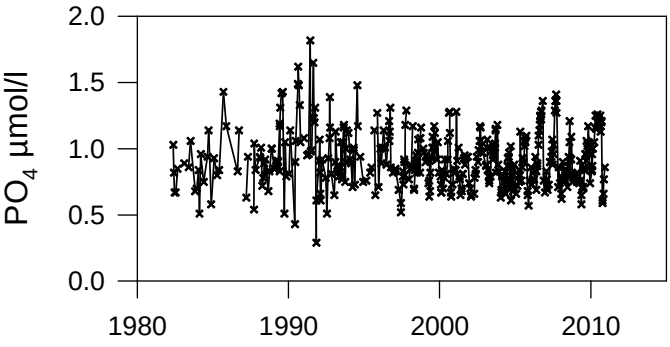
O_2 ml/l

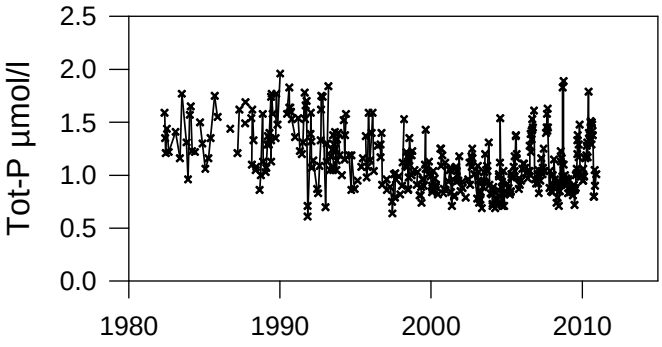


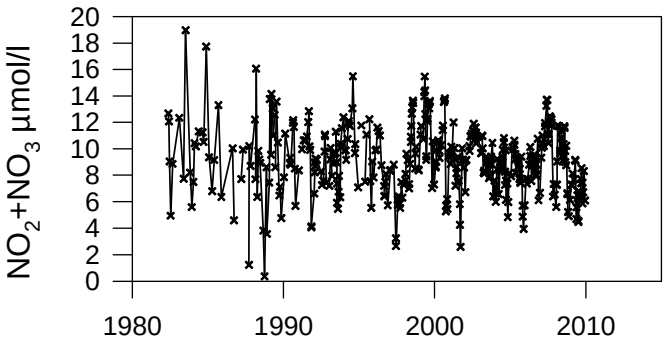
STATION ANHOLT-E DEEP WATER (50m)

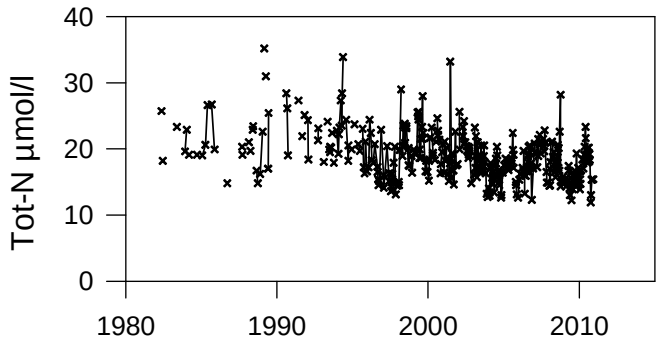


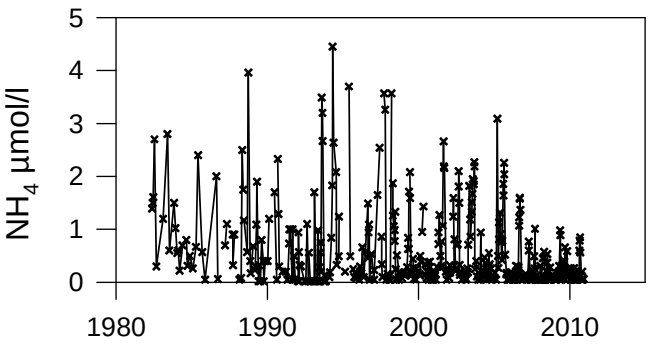


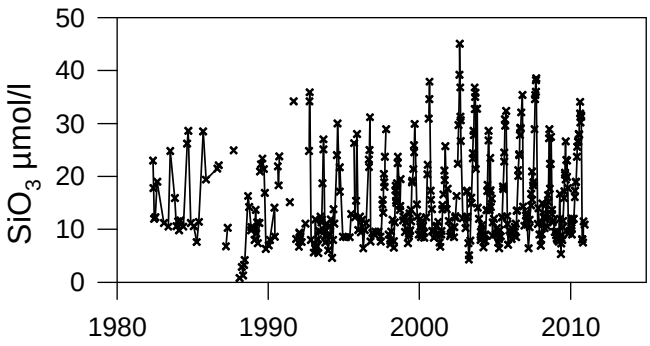


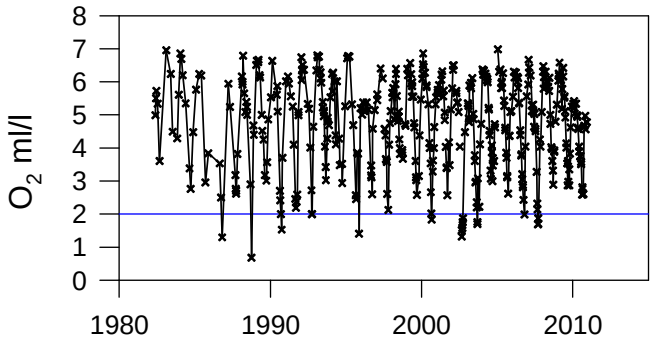






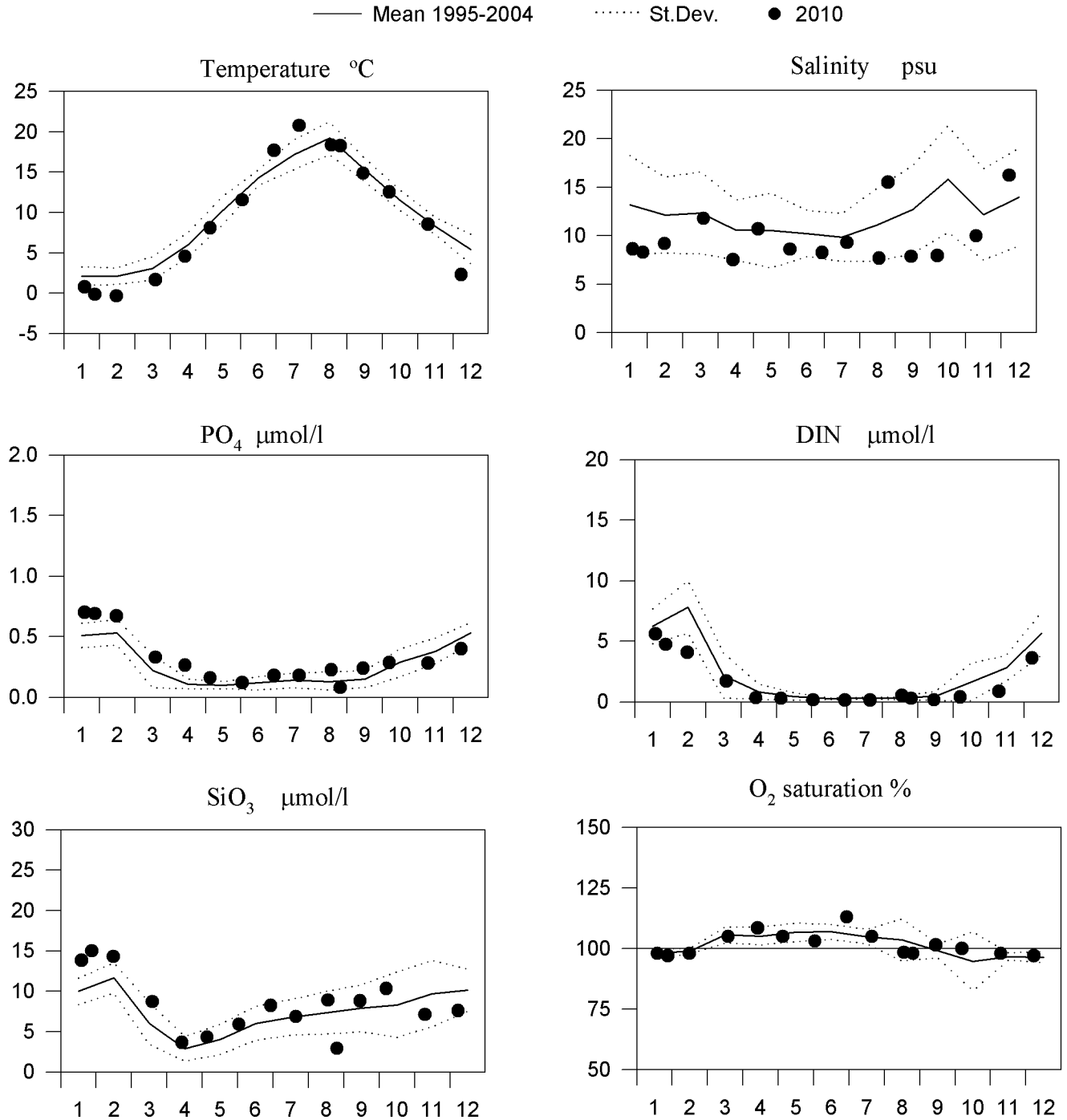




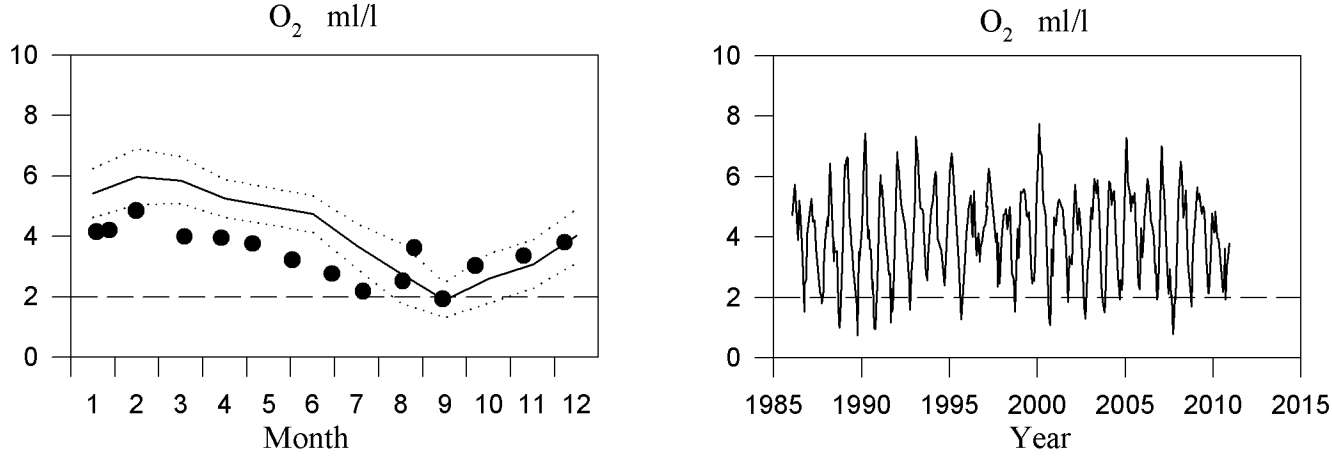


STATION W LANDSKRONA SURFACE WATER

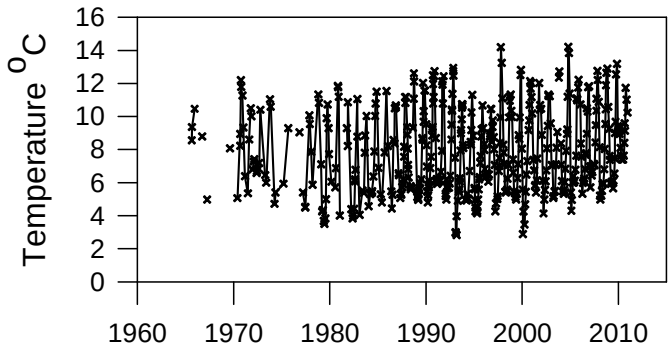
Annual Cycles

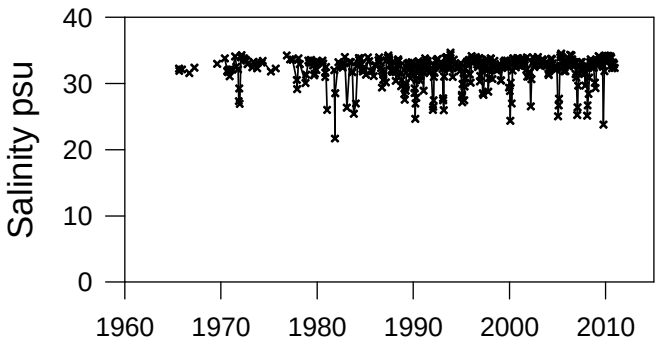


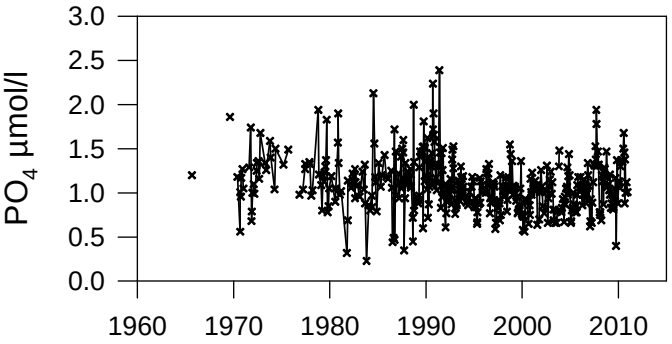
OXYGEN IN BOTTOM WATER

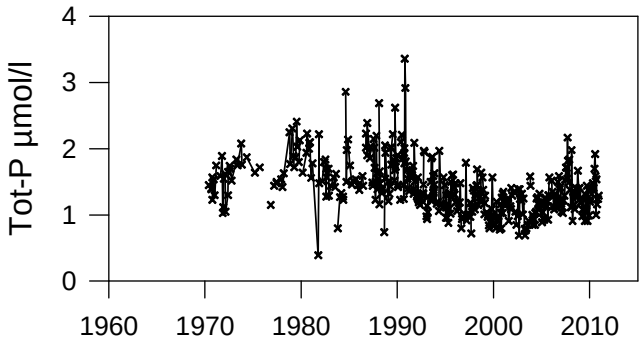


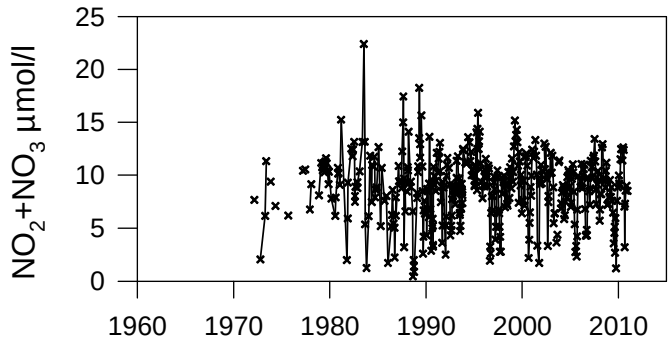
STATION W LANDSKRONA DEEP WATER (40m)

