SMHI

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Årsrapport 2009

Annual Report 2009

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Exceptional events during 2009

- The oxygen situation in the deep water of central and northern Baltic Proper was extremely bad.

Short description of the state of the environmental

The annual mean air temperature was about 1°C above normal for Sweden as a whole. It was also relatively wet in large parts of the country, excepting the far south and far north, which were dryer than normal. While April was much warmer than normal, the summer started with a cold June. In the far north and south, July was a typical warm, dry summer month, but rain dominated in the central part of the country. The summer warmth remained into late September while October was colder than normal. In mid November a sever storm passed Skåne. December started mild and wet but soon cold dominated and by Christmas the whole of Sweden was covered by snow.
The ice extent during winter 2008/2009 can be considered light in all sea areas.

During the first part of the year, runoff from the land to the Skagerrak was normal, while for Kattegat it was below normal. Runoff to the Skagerrak from mid July to mid September was clearly above normal, while for Kattegat it was just above mean, with the exception of a high peak at the beginning of September. At the turn of November/ December there was another high peak in discharge to both the Skagerrak and Kattegat with flows twice as high as normal.

For the Baltic Proper, runoff was generally below normal during the main part of the year. In July and at the turn of November/December however, freshwater supply was 20 to 30% above mean levels.
In the Bothnian Sea, the spring flood occurred as a few peaks during April and in the beginning of May when the discharge was higher than normal. At the turn of July/August flows reached twice the normal. In August, September and at the end of November peaks with high flows occurred, while the discharge during the rest of the year was normal. Runoff to the Bothnian Bay was at typical levels during the first and last parts of the year. A strong peak occurred at the beginning of May, while runoff during summer was lower than normal.

Hydrography and hydrochemistry

A few smaller Baltic inflows of saline, oxygen rich water occurred during January, May and September. The effects of these inflows were seen in the Arkona Basin, but they were not large enough to influence conditions further into the Baltic. During the second half of November a larger inflow of ca. 35 km^3 took place, which affected the conditions in the Arkona- and Bornholm Basins. Further into the Baltic Proper the deep water was stagnant throughout the year.

Skagerrak, Kattegat and the Sound

The surface water temperature in Skagerrak, especially in the central parts, was below normal during February. Surface water temperatures in both the Skagerrak and Kattegat were above normal at the end of June. During the remainder of the year they were normal. Concentrations of the nutrients phosphate and silicate were elevated levels at the start of the year. This was especially clear for silicate in the Kattegat. The spring bloom started in early February, whereupon nutrient concentrations quickly fell to typical levels for spring/summer. Concentrations of phosphate and silicate increased in Kattegat surface waters due to a couple of strong outflows from the Baltic. These occurred during a few short periods in spring and summer. During autumn, nutrient concentrations increased again, and in December they were at normal levels throughout the area.

At the end of August, low oxygen concentrations (1.8 and 1.7 ml/l) were found in the bottom water of Laholm Bay and Skälderviken respectively. Lowest oxygen concentration in the open Kattegat was 2.5 ml/l, measured at station Anholt E in October. In the open Skagerrak there is normally no lack of oxygen in the deep waters. The lowest value during 2009 was 3.2 ml/l, measured in October at Släggö, at the mouth of the Gullmar fjord.

High chlorophyll *a* concentrations and high diatom diversity indicated that the spring bloom had started by the time of the February sampling. The toxic (to fish) species *Pseudochattonella farcimen* was observed in the open Skagerrak (Å17) and in the Kattegat in February. By March it had developed into a minor Kattegat bloom.

The potentially toxic flagellate *Chrysochromulina* spp. was found blooming in the Skagerrak and Kattegat during June. *Emiliania huxleyi*, a flagellate known for colouring the water to a beautiful shade of turquoise, bloomed at P2 in the Skagerrak coastal area. The turquoise water was observed at several stations in June.

Unusually high cell numbers and many species of diatoms were found in both the Kattegat and Skagerrak areas from September to December.

Baltic Proper

Surface water temperatures were normal levels throughout the year. They were lowest in February and highest during August. Phosphate concentrations were high during the first and last months of the year, especially in the southern parts. Silicate and the sum of inorganic nitrogen were at normal levels. The spring bloom took place in March/April and thereafter inorganic nitrogen concentrations remained below the detection limit until October.

Hydrogen sulphide was present in the bottom water of the Bornholm Basin for a short period in September. However, oxygen concentrations were below 2 ml/l for the main part of the year. An inflow of deep water at the end of the year increased concentrations to ca 3.5 ml/l. Low oxygen concentrations (< 2 ml/l) were measured in the Arkona Basin during the end of summer and in the south-eastern Baltic Proper during the whole year.

As in previous years, the oxygen situation in the deep waters was bad. Oxygen depleted areas were found in the western-, eastern- and northern Gotland Basins. In these basins 22% of the bottom area was affected by hydrogen sulphide and 48% by low oxygen concentrations (< 2ml/l; hypoxia). The extent of hydrogen sulphide was somewhat lower than in 2008, while the extent of hypoxia was similar. Taken together, the measurements during 2009 showed that 16% of the total bottom area of the Baltic Proper is affected by oxygen depletion and 35% by hypoxia.

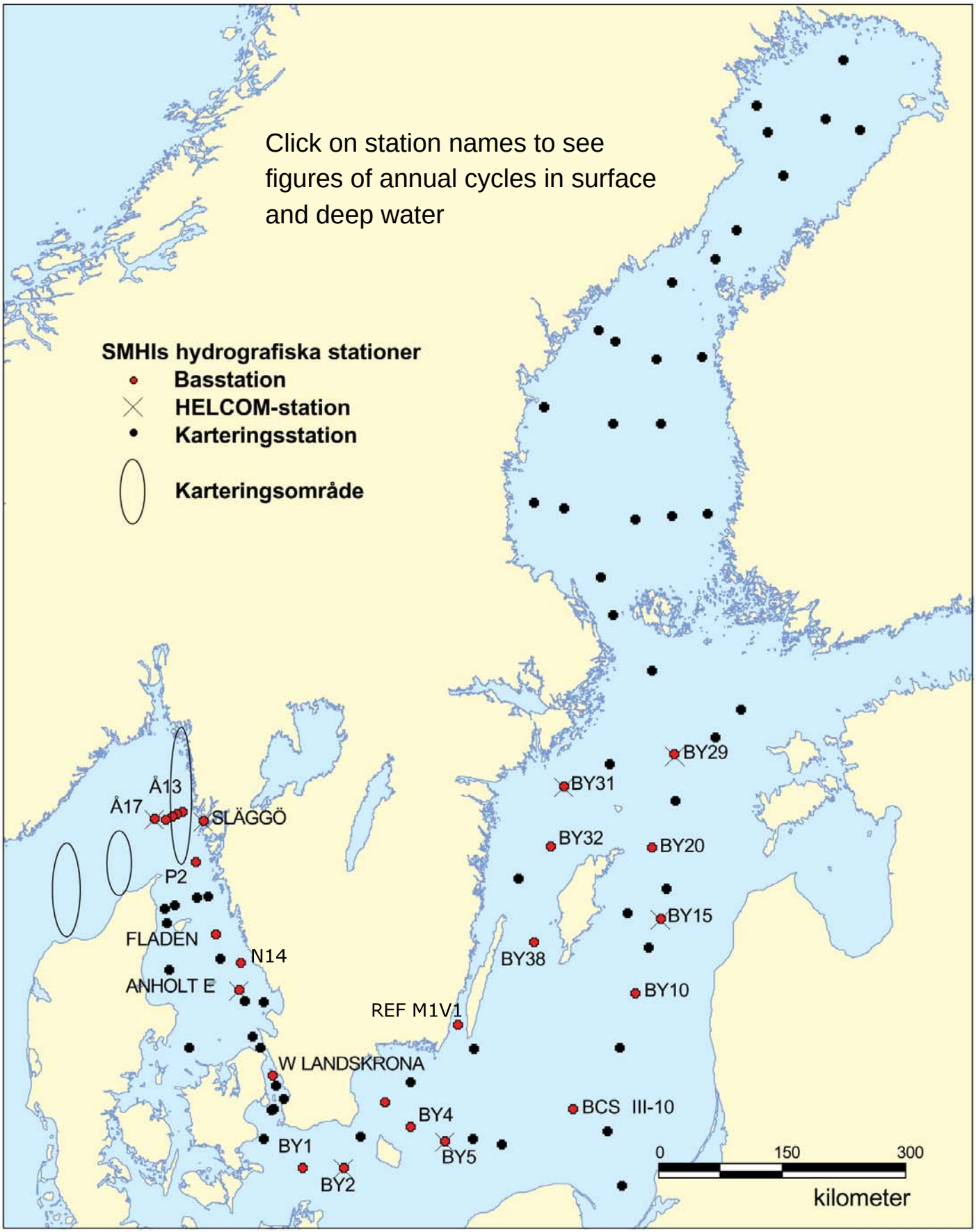
A minor bloom of the flagellate *Chrysochromulina polylepis*, a species that is potentially harmful to fish, was observed at the stations BY2 and BY5 in the Southern Baltic, and at REF M1V1 in the Kalmar Sound in January. The spring bloom was ongoing in the Southern Baltic during the March sampling. Diatoms were present with high cell numbers. *Chrysochromulina polylepis* was present at all phytoplankton stations, being most numerous in the Southern Baltic. Chlorophyll *a* concentrations were enhanced at the stations where blooms were observed, although these were close to the average for March. By the April sampling the diatom bloom had spread north. *Chrysochromulina polylepis* remained abundant in the Southern Baltic. By May it was abundant at all phytoplankton stations.

The cyanobacteria bloom (blue-green algae) started in June with the non toxic *Aphanizomenon* spp. dominating, and surface accumulations were observed on satellite pictures. The largest amounts of cyanobacteria were analysed from samples collected east and southwest of Gotland. As June became July, dense accumulations of cyanobacteria

were observed: *Aphanizomenon* spp. and the potentially toxic species *Nodularia spumigena* were abundant at most Baltic stations. Cyanobacteria were still present at the end of July and in August, but not in large amounts.

The cyanobacteria bloom during 2009 was relatively weak. The bloom occurred as two peaks: an early one in the south and a later one to the north. The first signs of a bloom were seen in the Hanö Bight at midsummer. During a period of less than a week surface accumulations could be seen all the way from the Hanö Bight up to Stockholm. The first surface accumulations were also seen at the end of June., but a cold and windy second half of July gave respite until the beginning of August. The most intensive blooms were seen east of Öland in mid July and in the Bothnian Sea in the first week of August. Compared to previous years the 2009 bloom was weaker than normal. The duration was among the shortest recorded since 1997, while the spatial extent was normal.