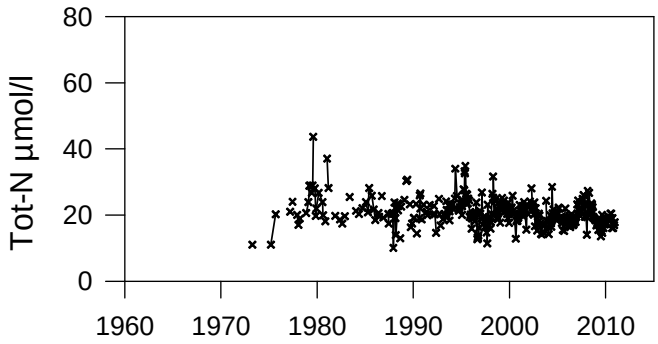


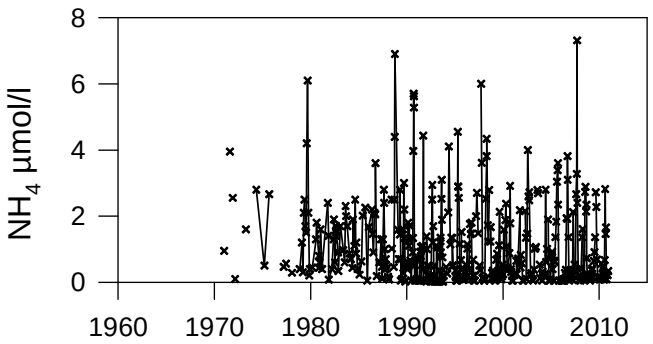


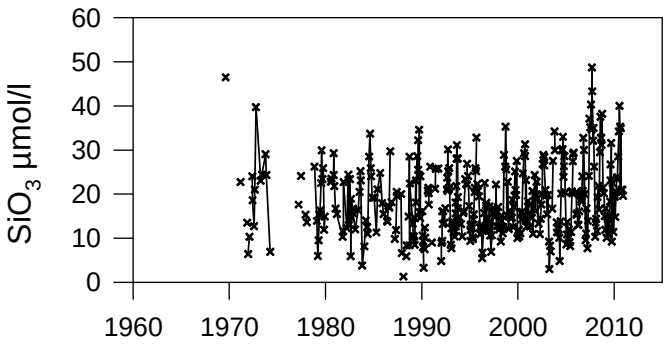


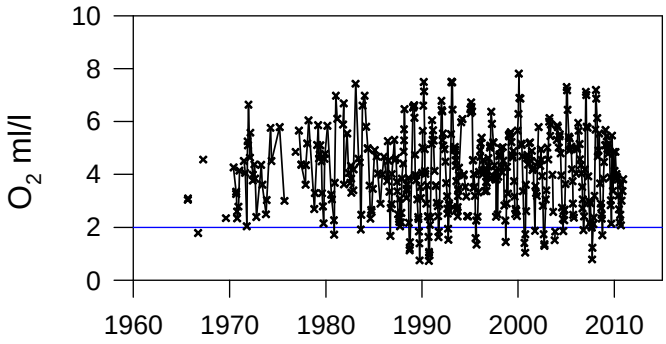








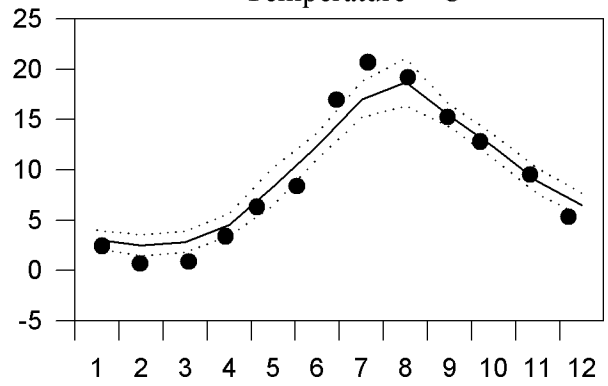




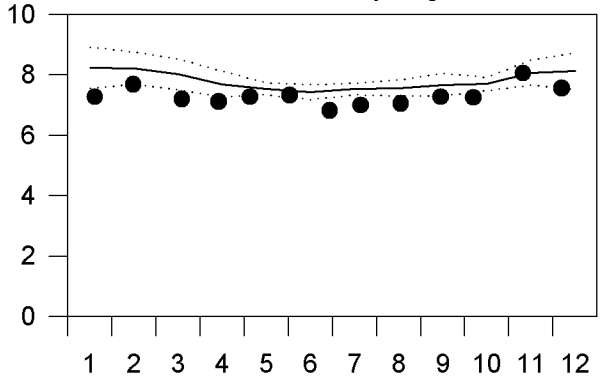
STATION BY1 SURFACE WATER

Annual Cycles

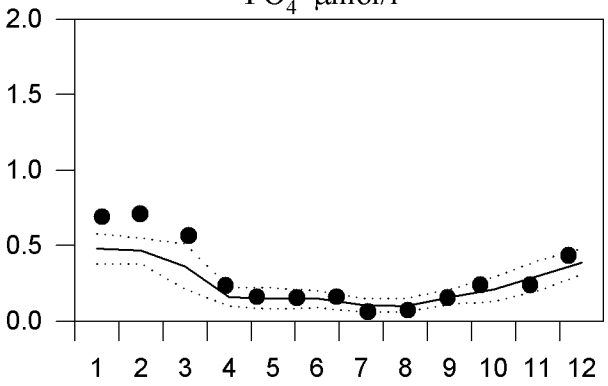
Temperature °C



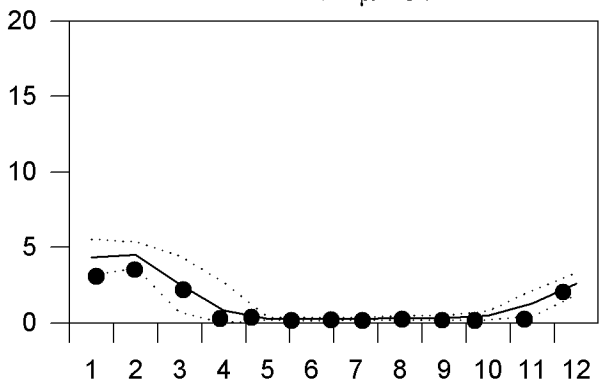
Salinity psu



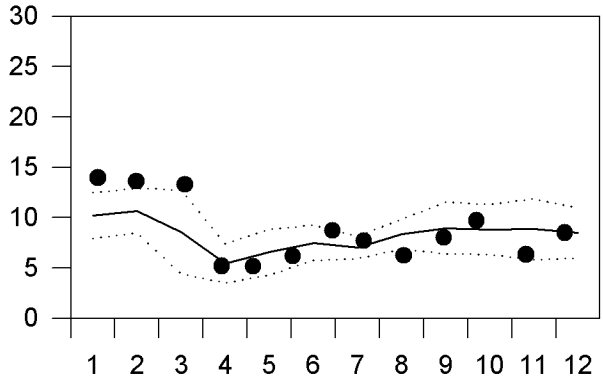
PO_4 µmol/l



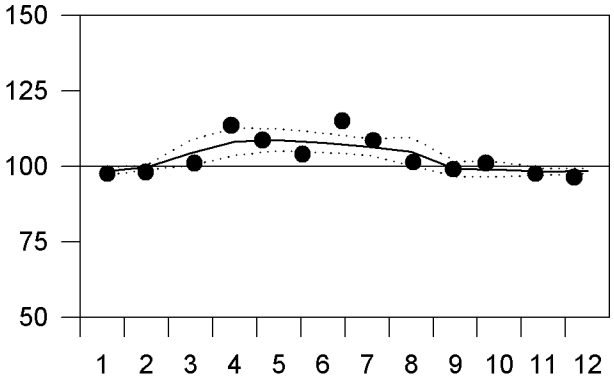
DIN µmol/l



SiO_3 µmol/l

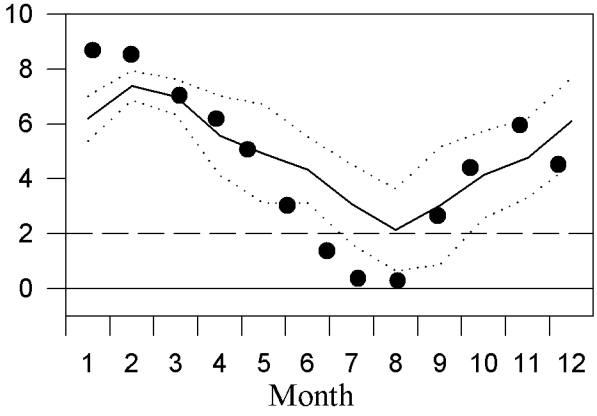


O_2 saturation %

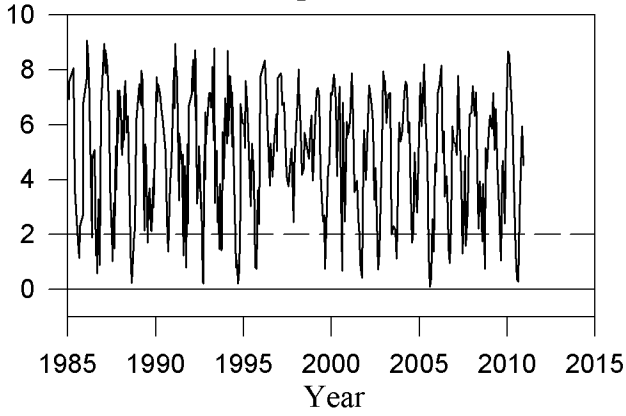


OXYGEN IN BOTTOM WATER

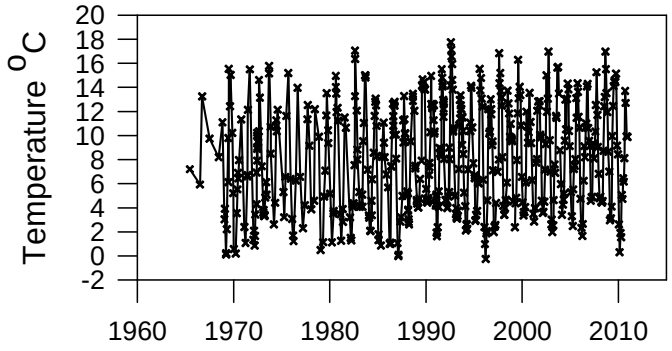
O_2 ml/l

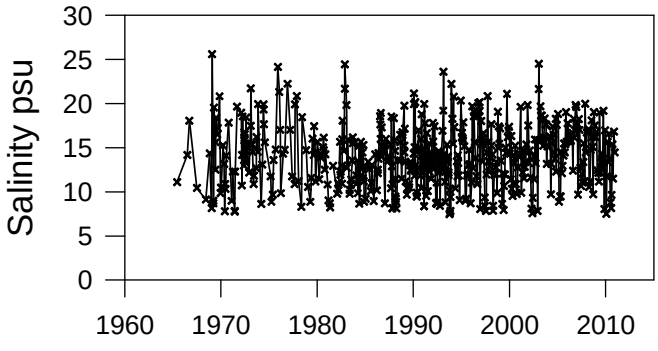


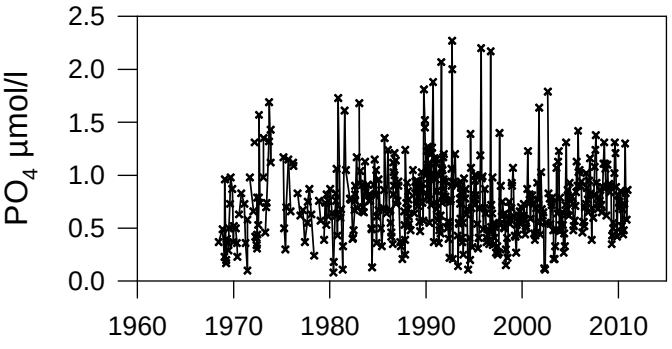
O_2 ml/l

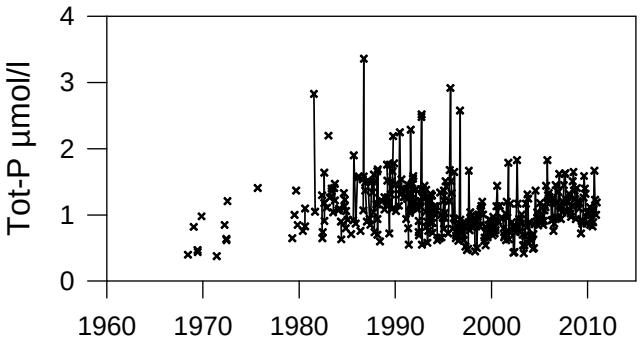


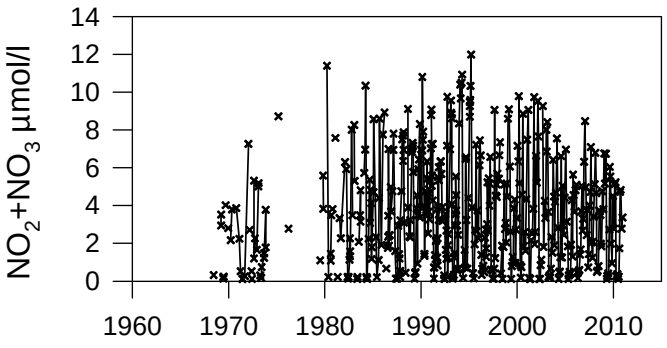
STATION BY1 DEEP WATER (40m)

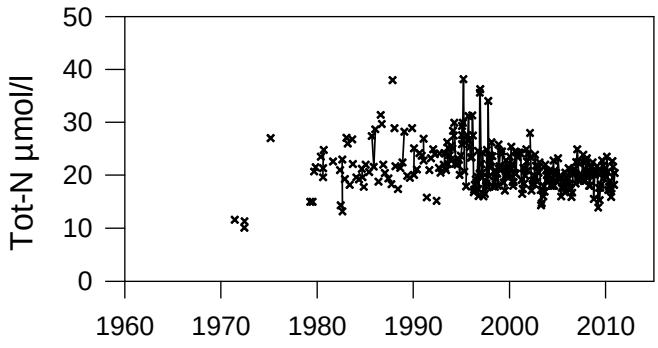


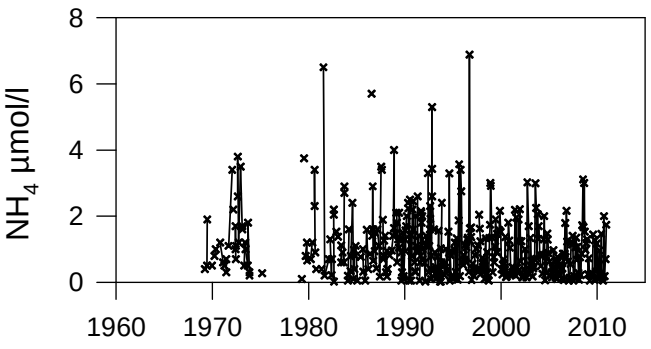


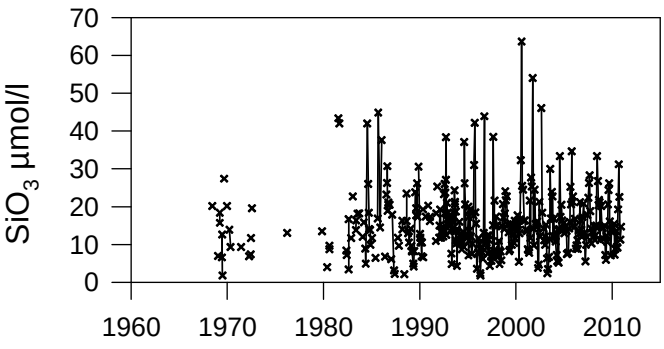


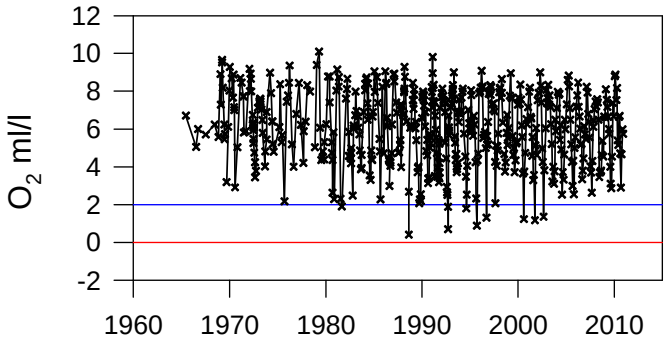








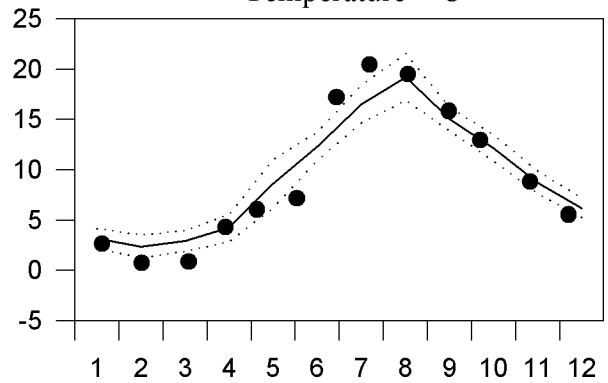




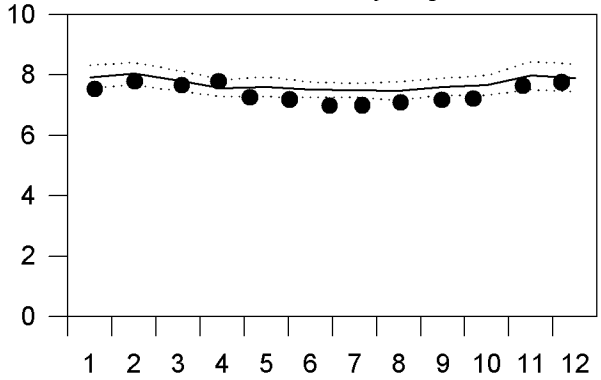
STATION BY2 SURFACE WATER

Annual Cycles

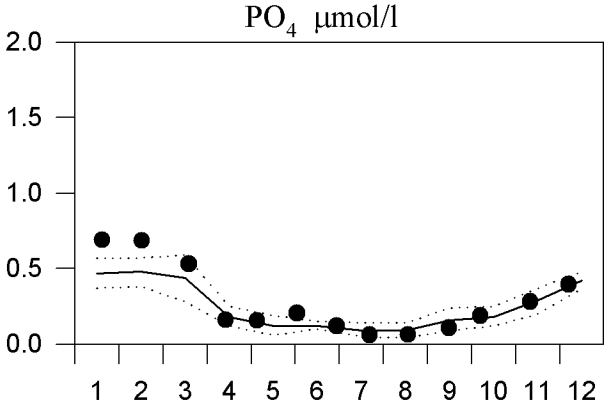
Temperature °C



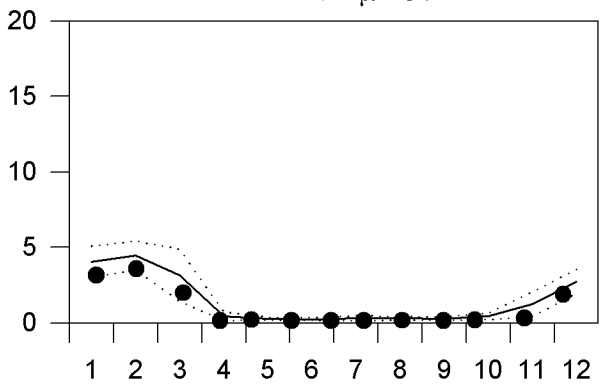
Salinity psu



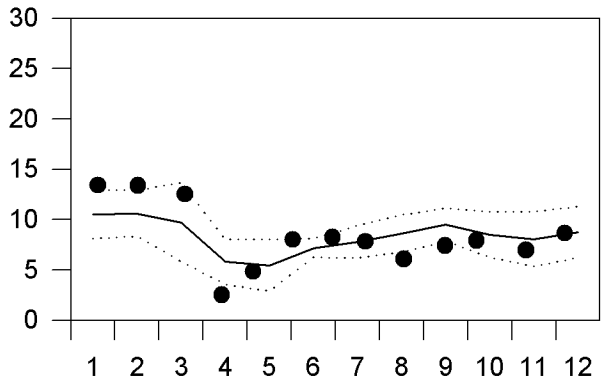
PO_4 µmol/l



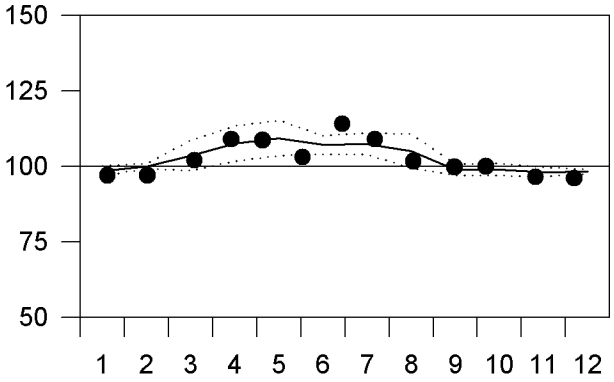
DIN µmol/l



SiO_3 µmol/l

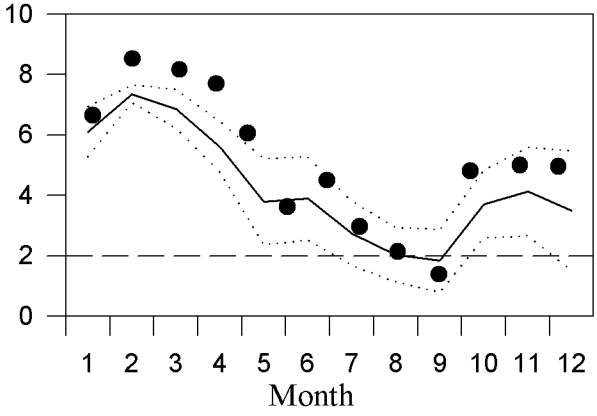


O_2 saturation %

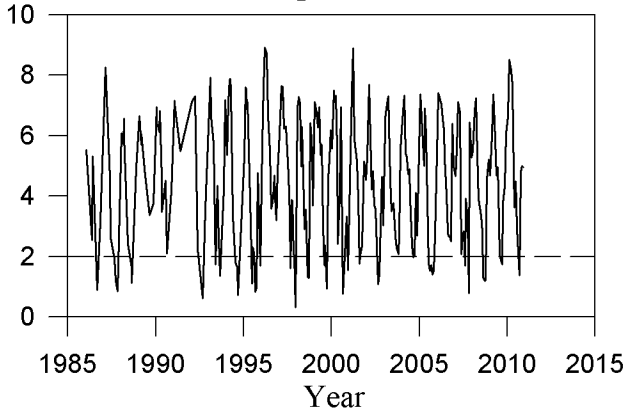


OXYGEN IN BOTTOM WATER

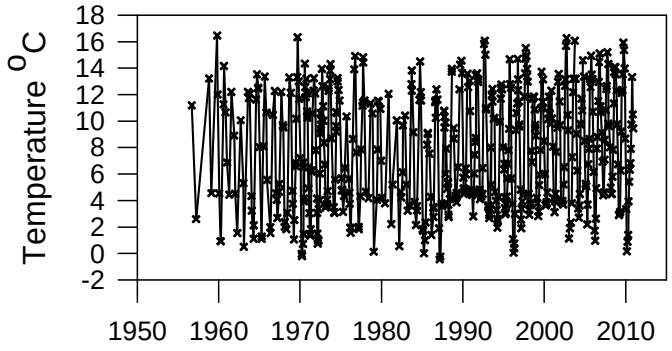
O_2 ml/l

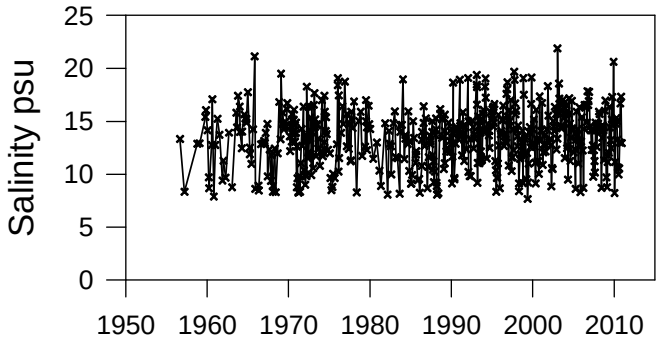


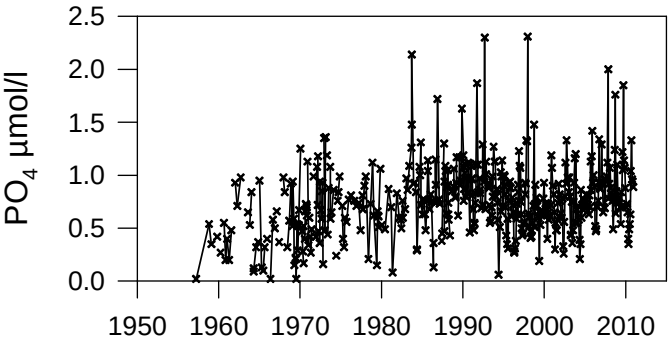
O_2 ml/l

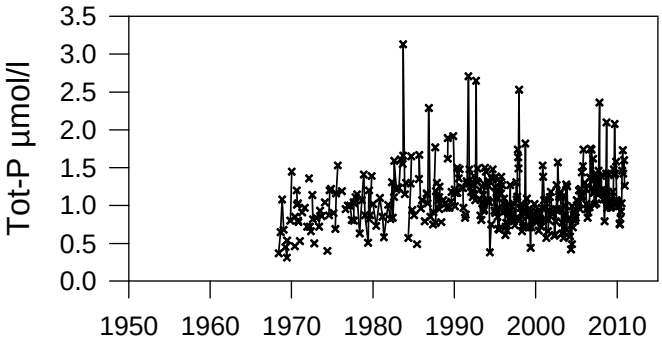


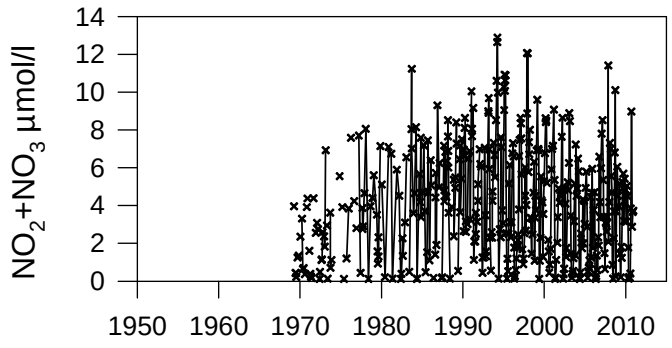
STATION BY2 DEEP WATER (40m)