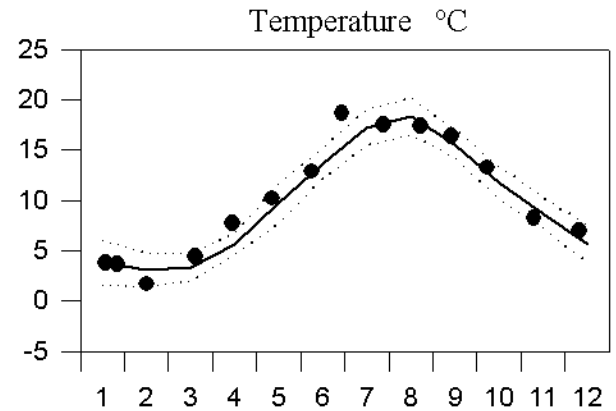
Hydrographical sampling stations

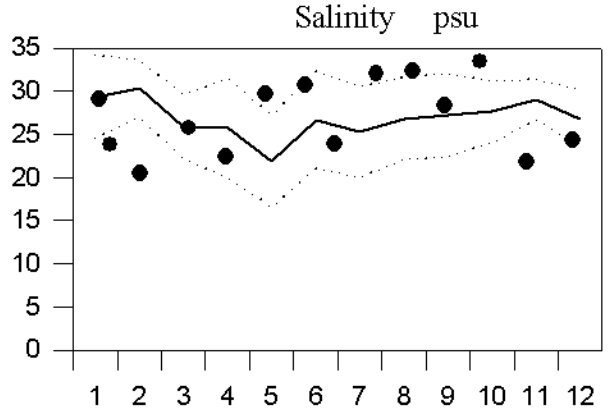


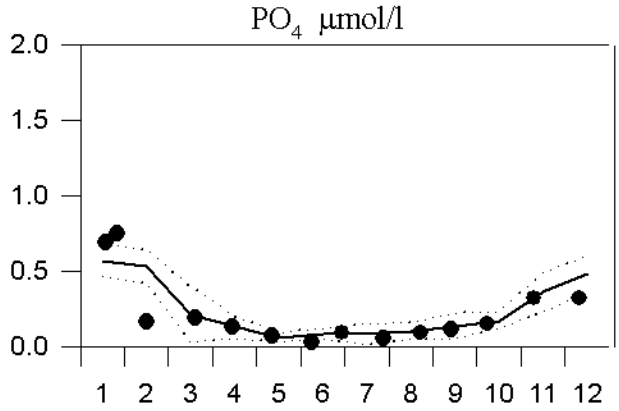
STATION P2 SURFACE WATER

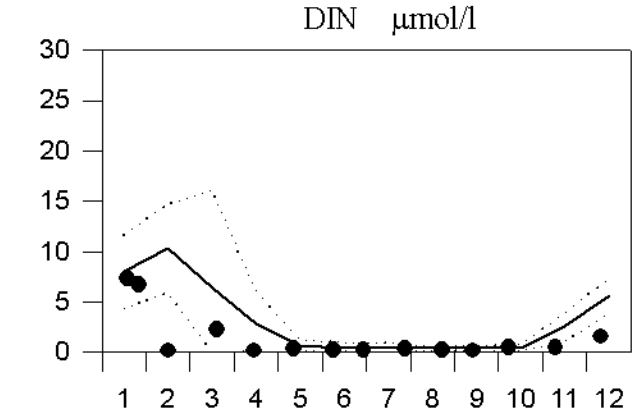
Annual Cycles

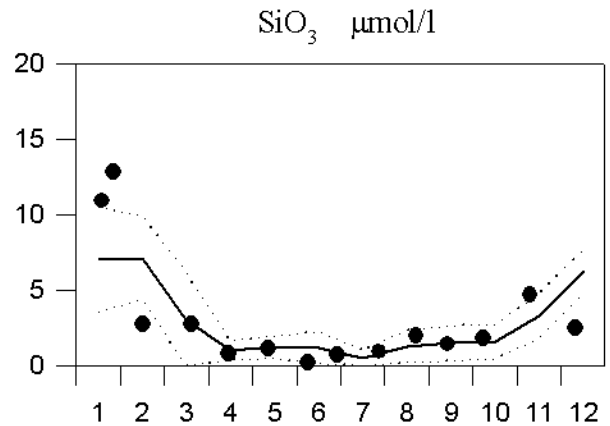
Mean 1995-2004 St.Dev. 2009

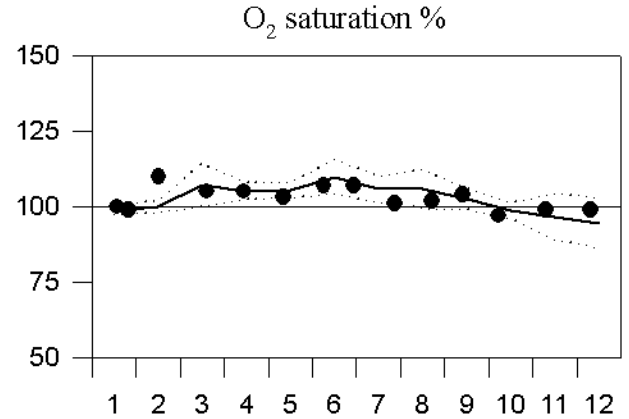




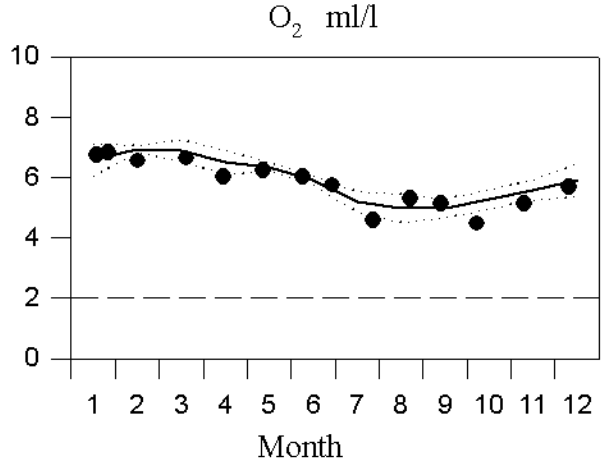


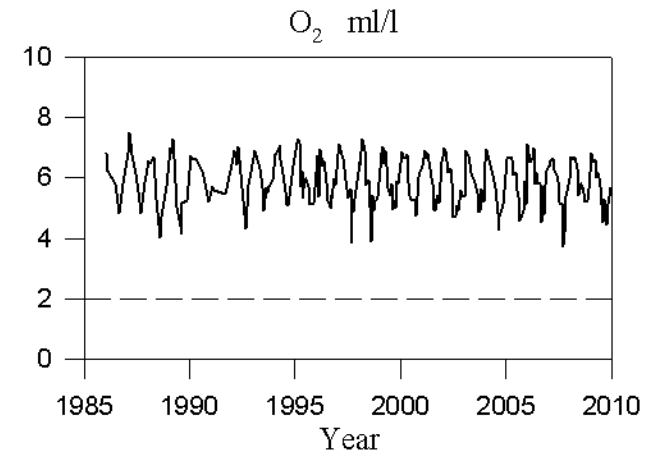




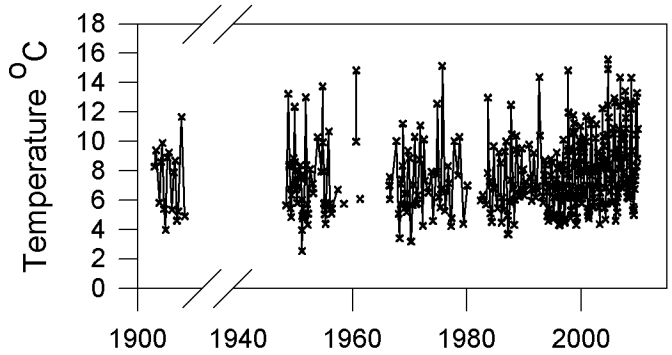


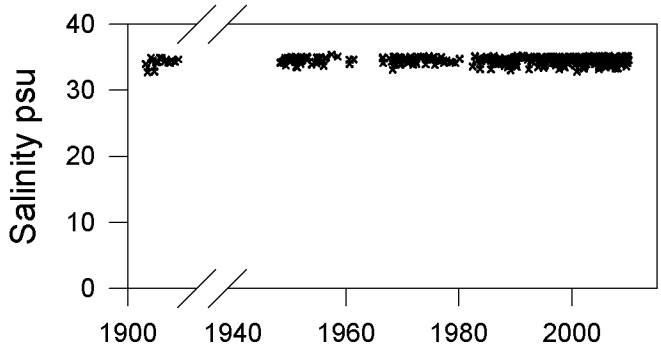
OXYGEN IN BOTTOM WATER

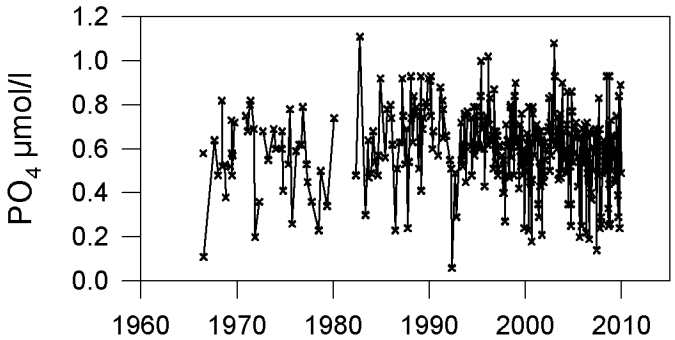


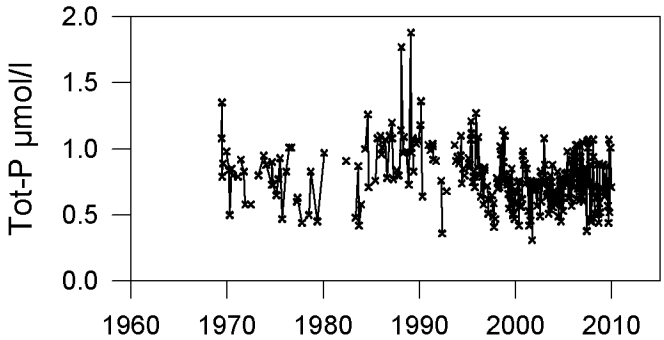


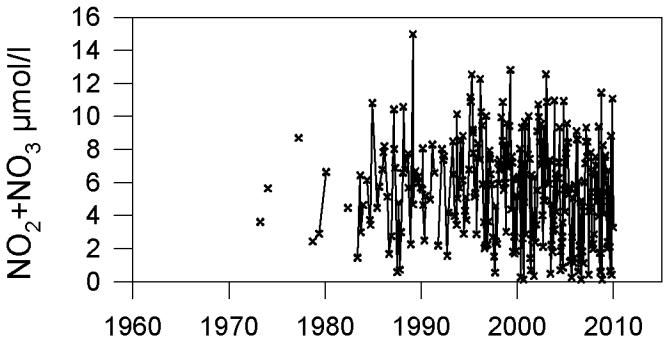
STATION P2 DEEP WATER (75m)

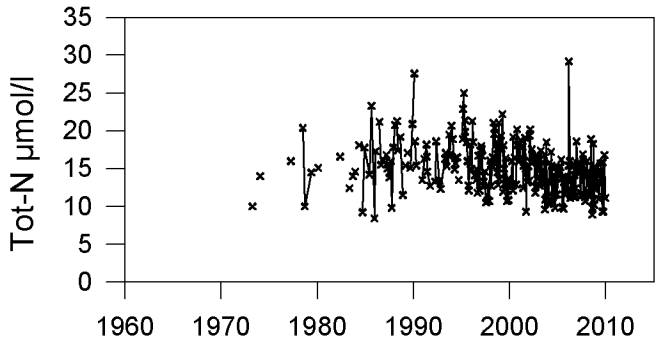


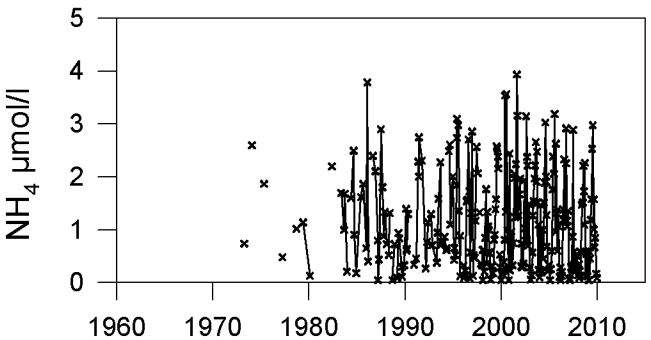


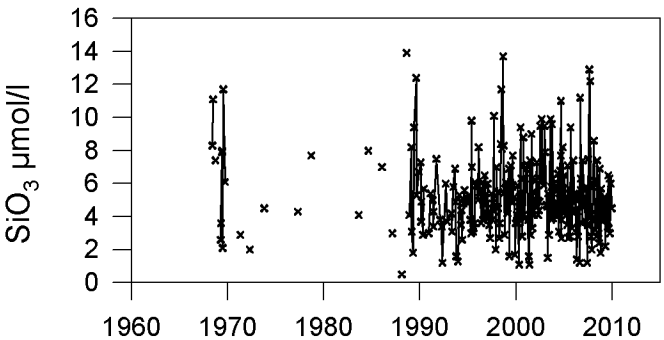


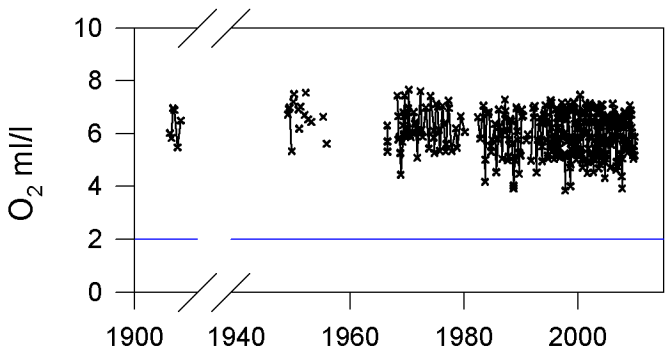






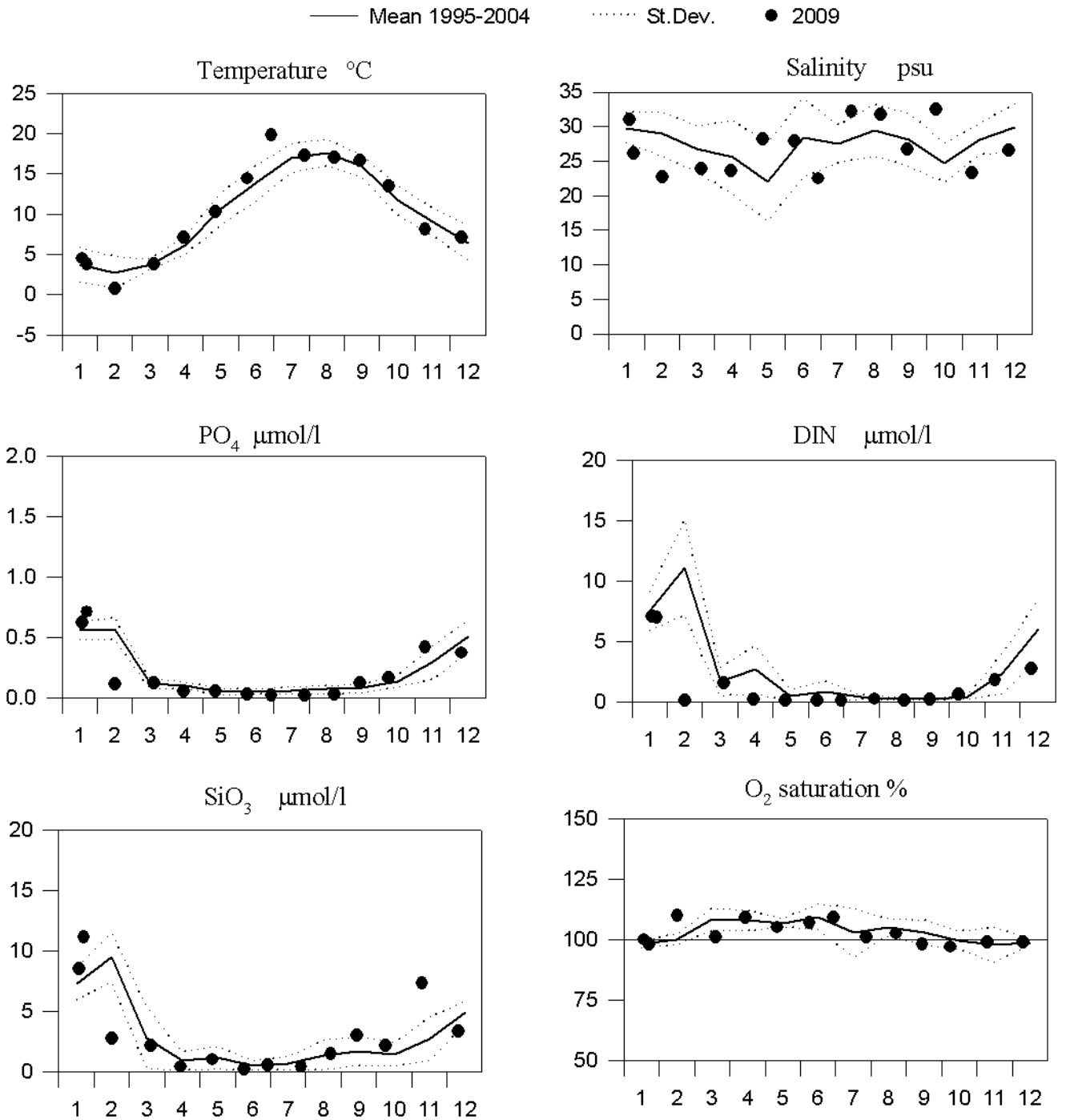




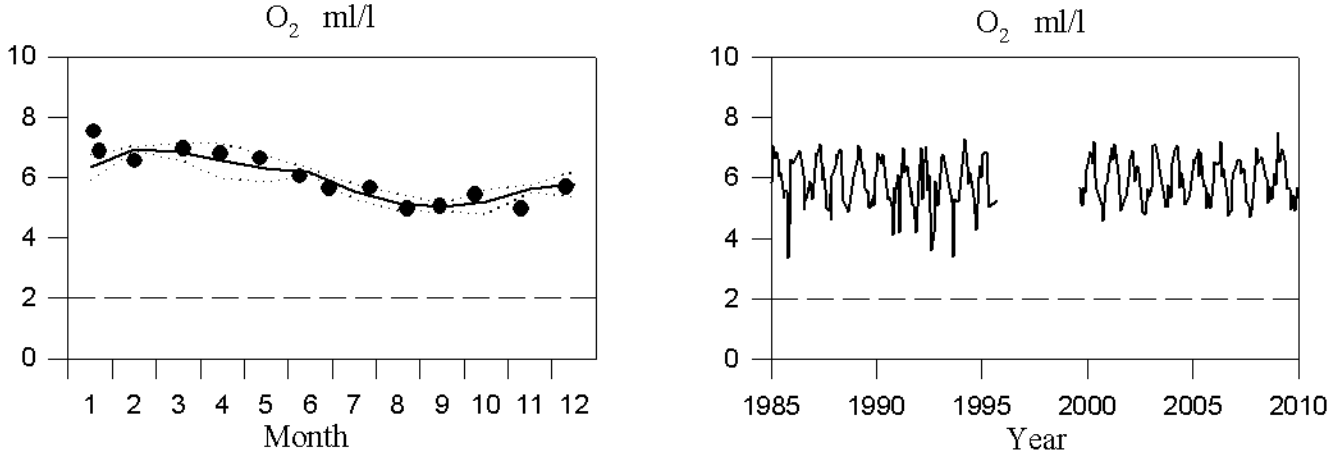


STATION Å13 SURFACE WATER