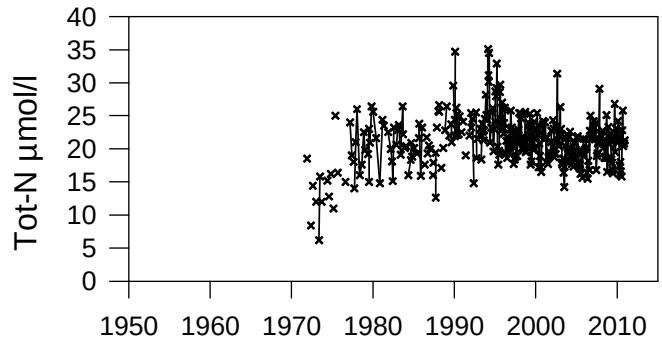


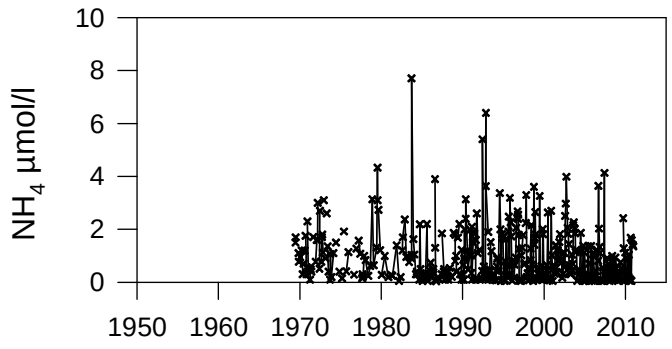


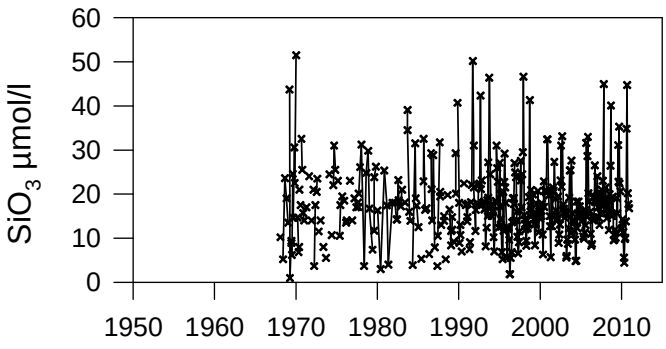


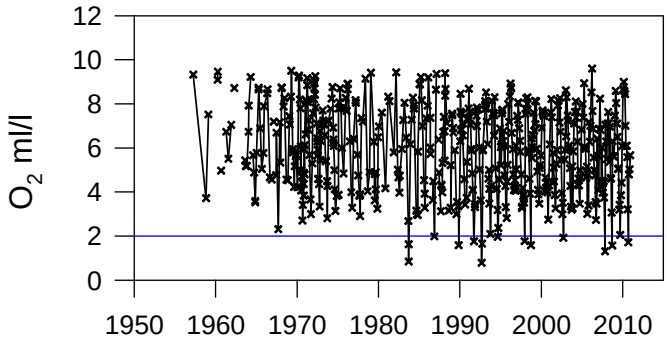










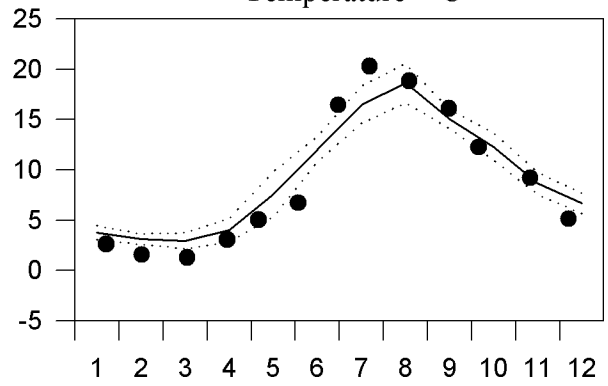


STATION BY4 SURFACE WATER

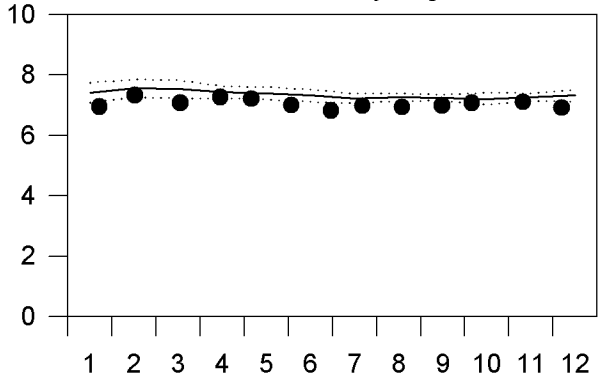
Annual Cycles

Mean 1995-2004 ····· St.Dev. ● 2010

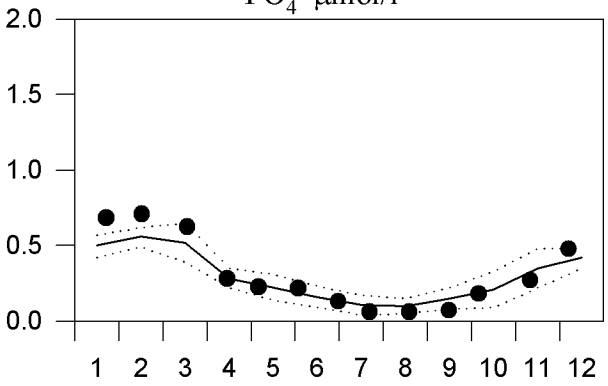
Temperature °C



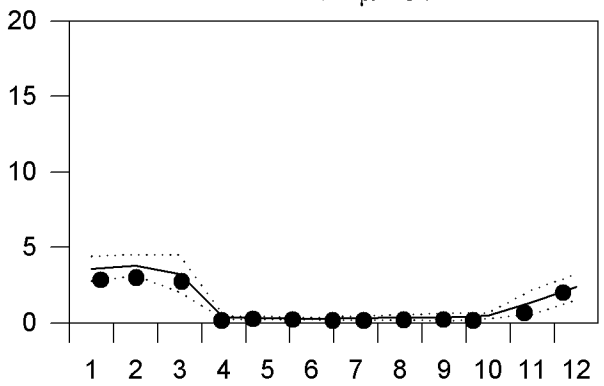
Salinity psu



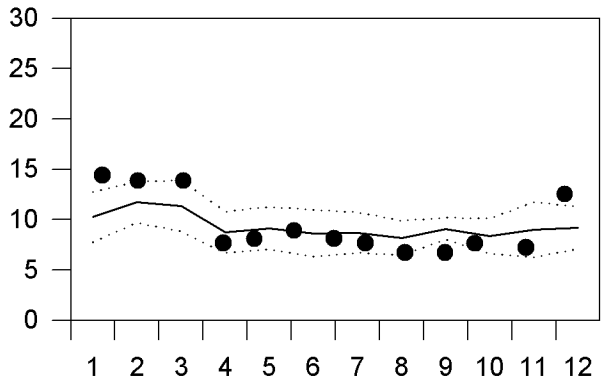
PO_4 µmol/l



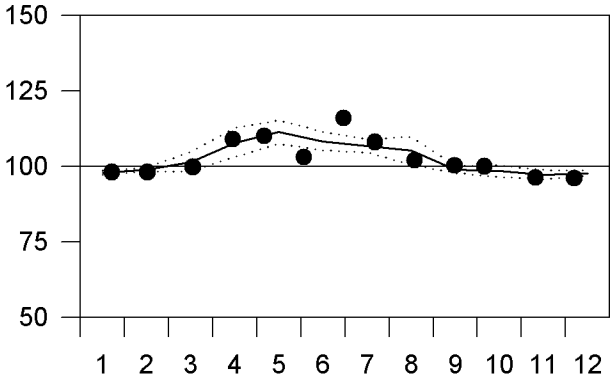
DIN µmol/l



SiO_3 µmol/l

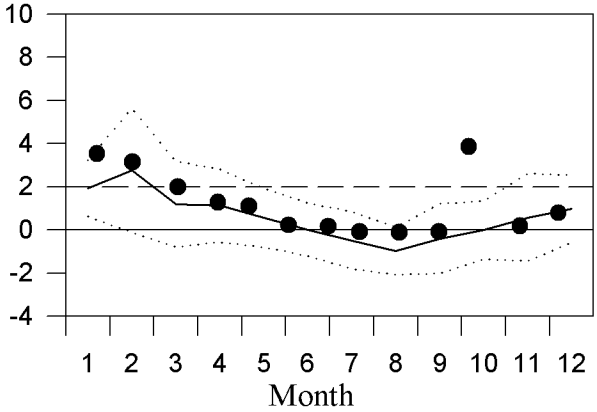


O_2 saturation %

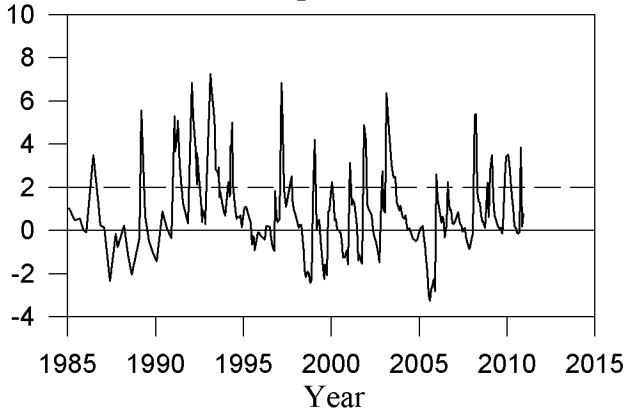


OXYGEN IN BOTTOM WATER

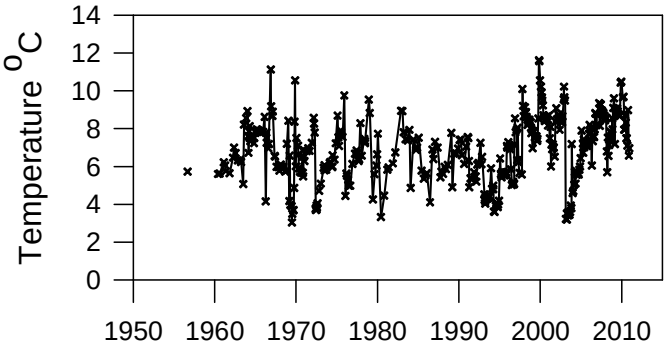
O_2 ml/l

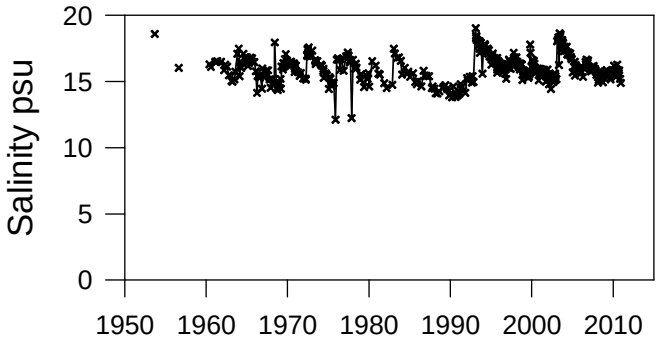


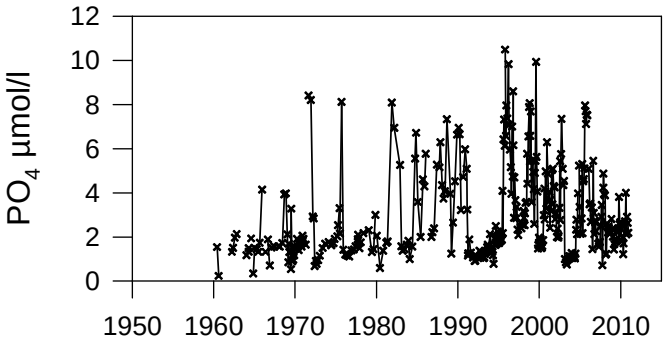
O_2 ml/l

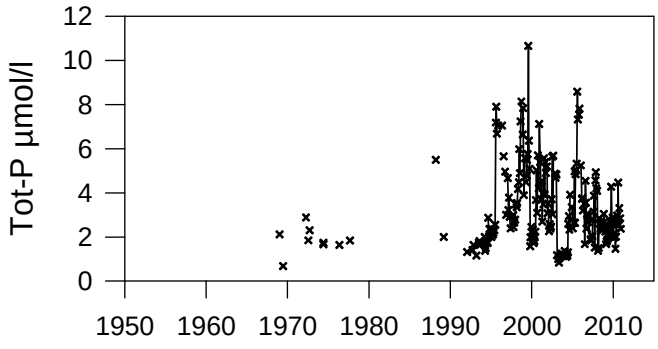


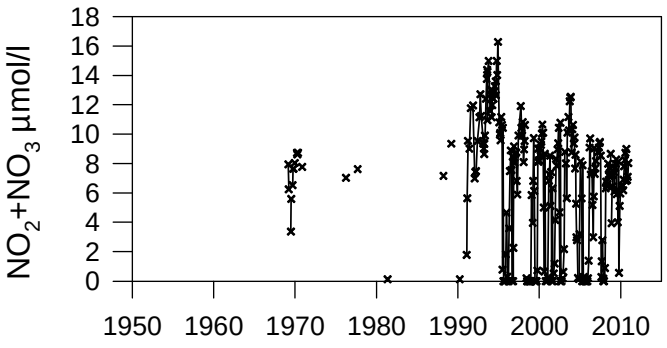
STATION BY4 DEEP WATER (80m)