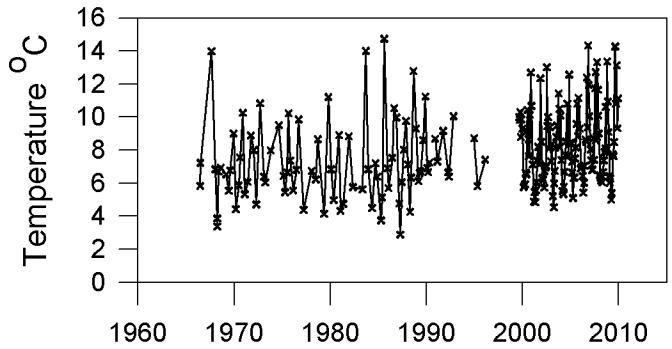
Annual Cycles

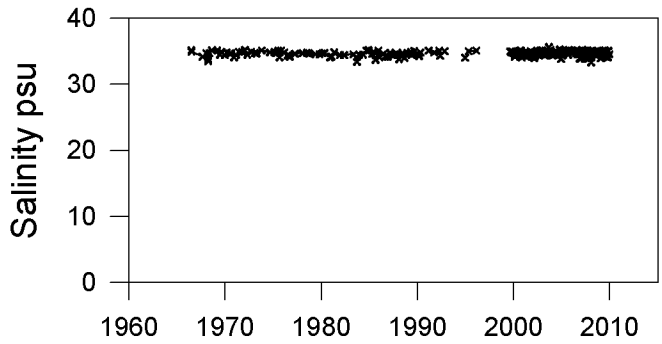


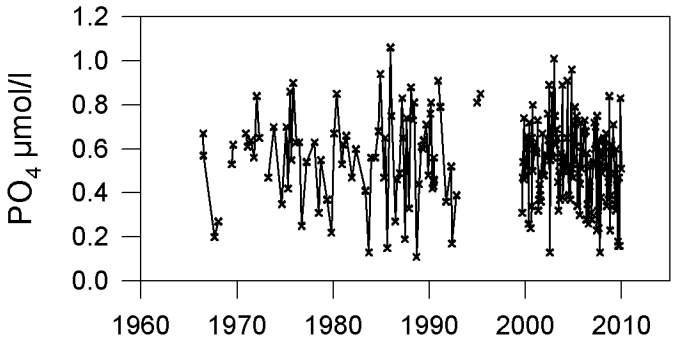
OXYGEN IN BOTTOM WATER

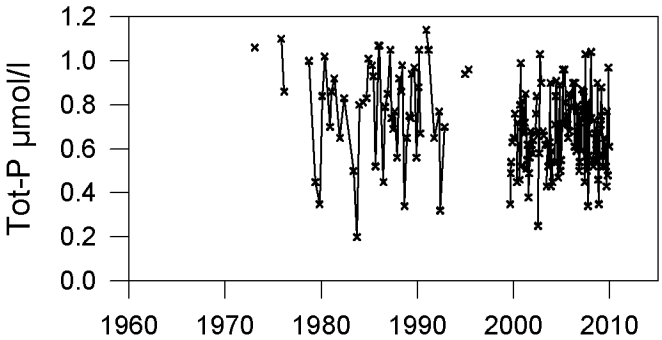


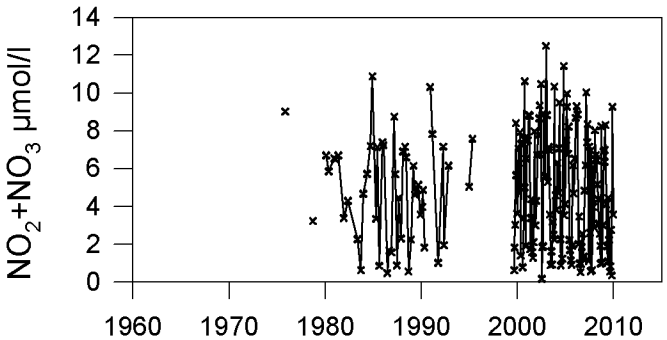
STATION Å13 DEEP WATER (75m)