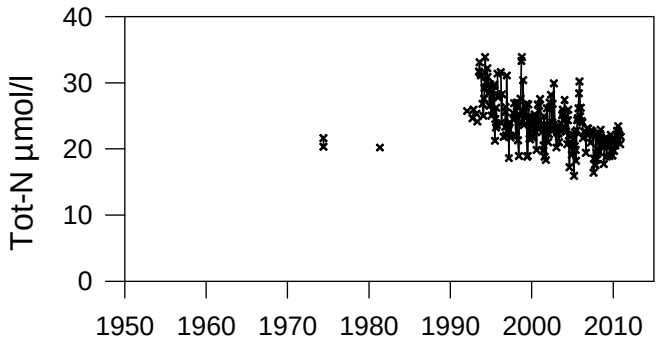


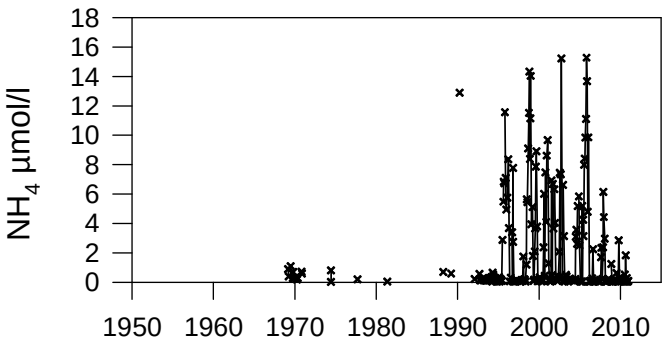


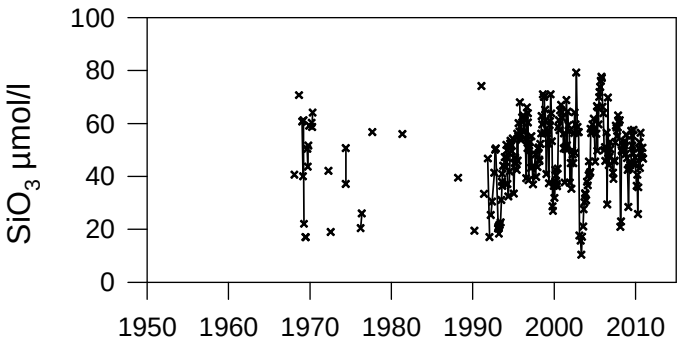


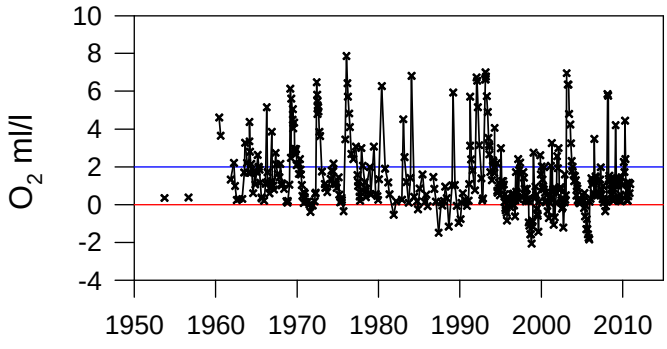










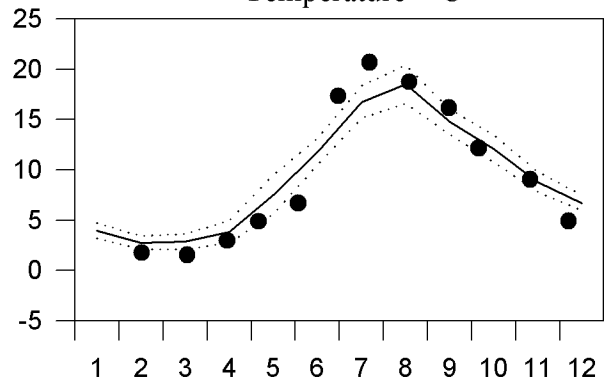


STATION BY5 SURFACE WATER

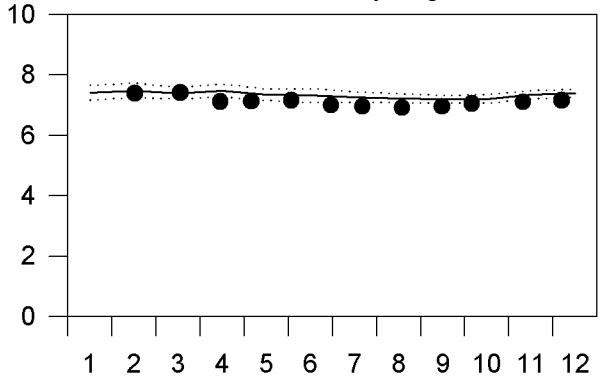
Annual Cycles

Mean 1995-2004 ····· St.Dev. ● 2010

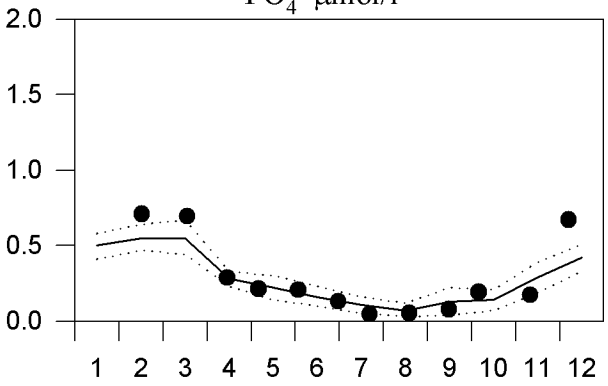
Temperature °C



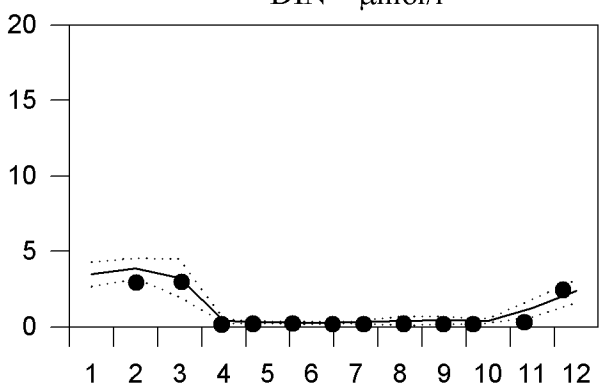
Salinity psu



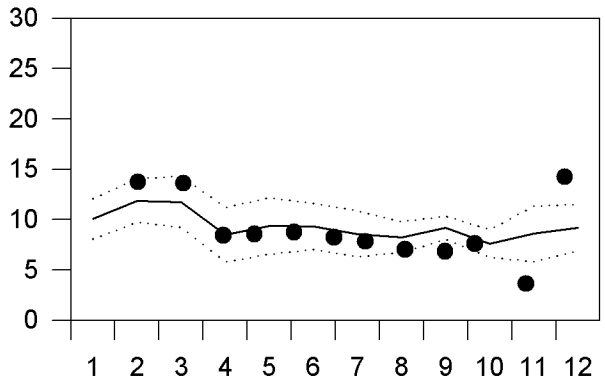
PO_4 µmol/l



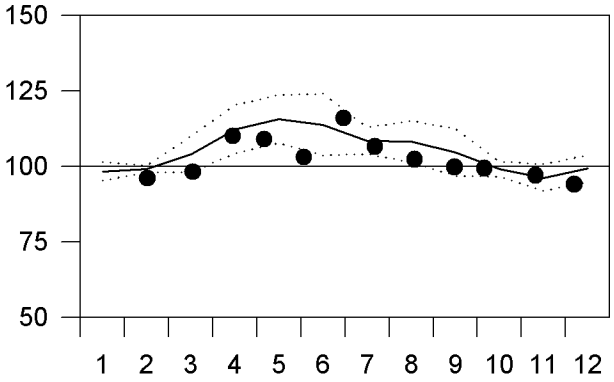
DIN µmol/l



SiO_3 µmol/l

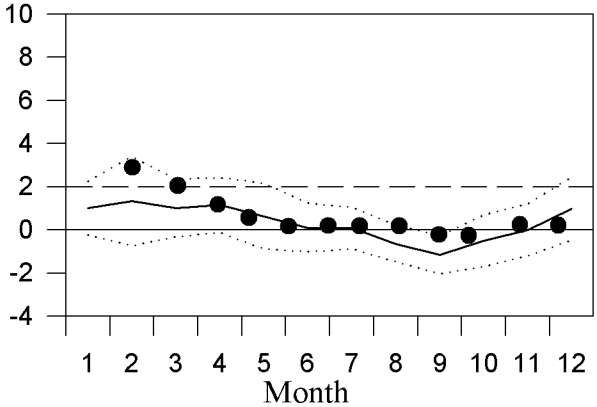


O_2 saturation %

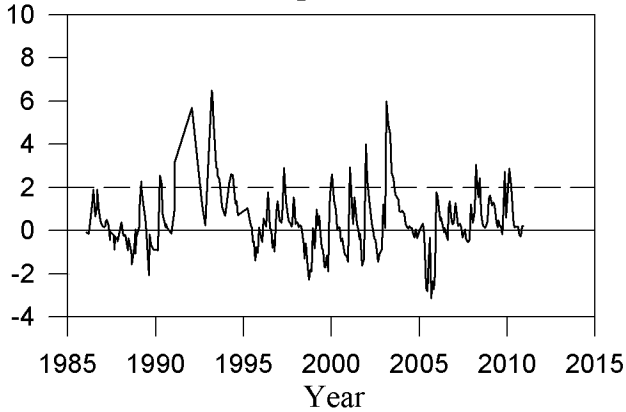


OXYGEN IN BOTTOM WATER

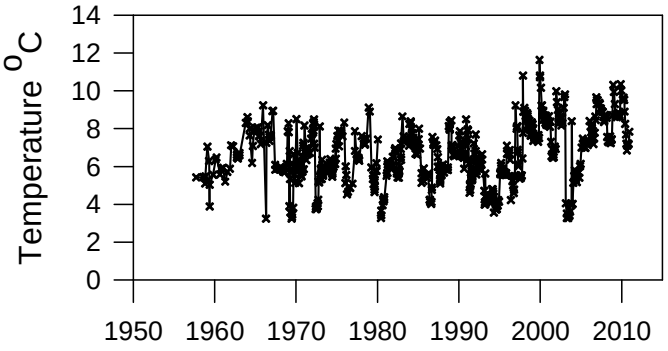
O_2 ml/l

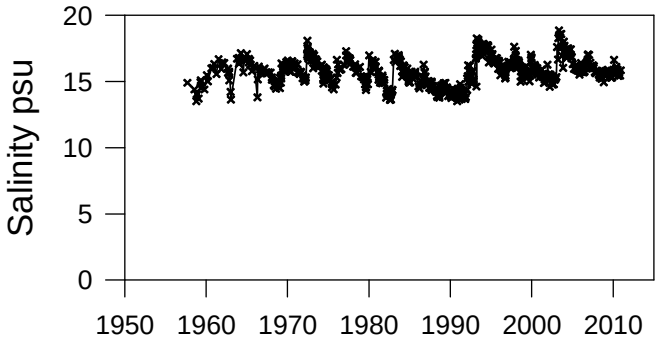


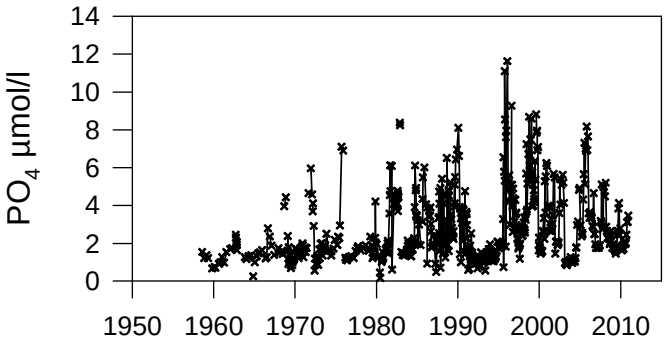
O_2 ml/l

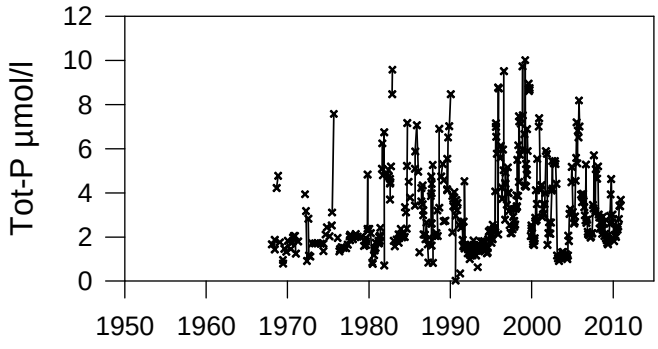


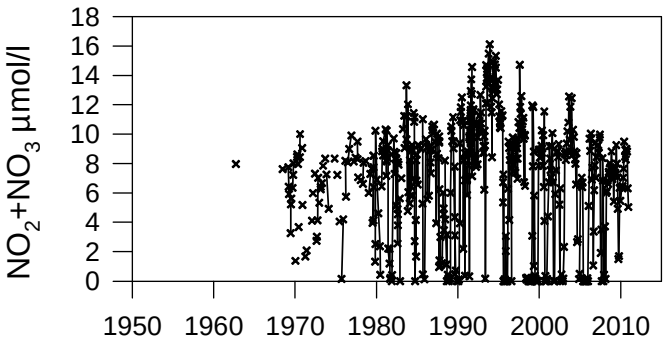
STATION BY5 DEEP WATER (80m)

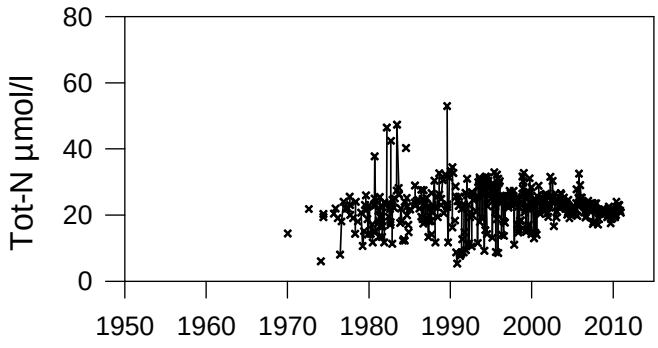


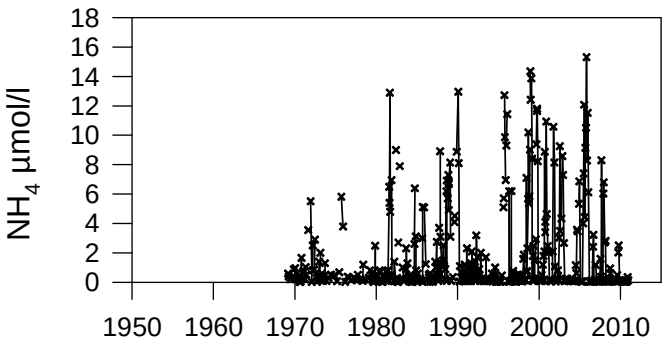


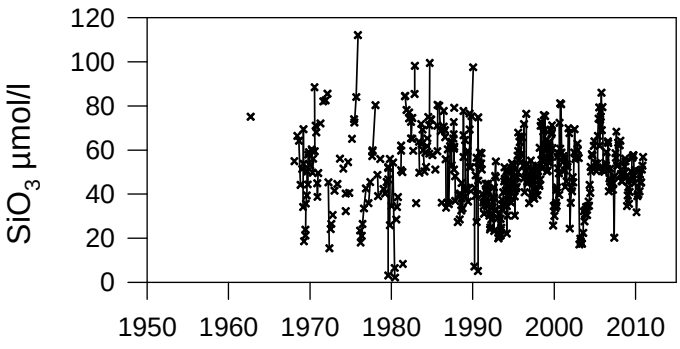


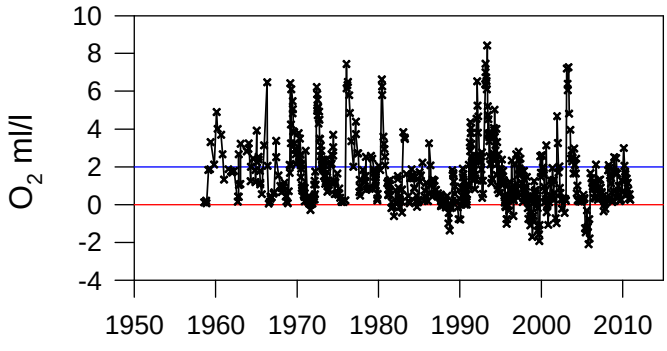






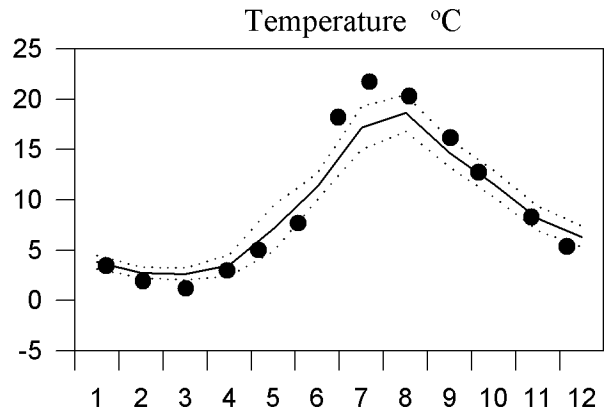


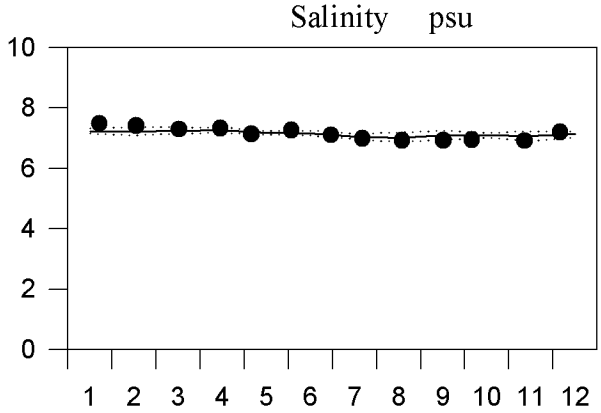


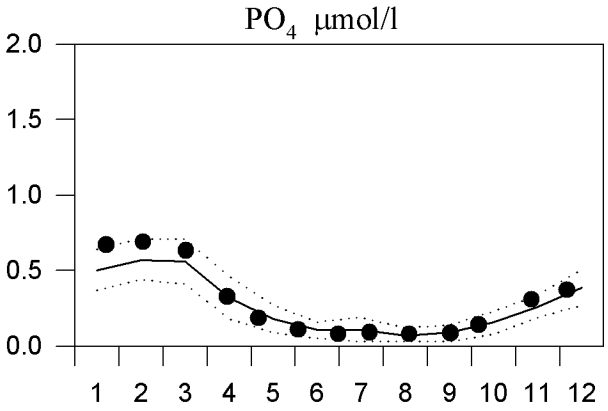


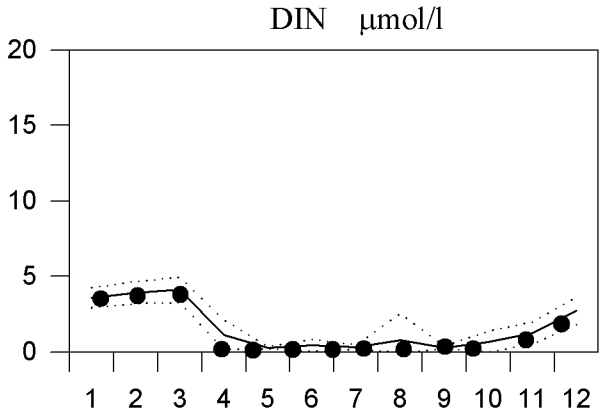
STATION BCS III-10 SURFACE WATER

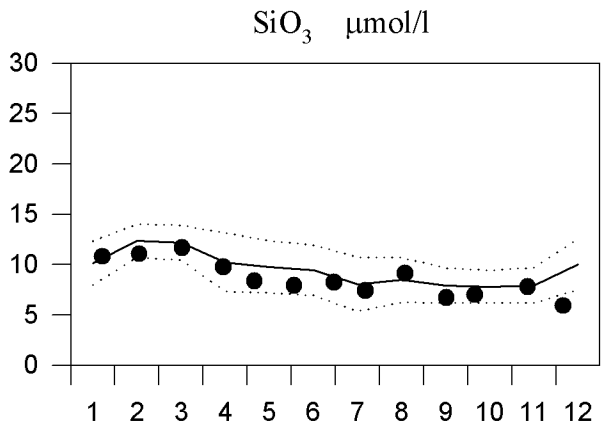
Annual Cycles

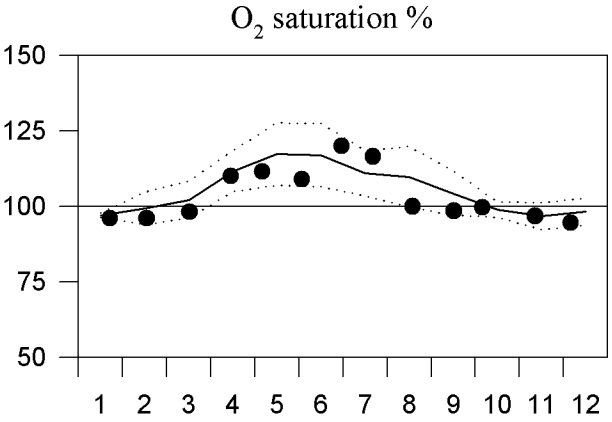




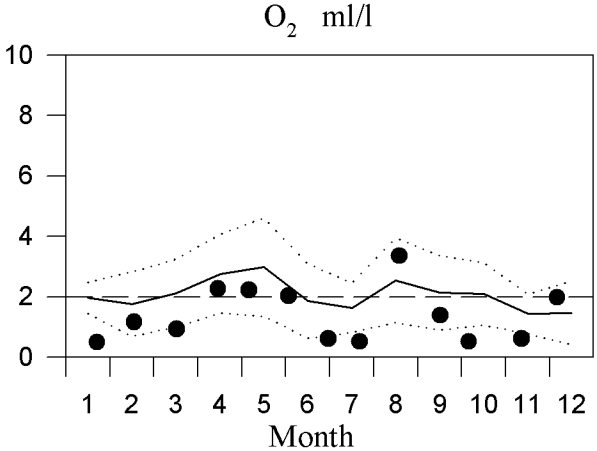


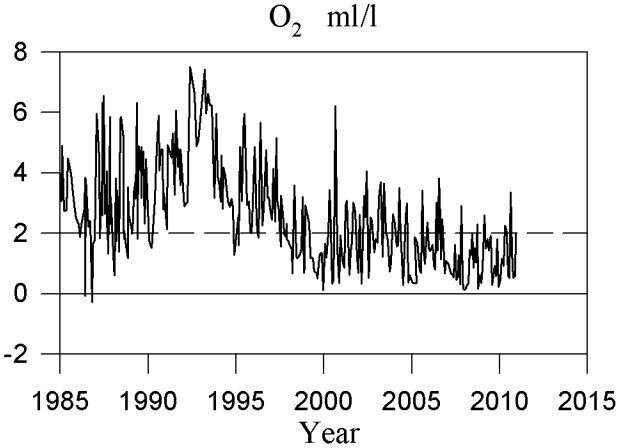




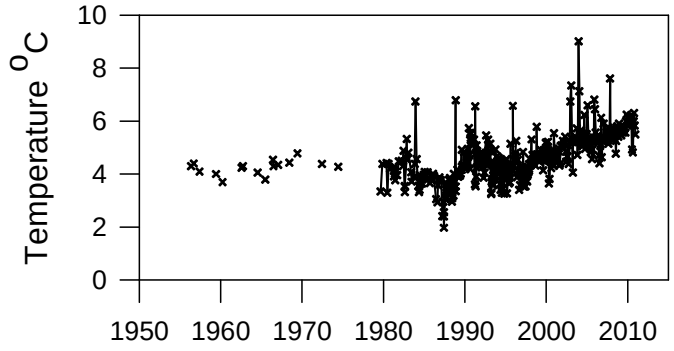


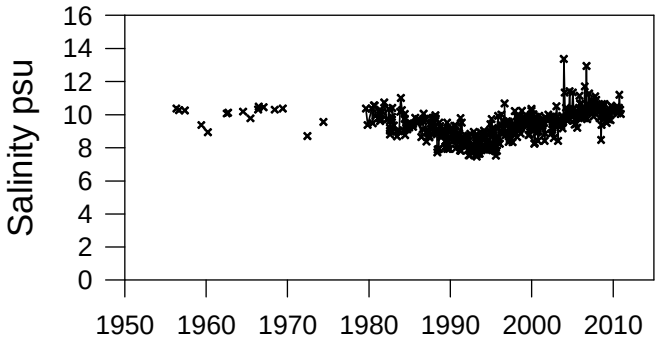
OXYGEN IN BOTTOM WATER

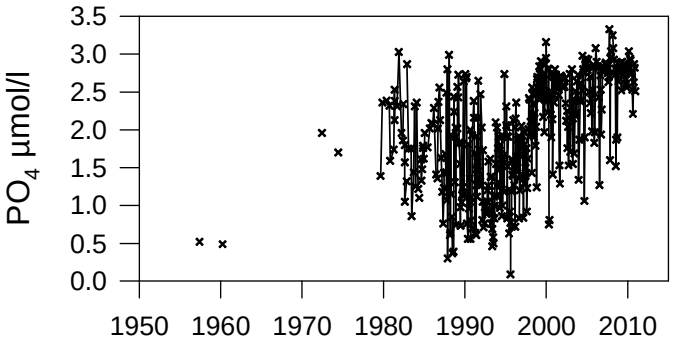


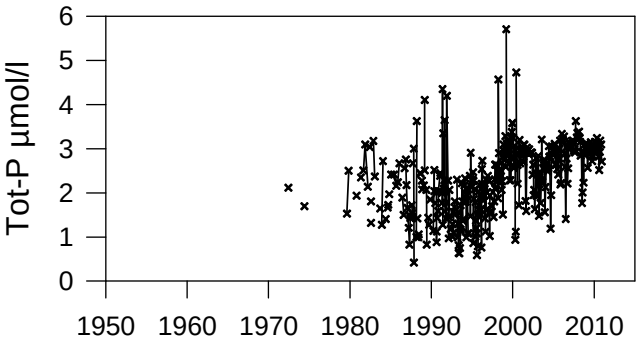


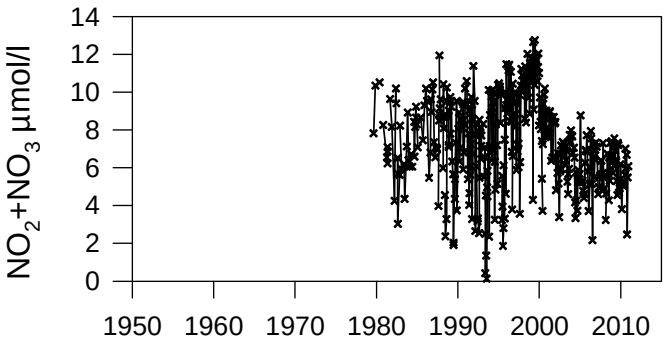
STATION BCS III-10 DEEP WATER (80m)