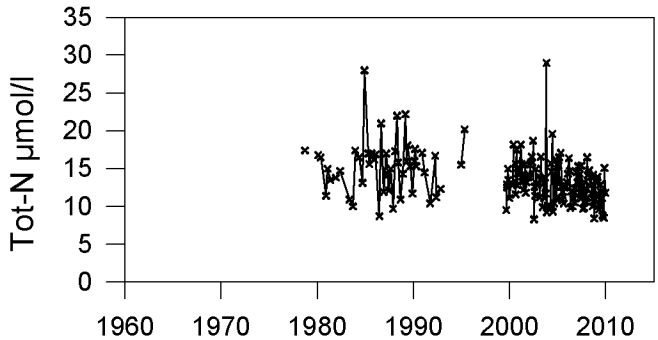


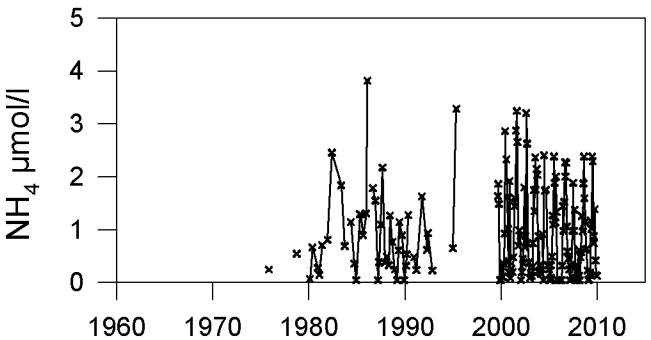


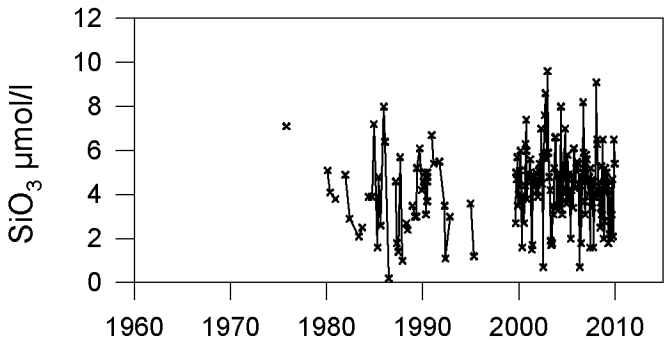


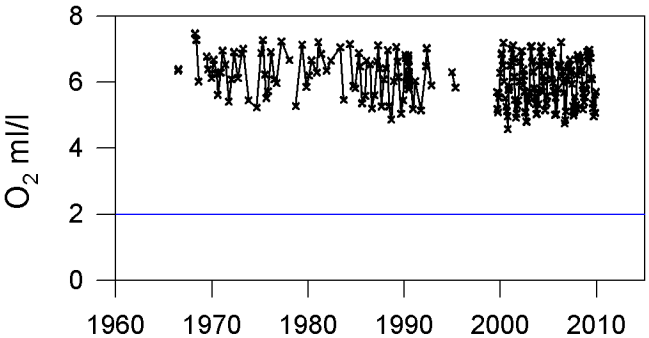






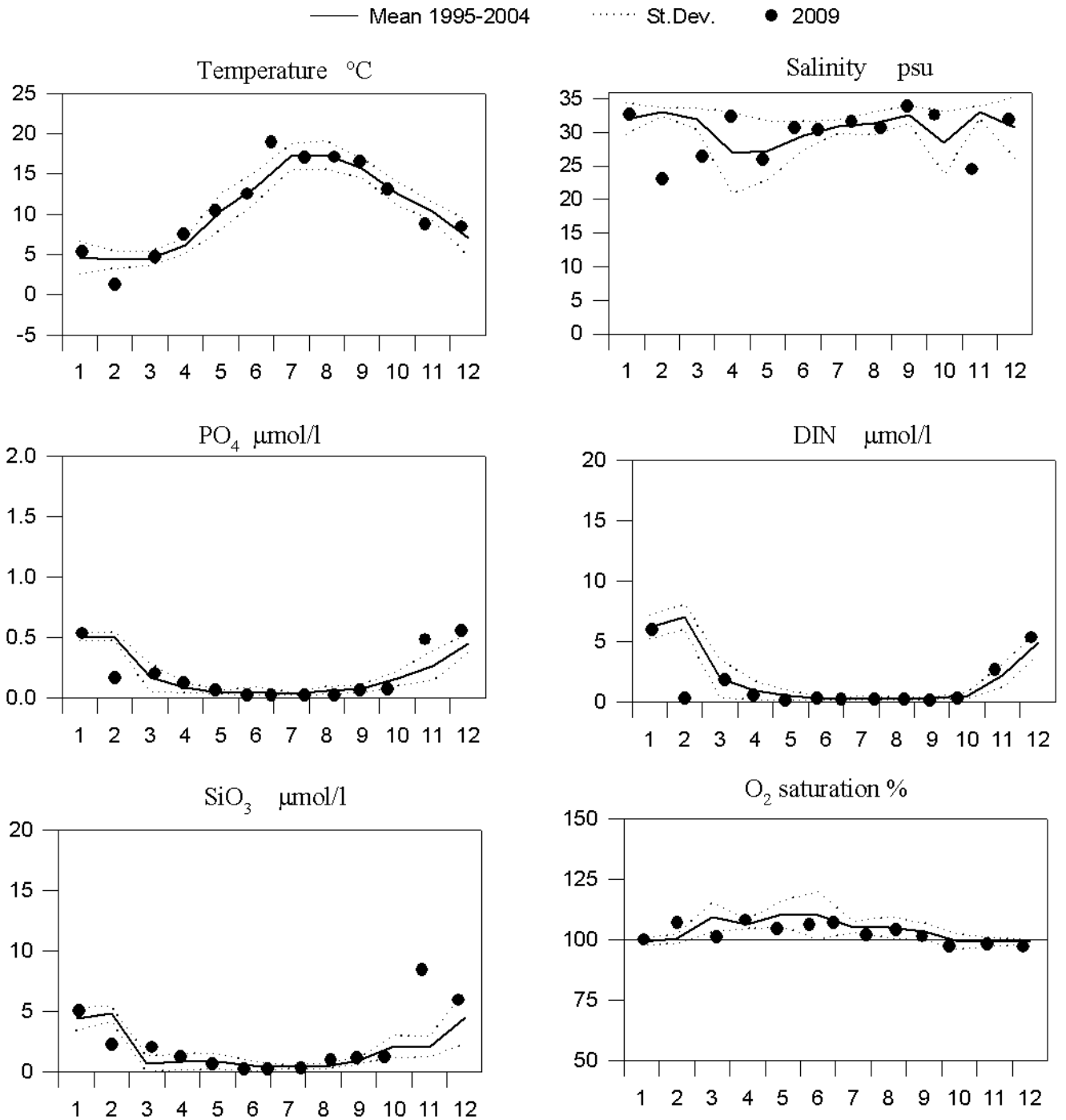




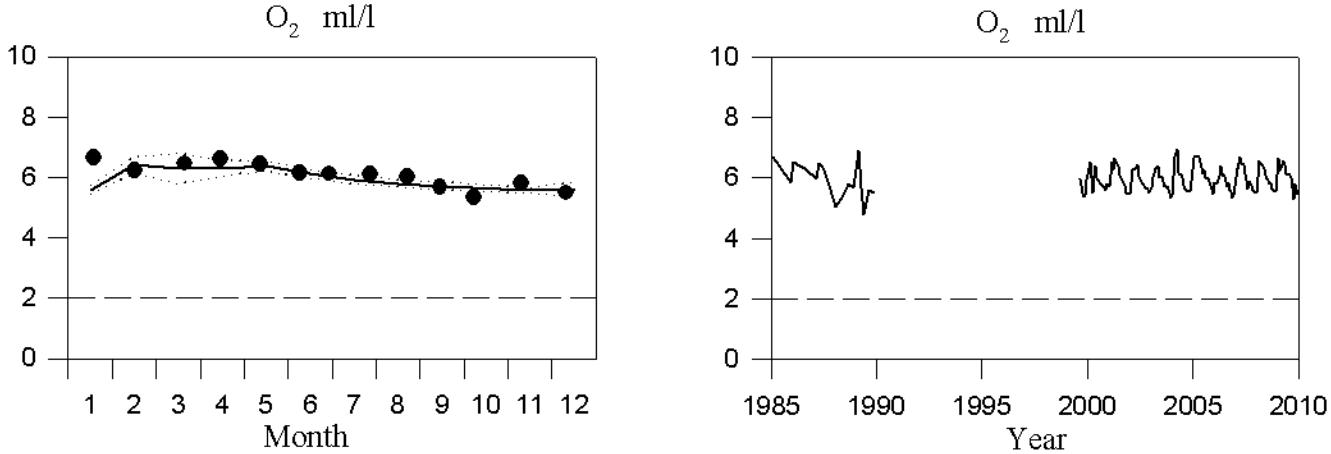


STATION Å17 SURFACE WATER

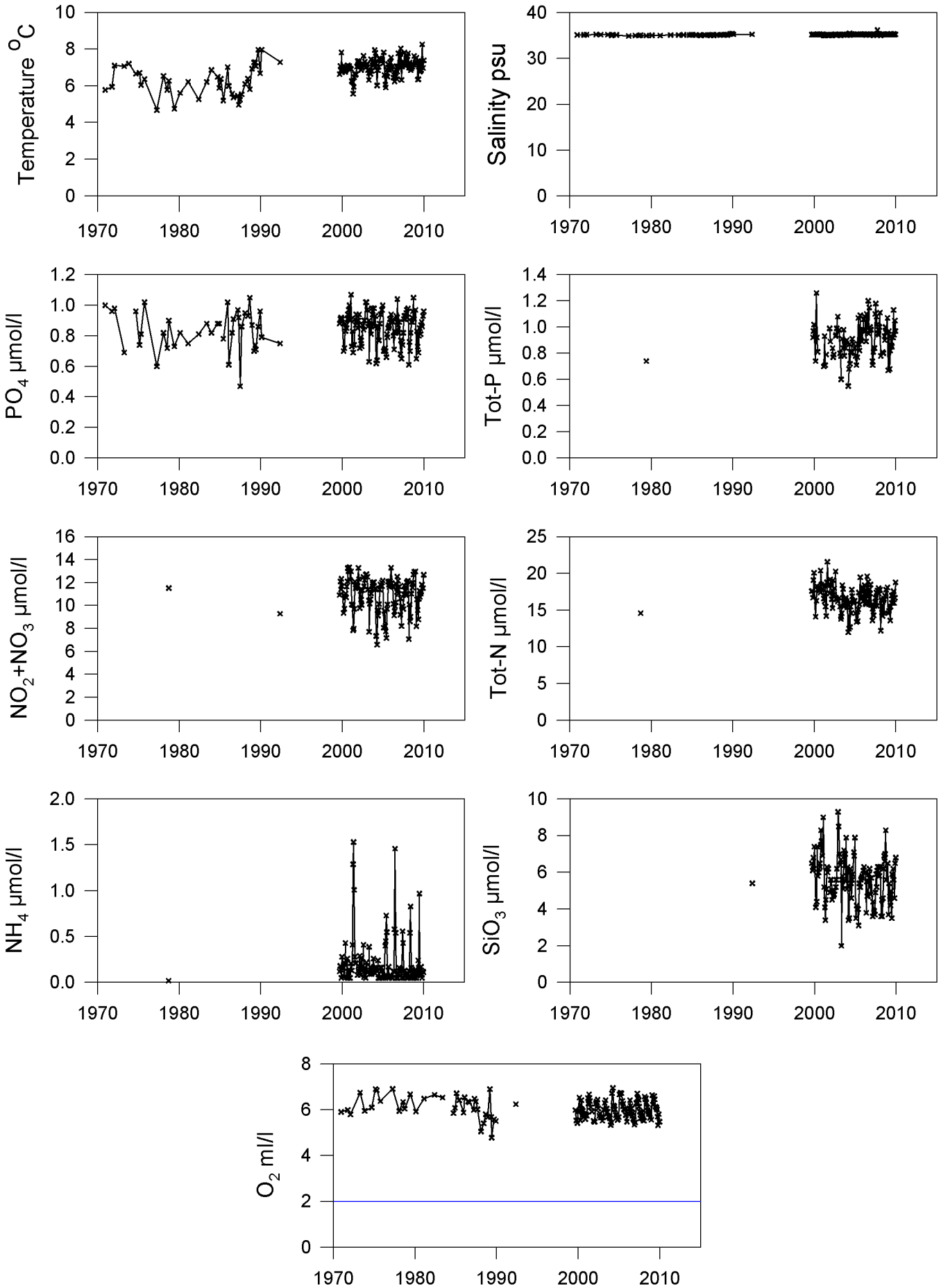
Annual Cycles



OXYGEN IN BOTTOM WATER



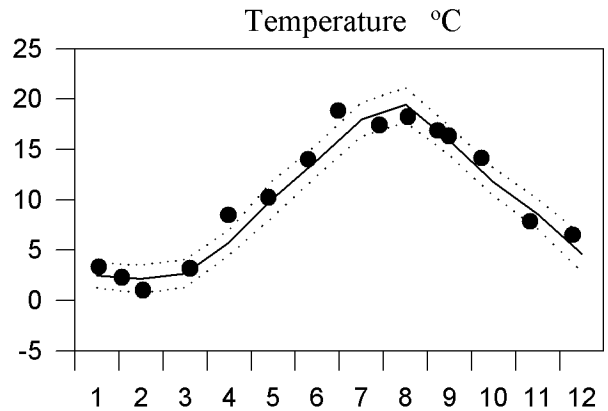
STATION Å17 DEEP WATER (300m)