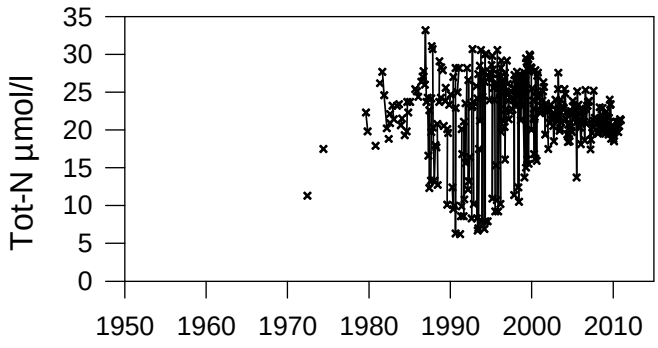


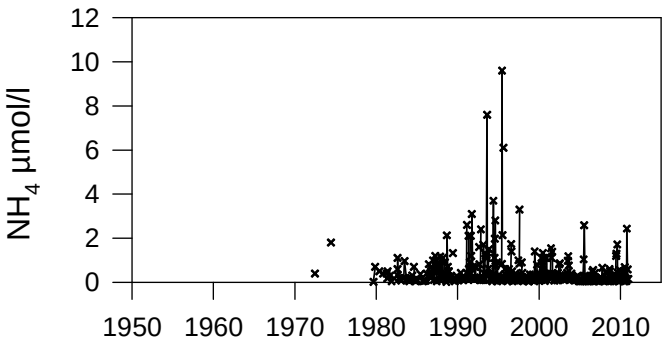


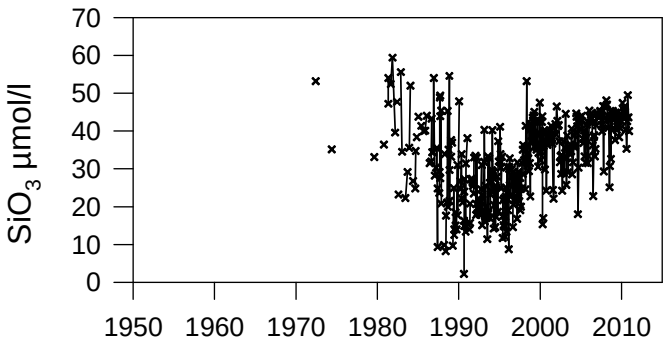


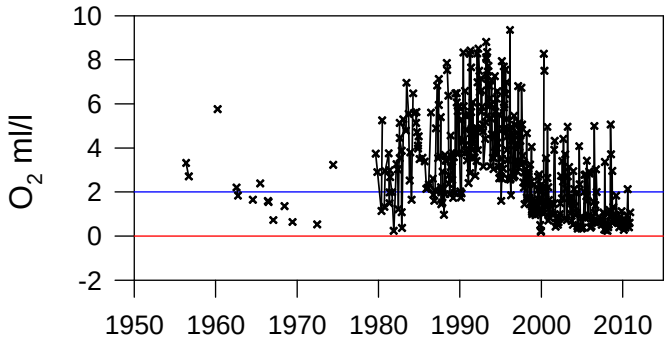






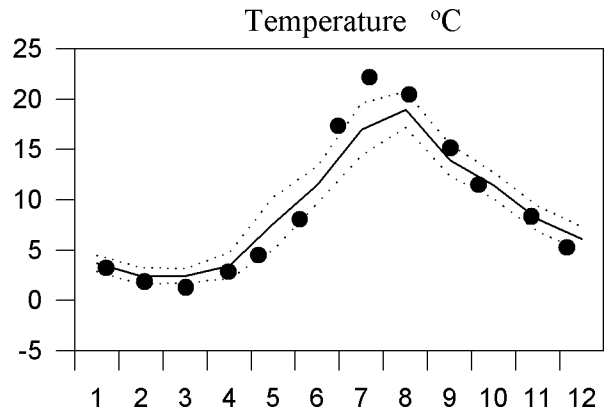


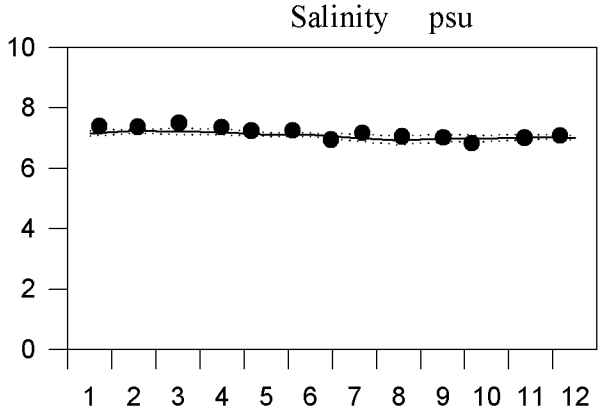


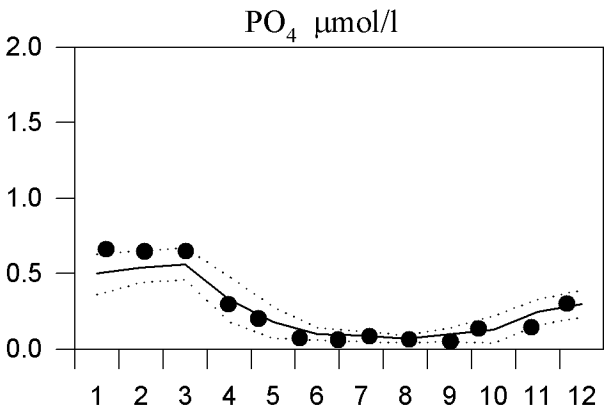


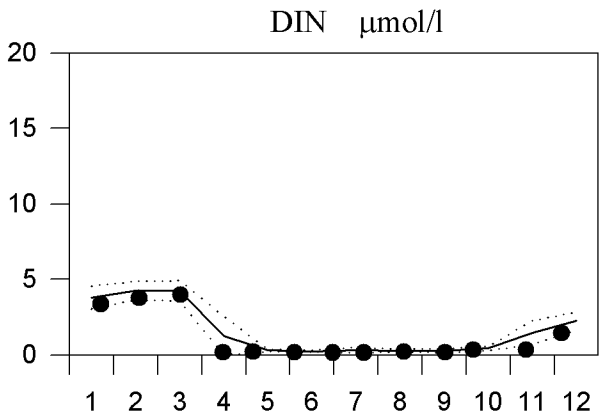
STATION BY10 SURFACE WATER

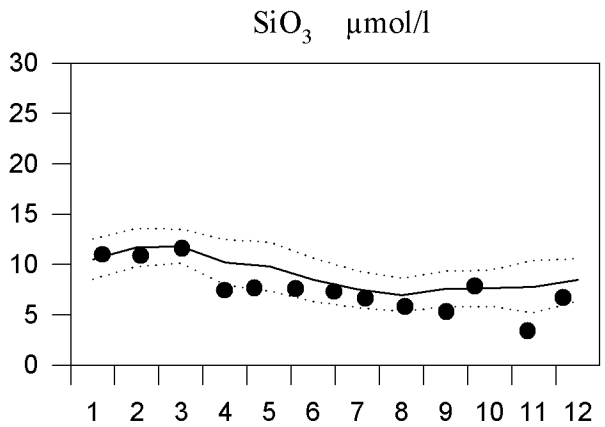
Annual Cycles

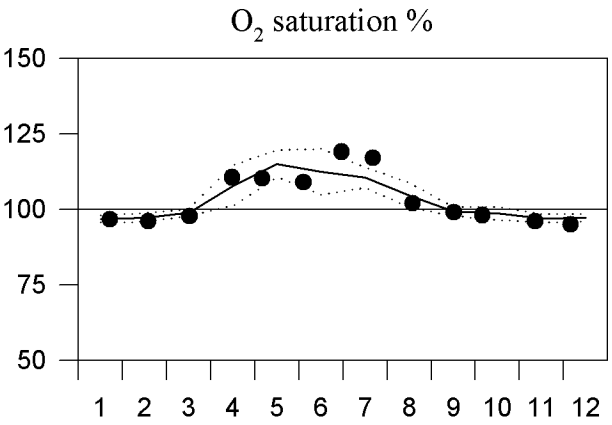




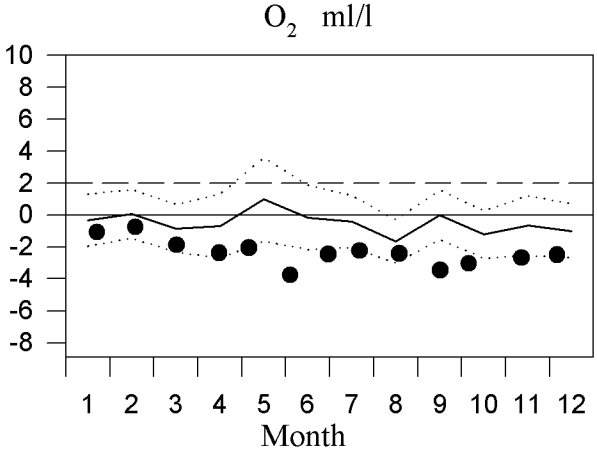


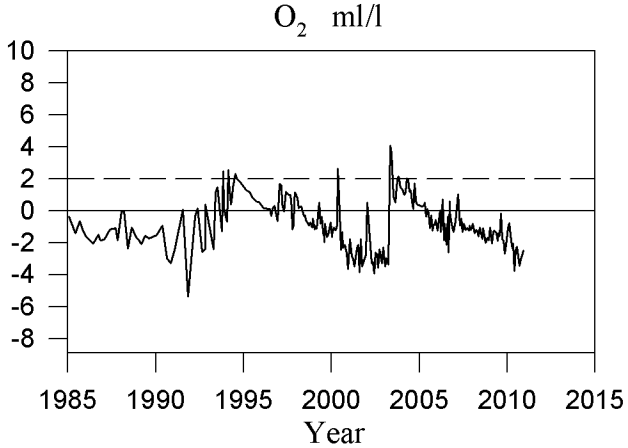




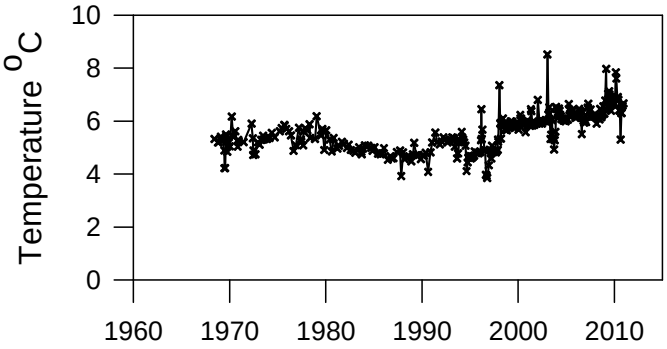


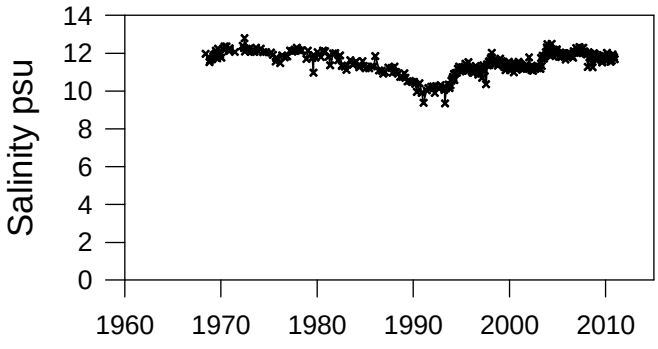
OXYGEN IN BOTTOM WATER

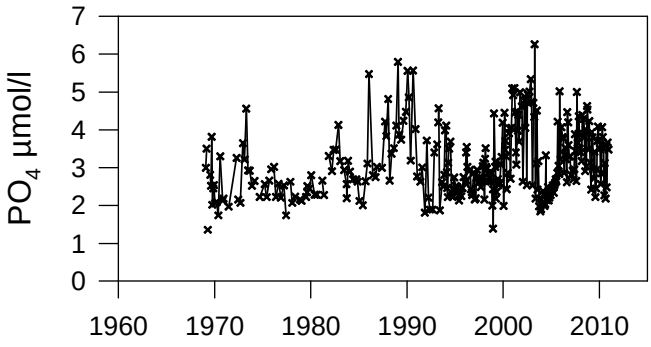


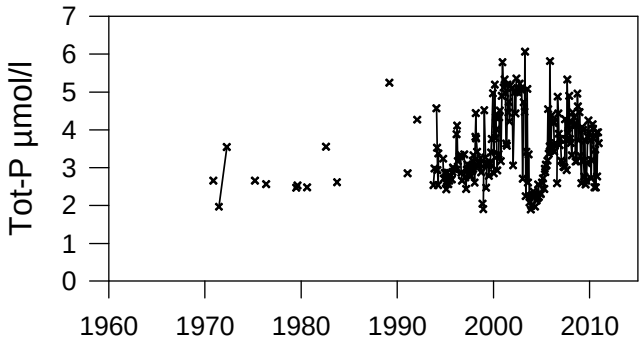


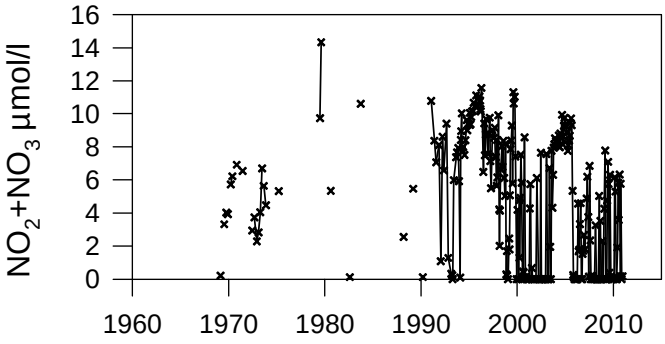
STATION BY10 DEEP WATER (125m)

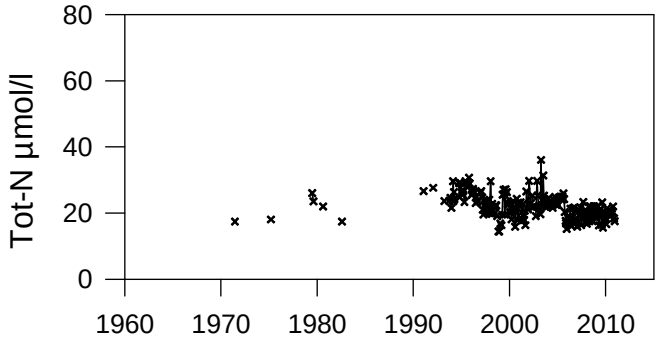


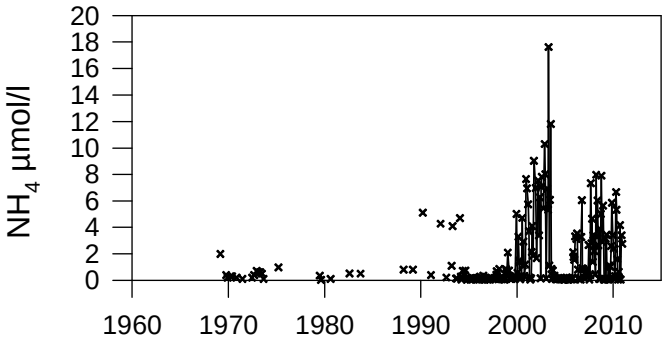


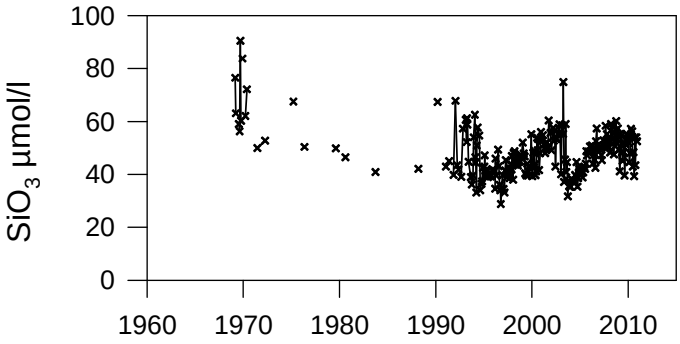


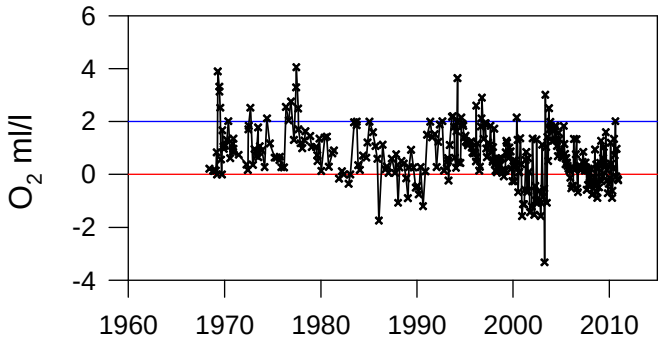








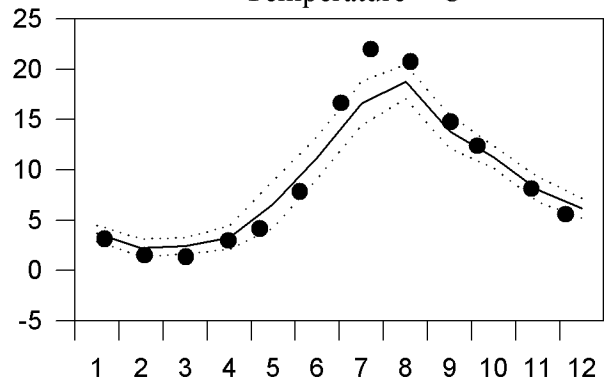




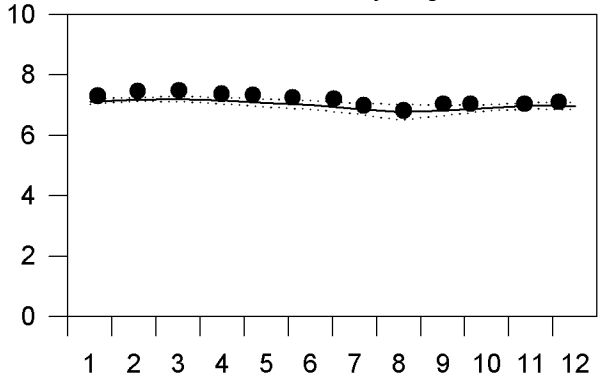
STATION BY15 SURFACE WATER

Annual Cycles

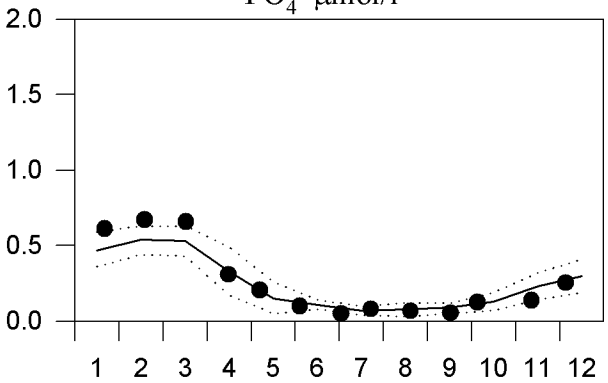
Temperature °C



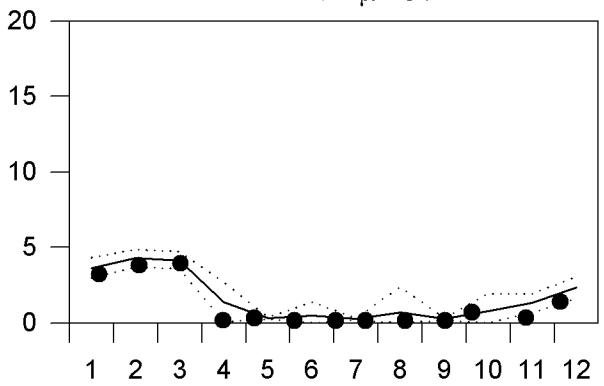
Salinity psu



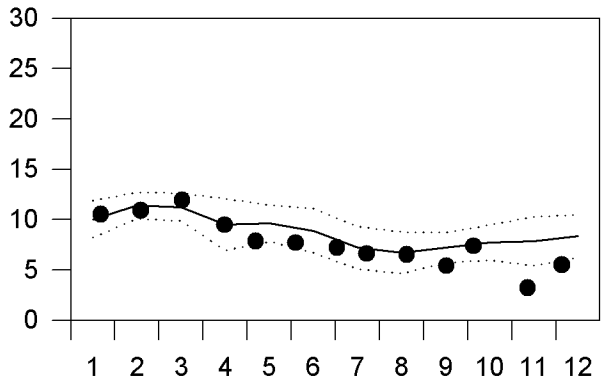
PO_4 µmol/l



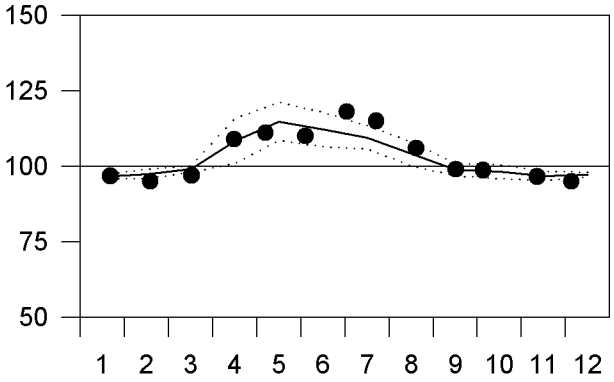
DIN µmol/l



SiO_3 µmol/l

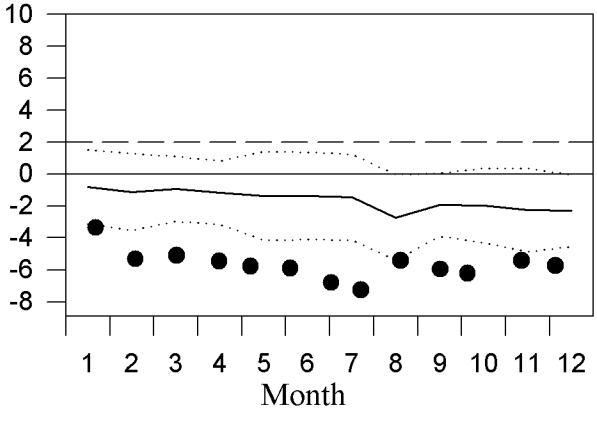


O_2 saturation %

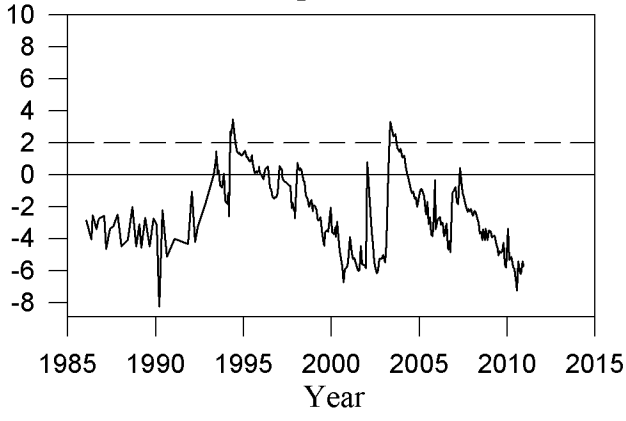


OXYGEN IN BOTTOM WATER

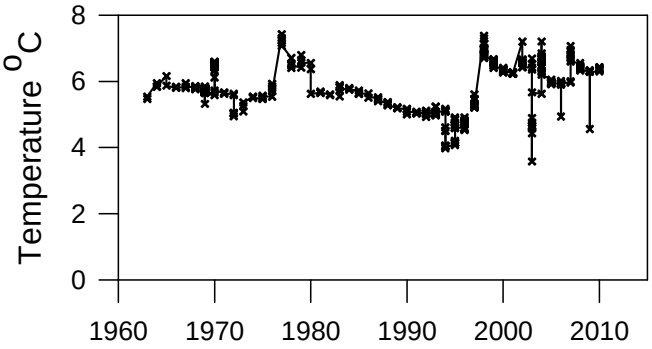
O_2 ml/l

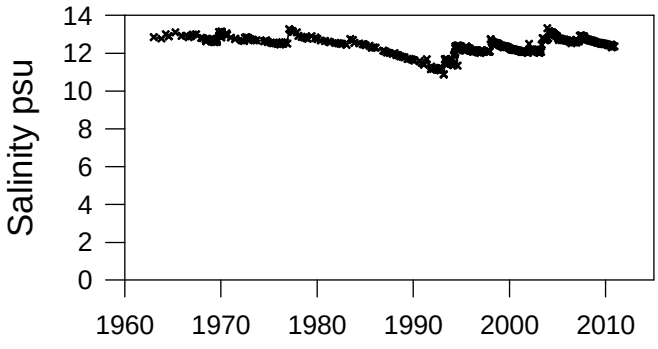


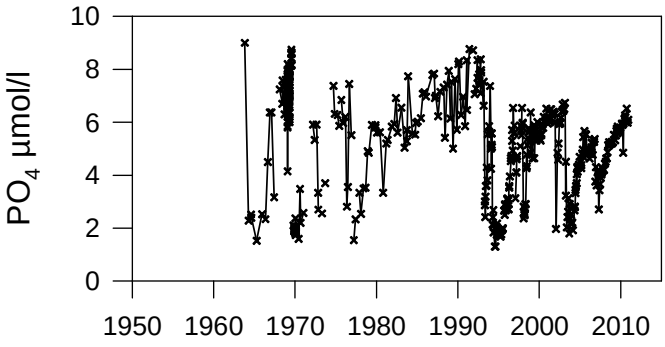
O_2 ml/l

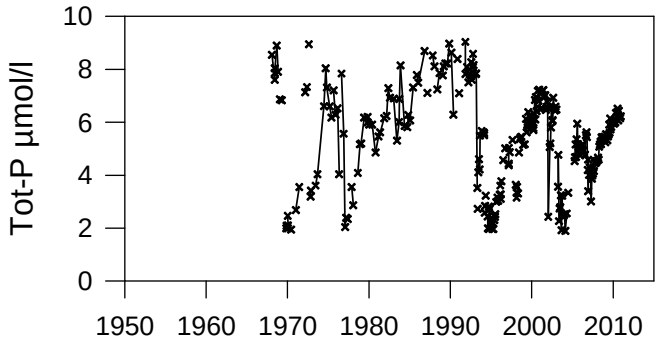


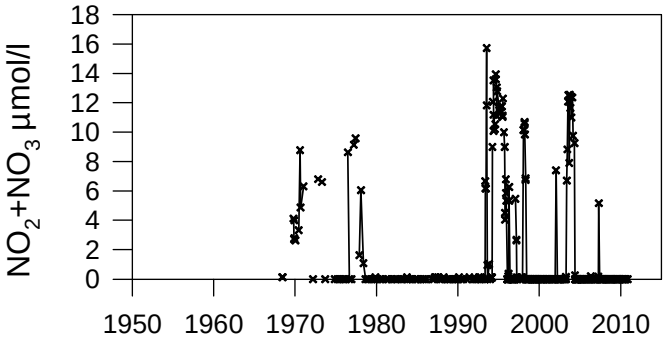
STATION BY15 DEEP WATER (240m)

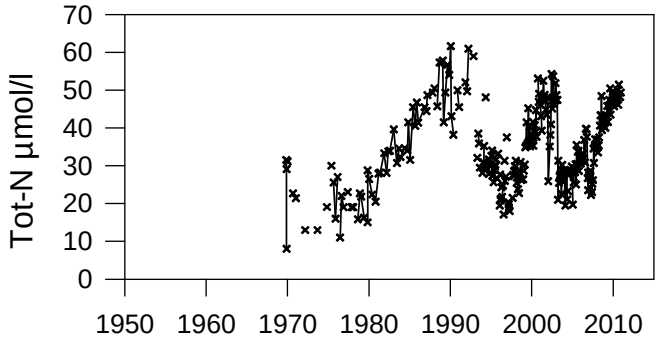


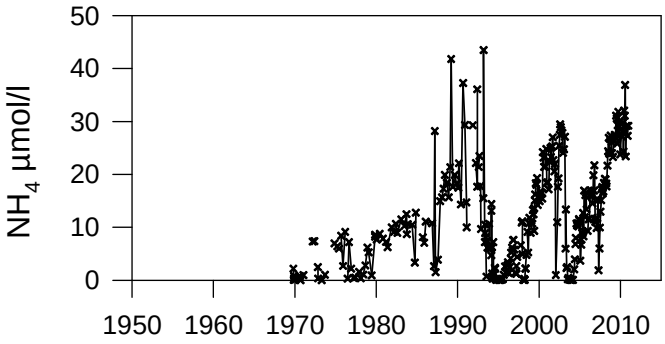


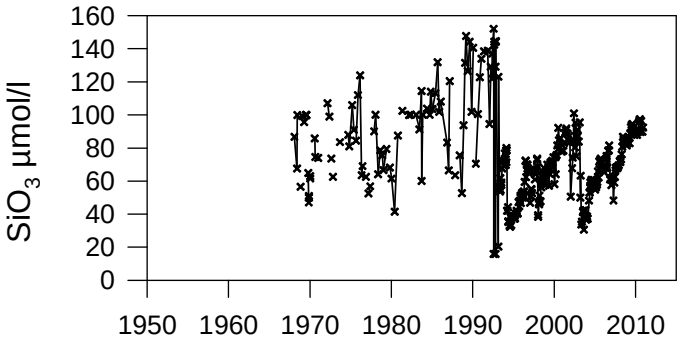


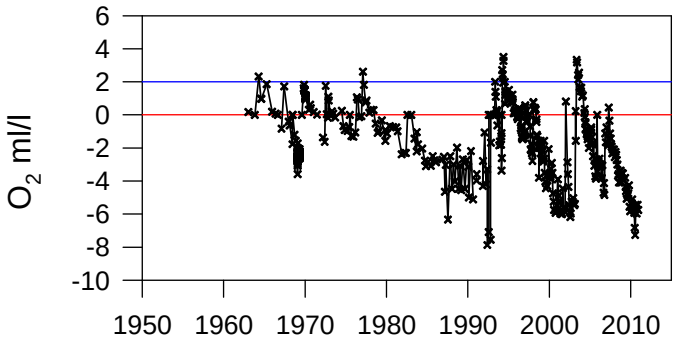








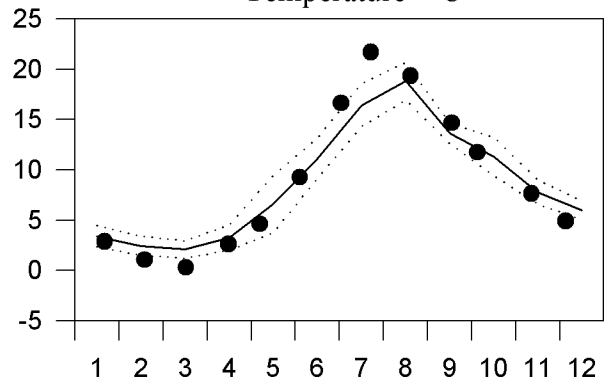




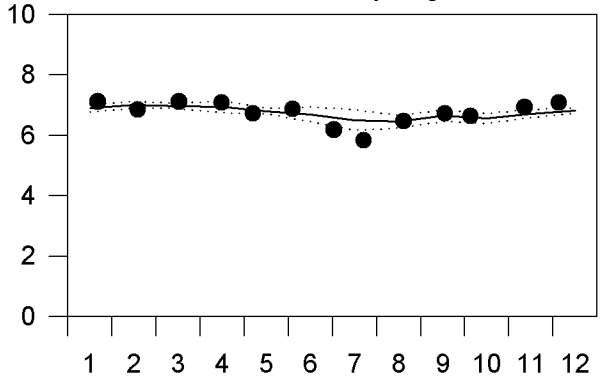
STATION BY20 SURFACE WATER

Annual Cycles

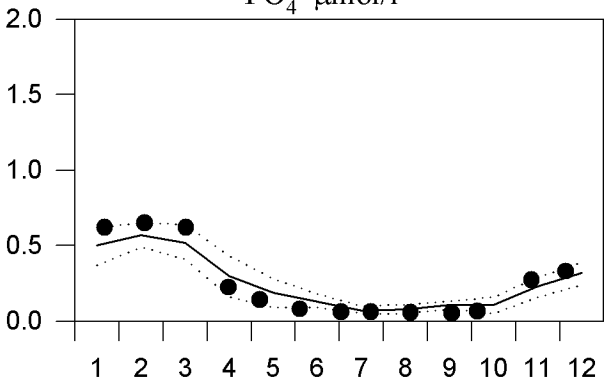
Temperature °C



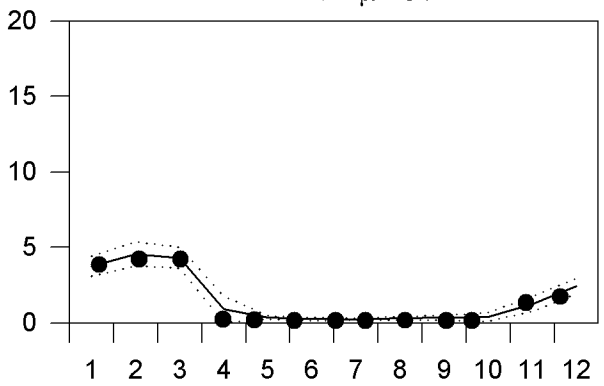
Salinity psu



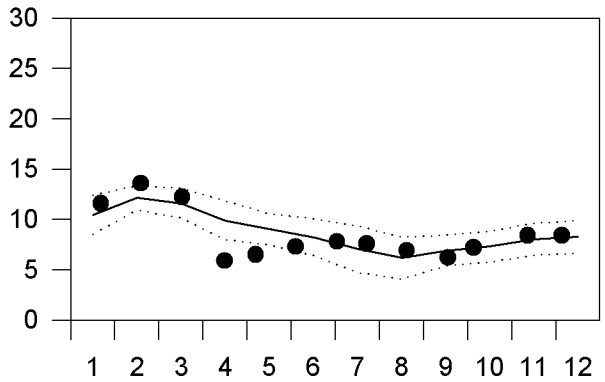
PO_4 µmol/l



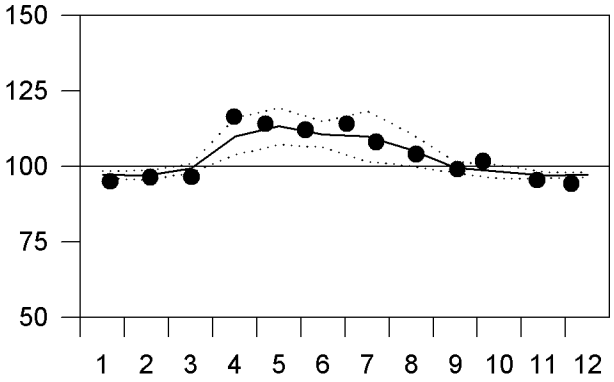
DIN µmol/l



SiO_3 µmol/l

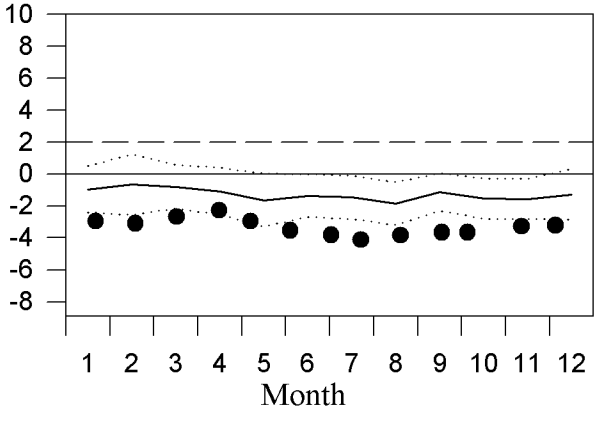


O_2 saturation %

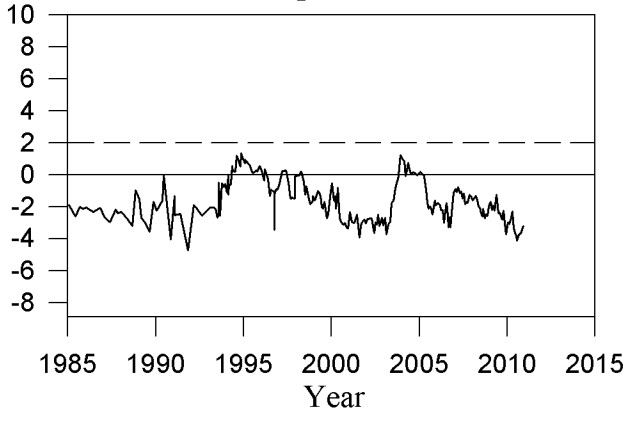


OXYGEN IN BOTTOM WATER

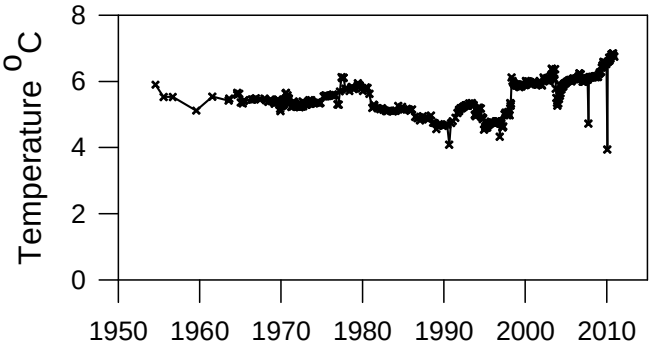
O_2 ml/l

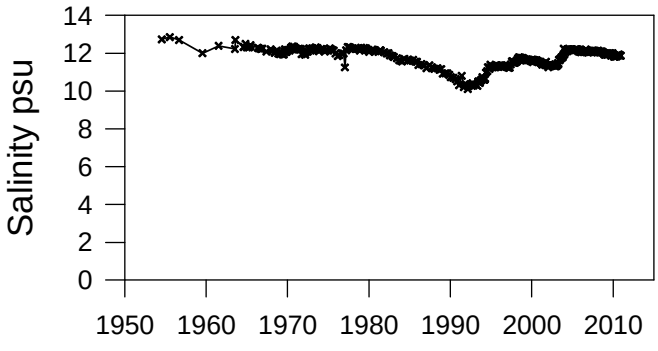


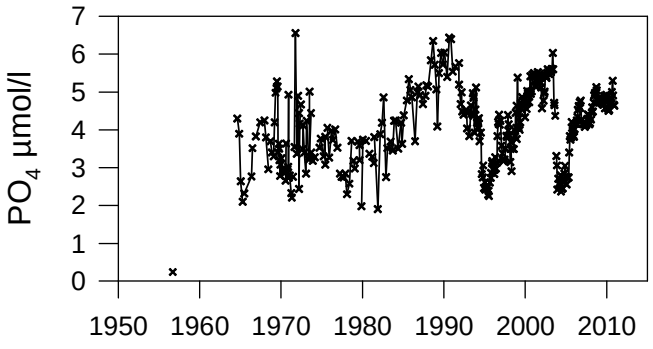
O_2 ml/l

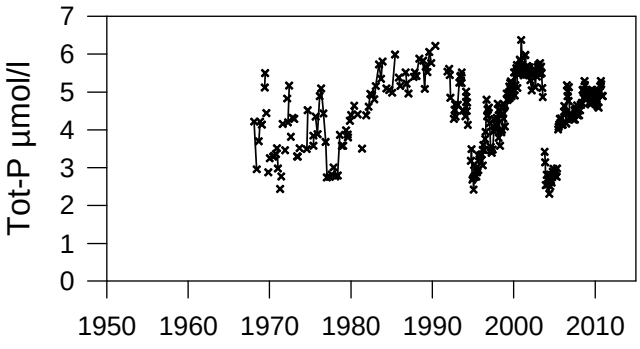


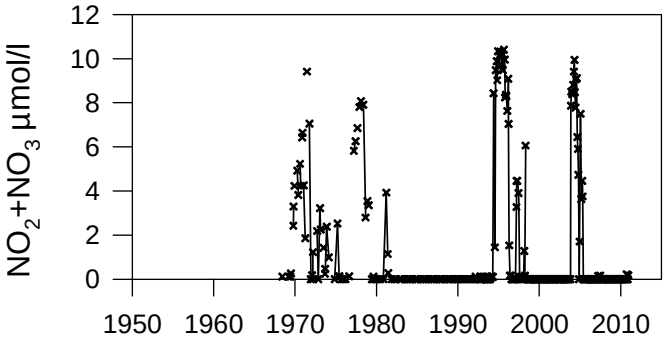
STATION BY20 DEEP WATER (175m)

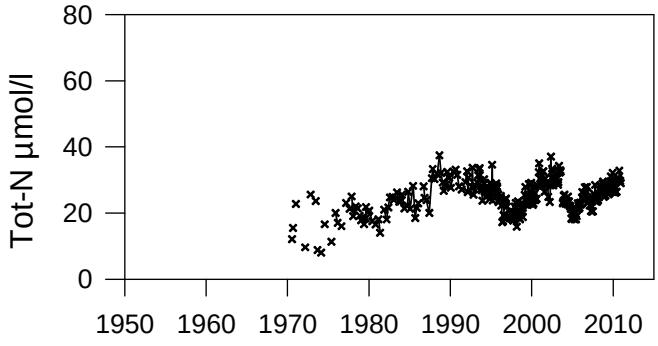


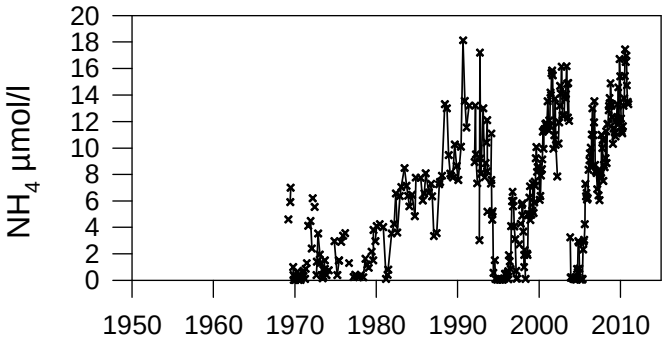


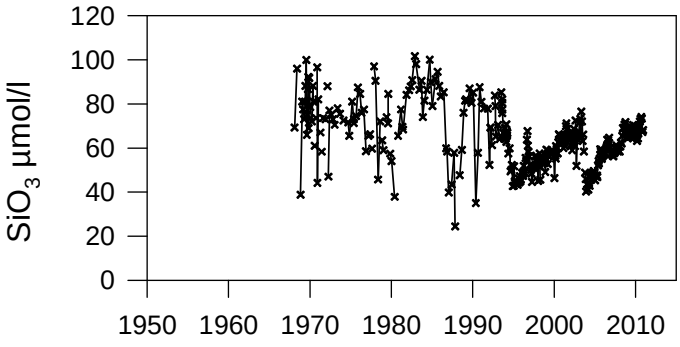


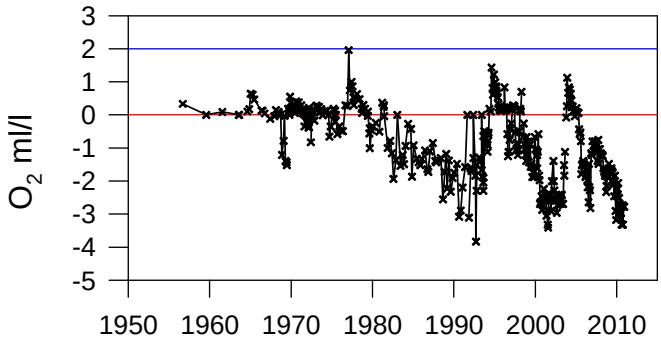








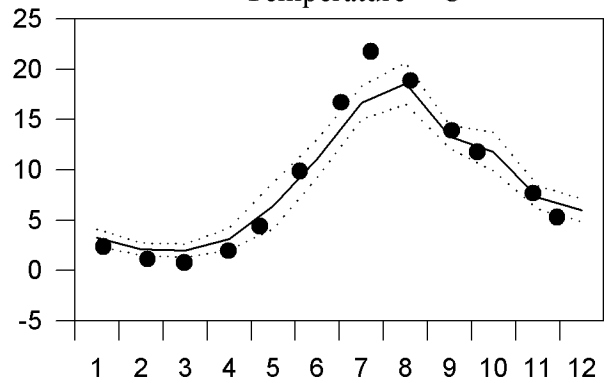




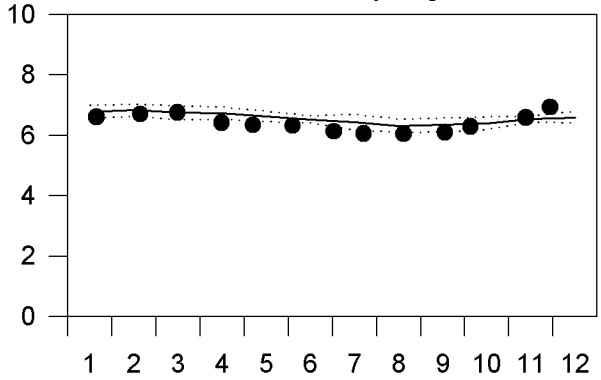
STATION BY32 SURFACE WATER

Annual Cycles

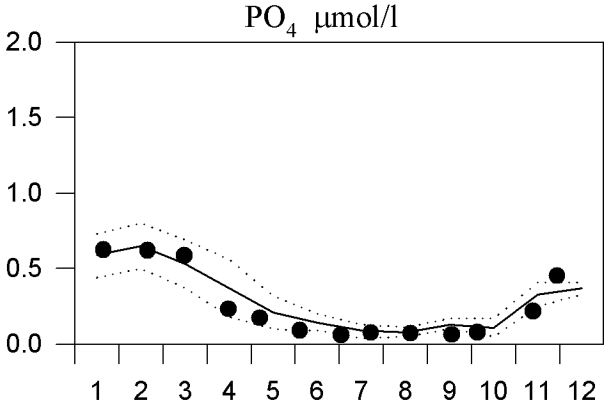
Temperature °C



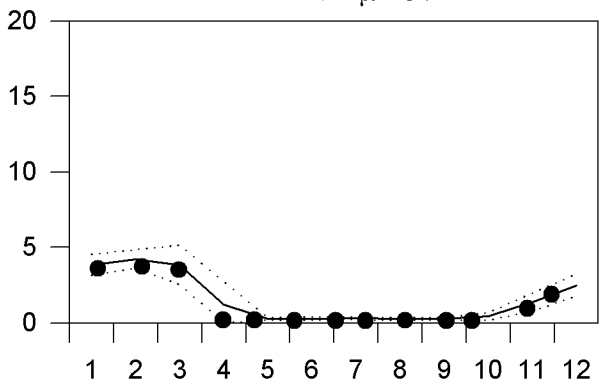
Salinity psu



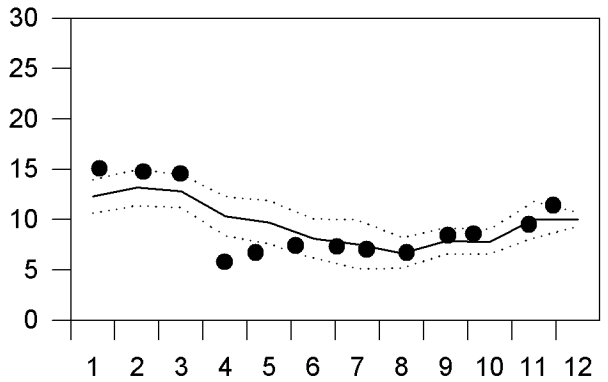
PO_4 µmol/l



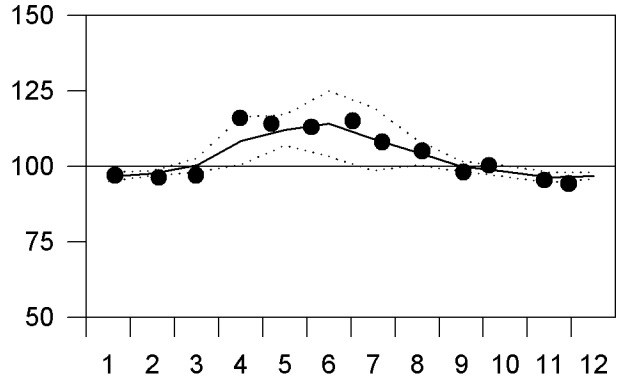
DIN µmol/l



SiO_3 µmol/l

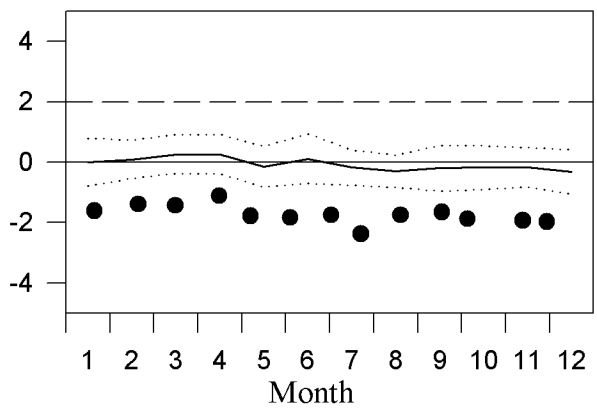


O_2 saturation %

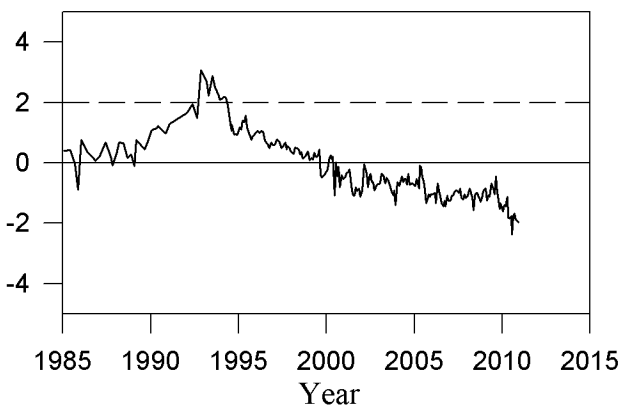


OXYGEN IN BOTTOM WATER

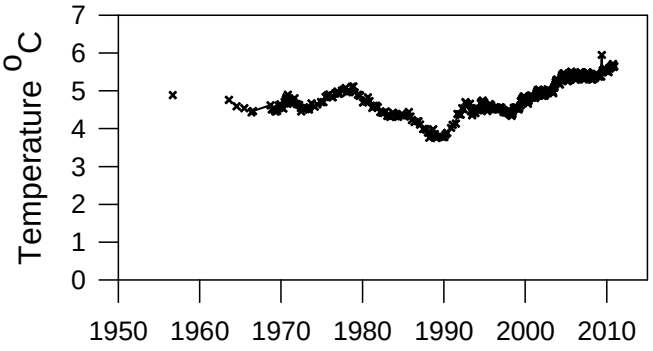
O_2 ml/l

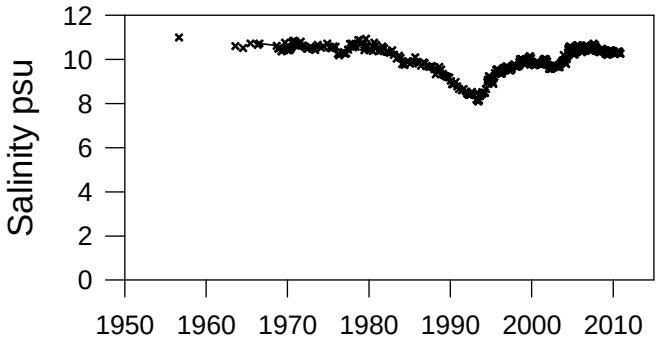


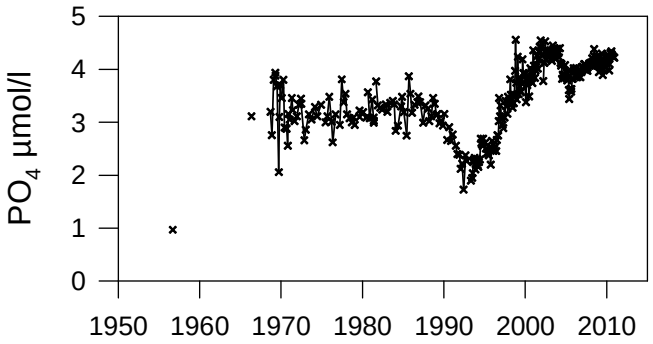
O_2 ml/l

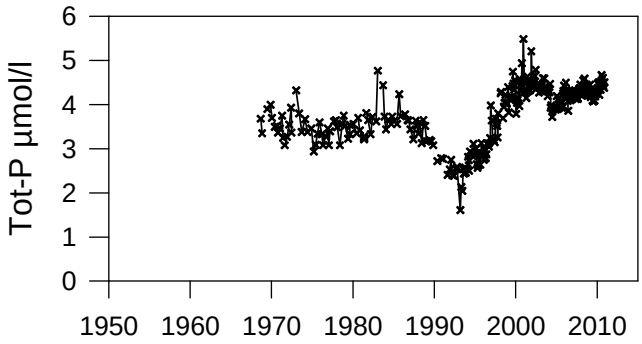


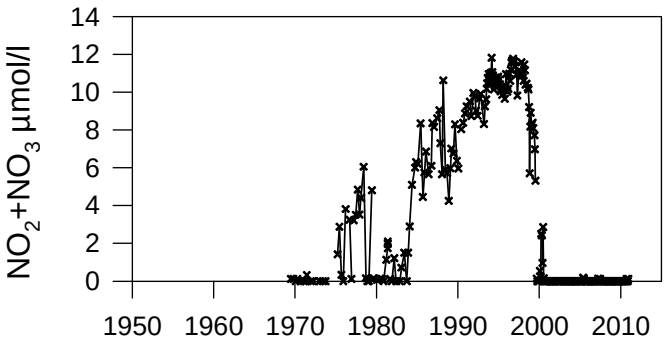
STATION BY32 DEEP WATER (175m)

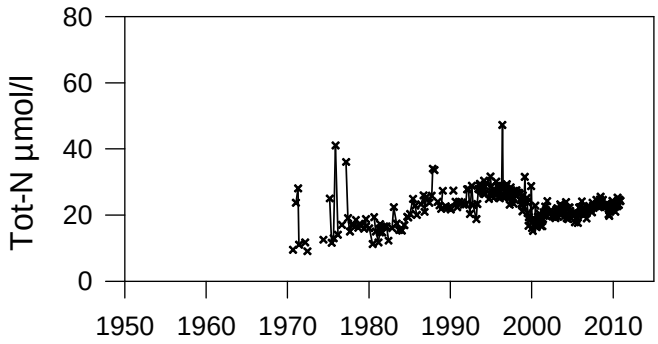


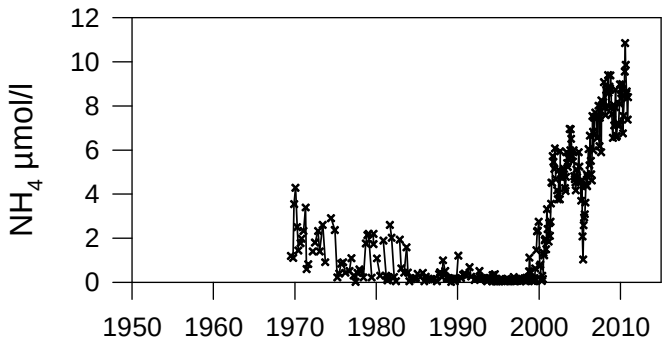


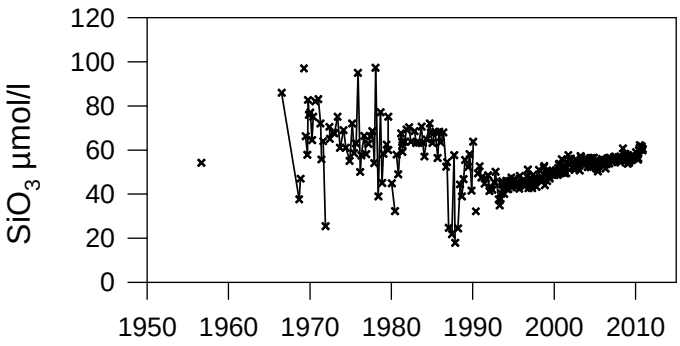


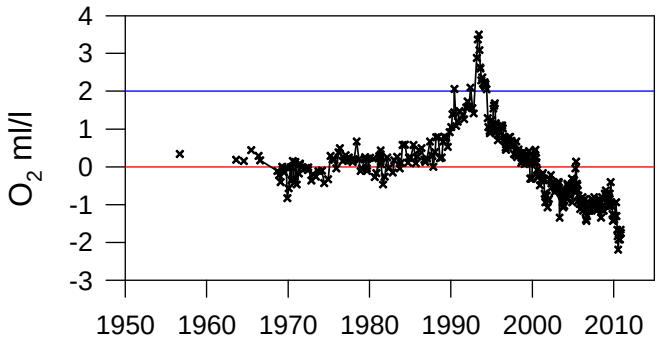










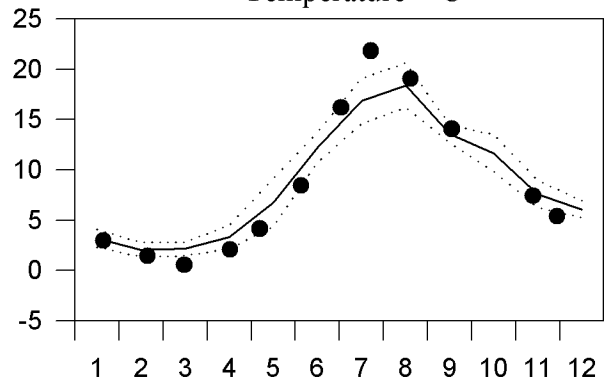


STATION BY38 SURFACE WATER

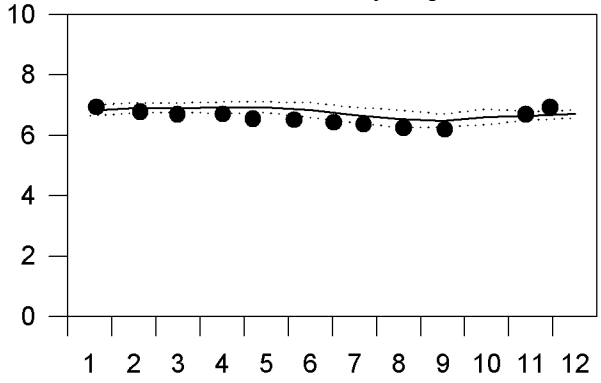
Annual Cycles

Mean 1995-2004 ····· St.Dev. ● 2010

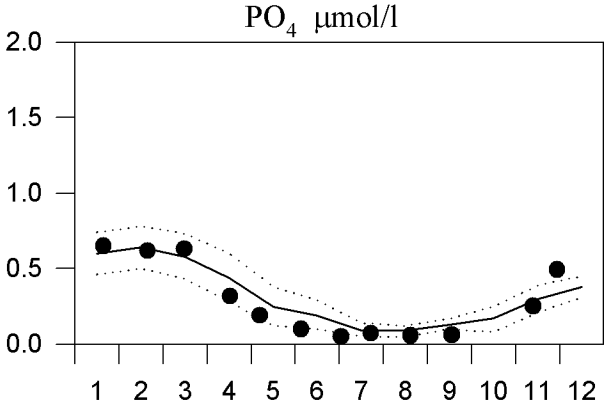
Temperature °C



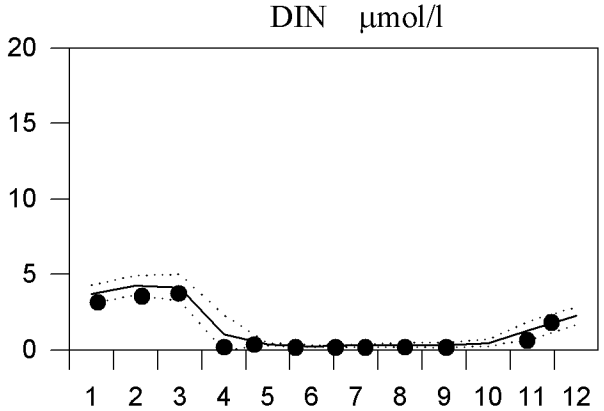
Salinity psu



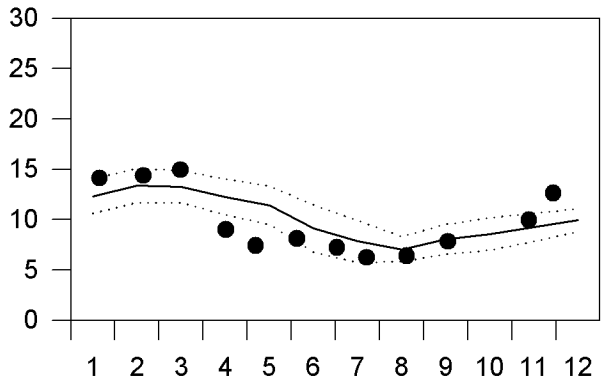
PO_4 µmol/l



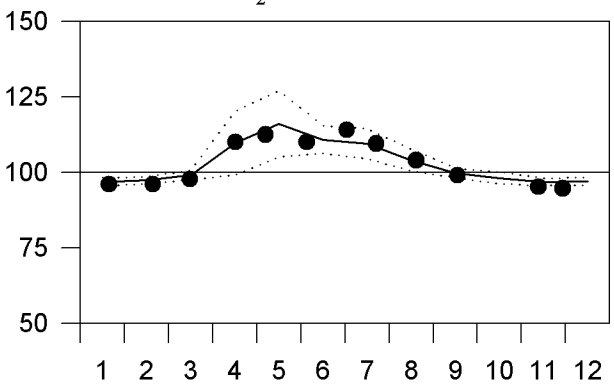
DIN µmol/l



SiO_3 µmol/l

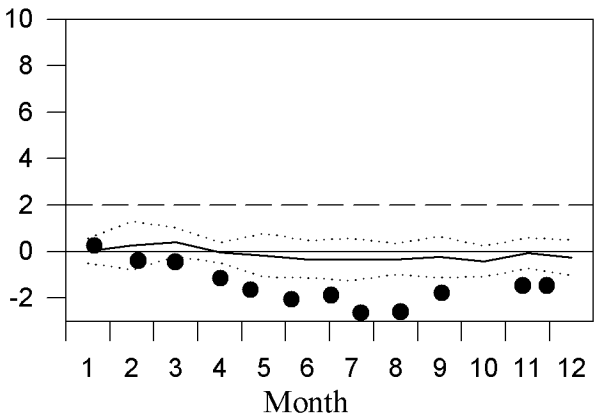


O_2 saturation %

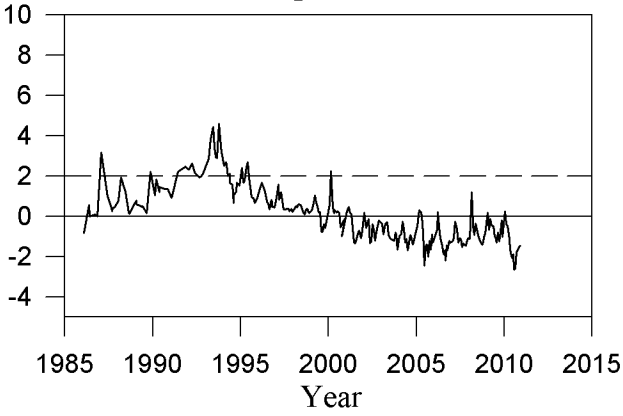


OXYGEN IN BOTTOM WATER

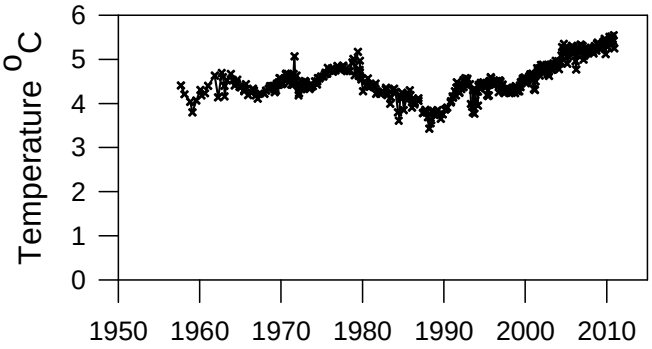
O_2 ml/l

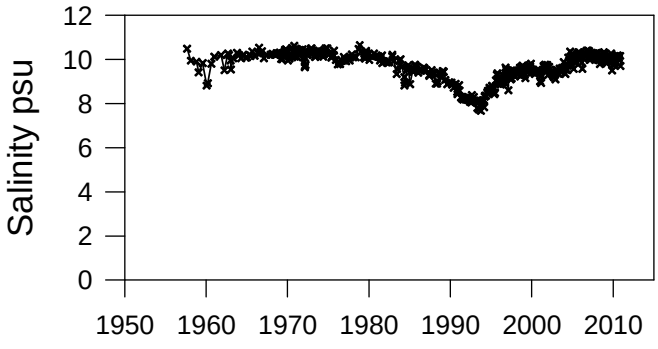


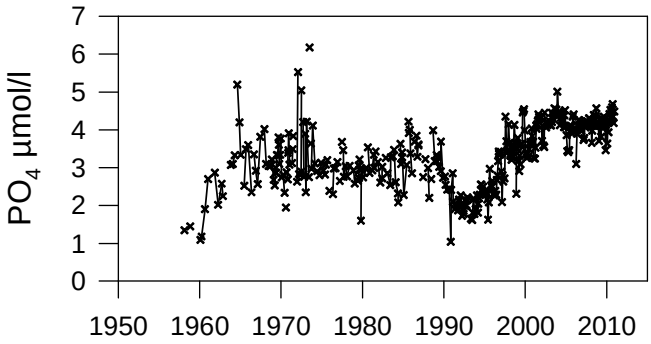
O_2 ml/l

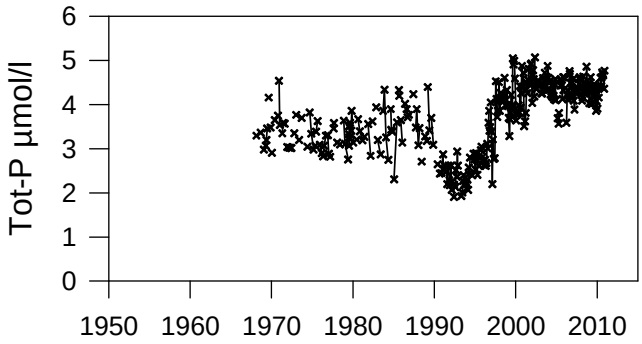


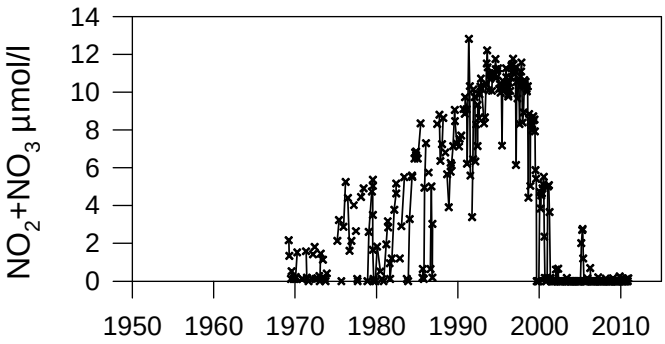
STATION BY38 DEEP WATER (100m)

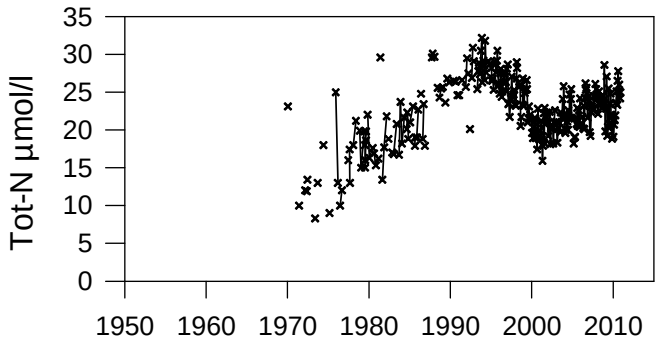


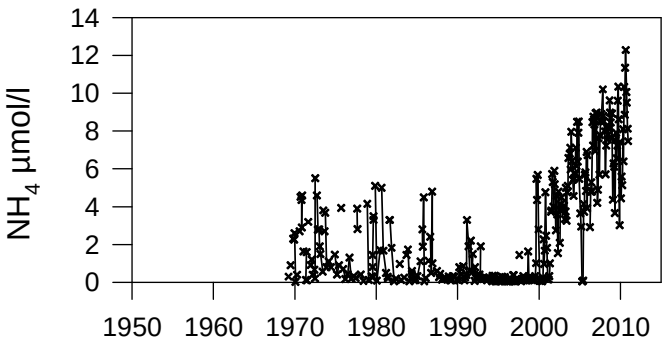


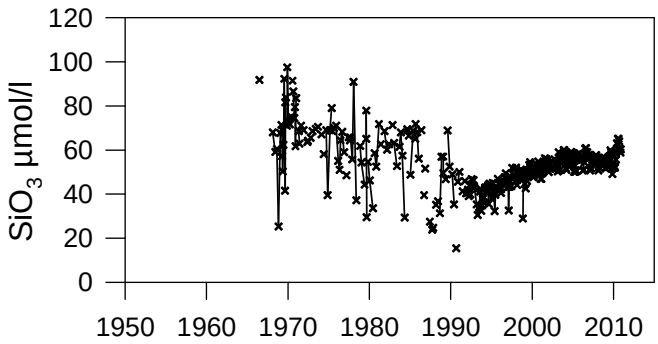


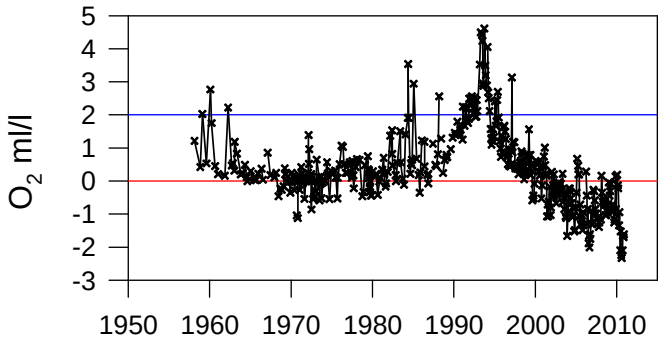










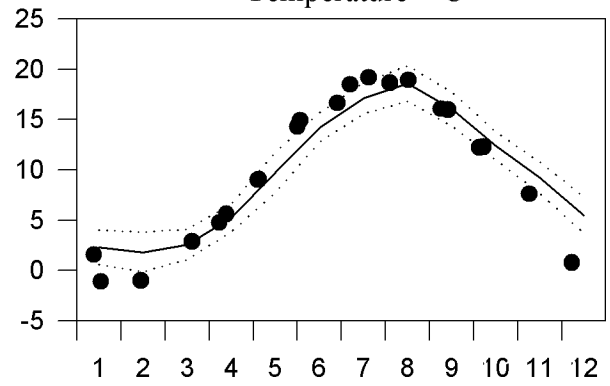


STATION SLÄGGÖ SURFACE WATER

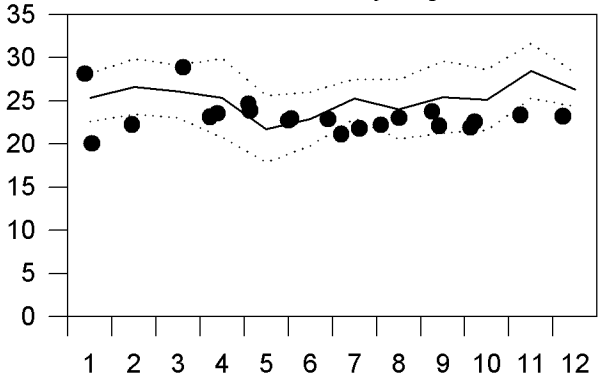
Annual Cycles

Mean 1995-2004 ····· St.Dev. ● 2010

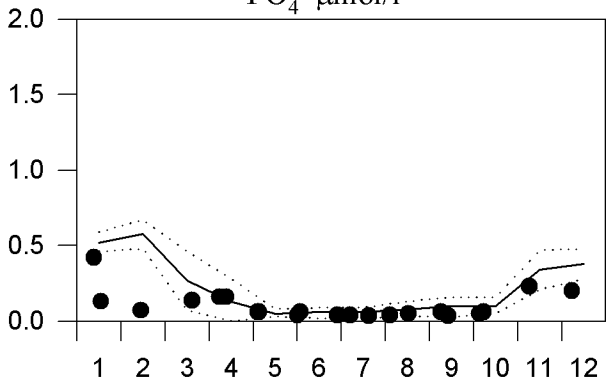
Temperature °C



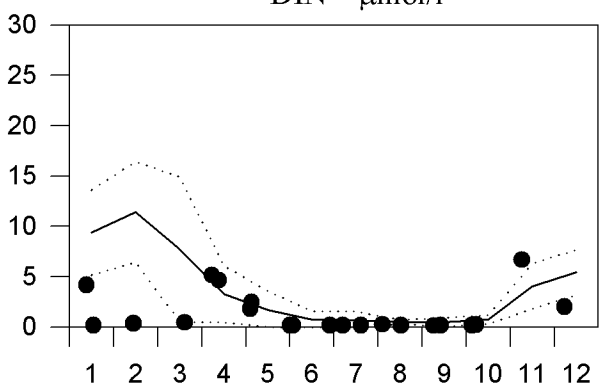
Salinity psu



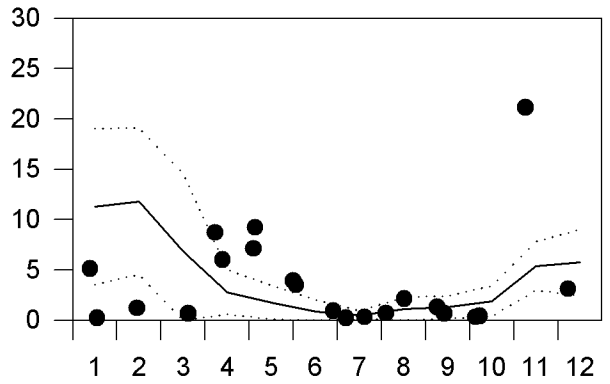
PO_4 µmol/l



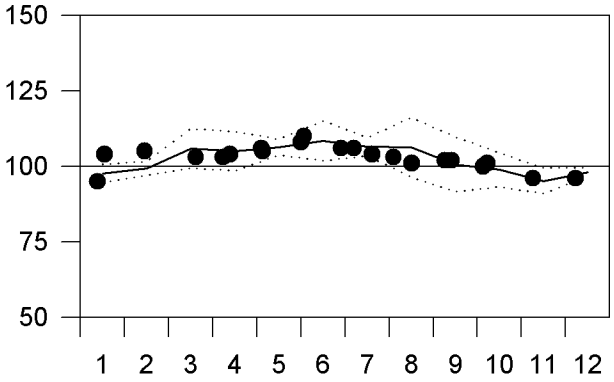
DIN µmol/l



SiO_3 µmol/l

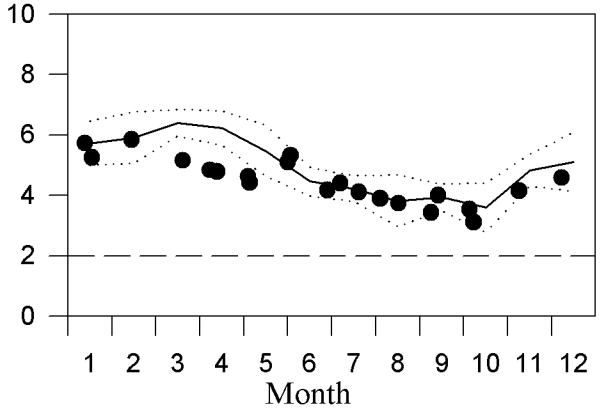


O_2 saturation %

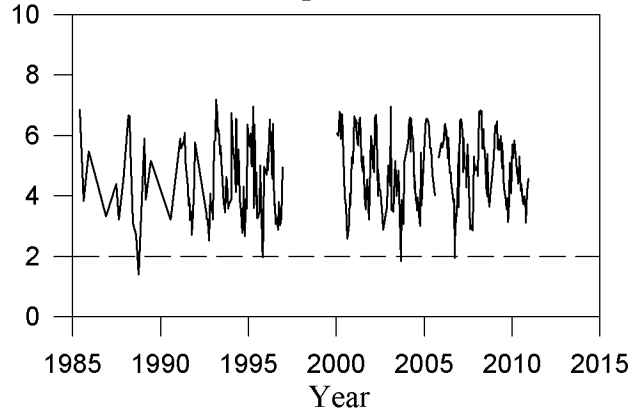


OXYGEN IN BOTTOM WATER

O_2 ml/l



O_2 ml/l



STATION SLÄGGÖ DEEP WATER (50m)