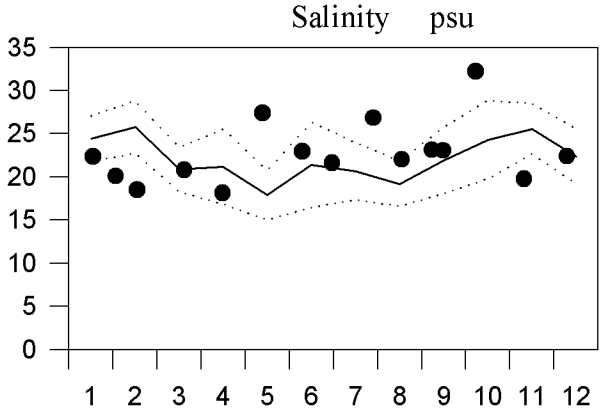


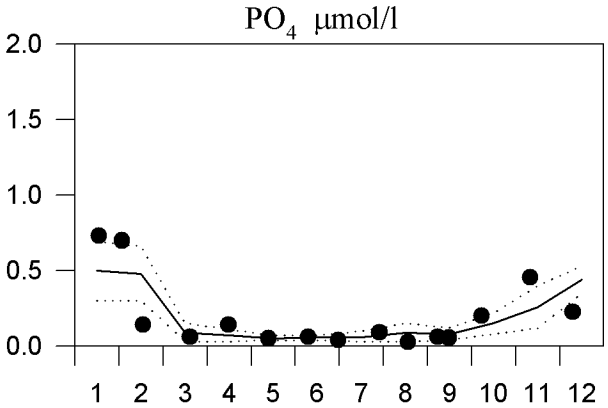
STATION FLADEN SURFACE WATER

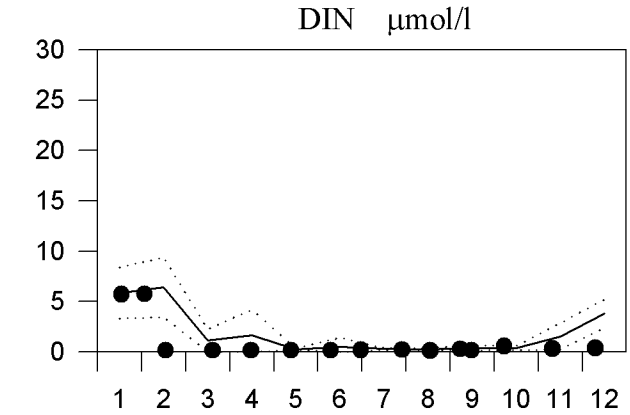
Annual Cycles

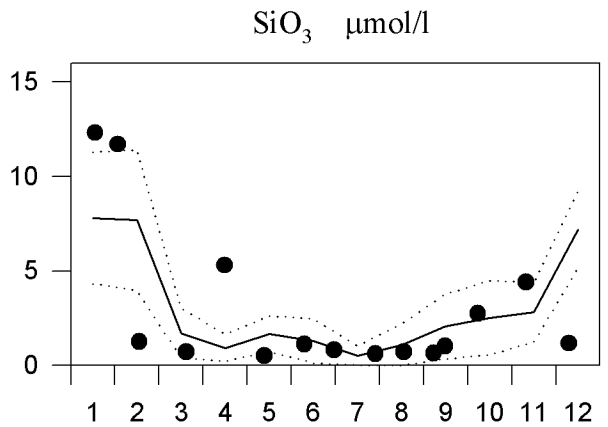
Mean 1995-2004 St.Dev. 2009

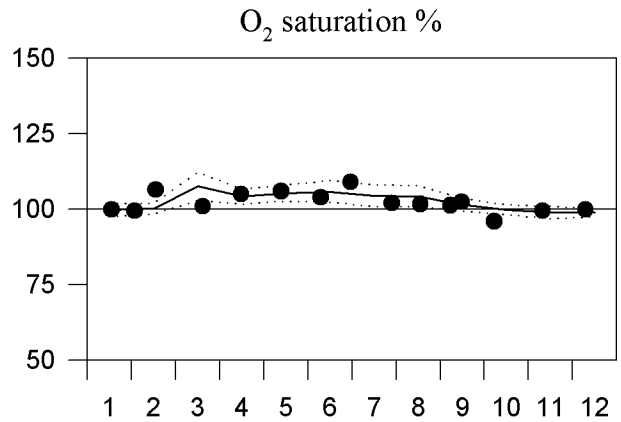




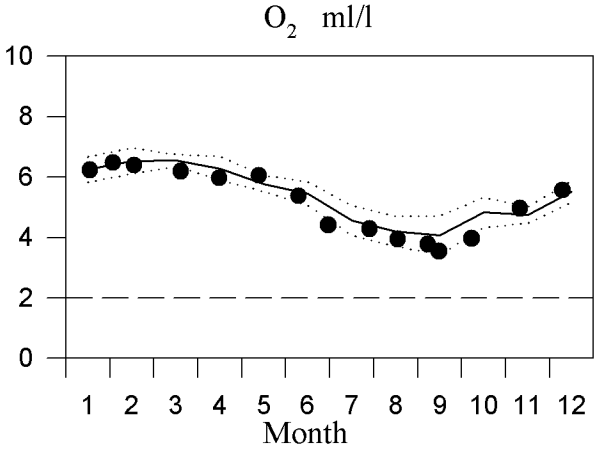


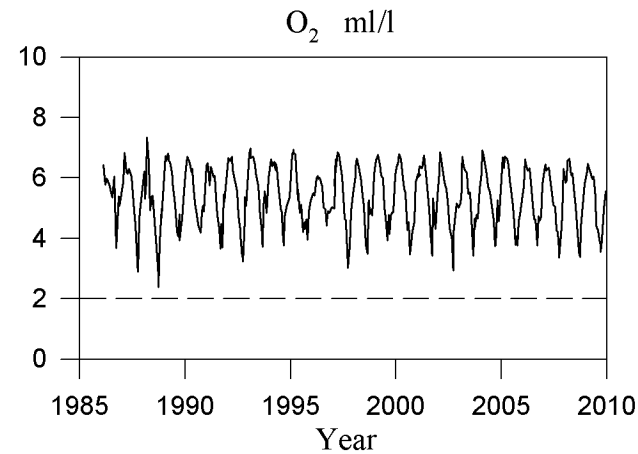




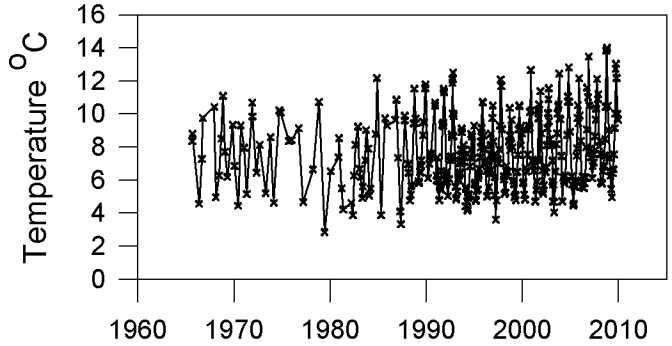


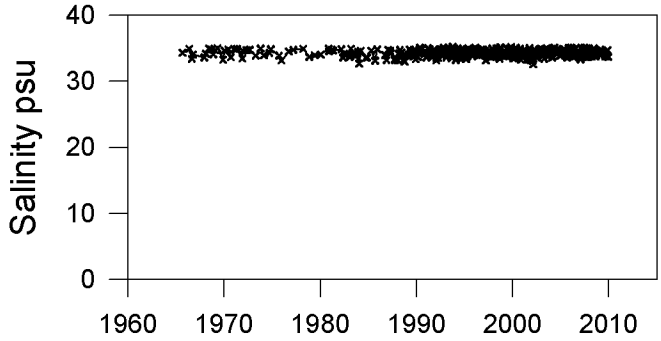
OXYGEN IN BOTTOM WATER

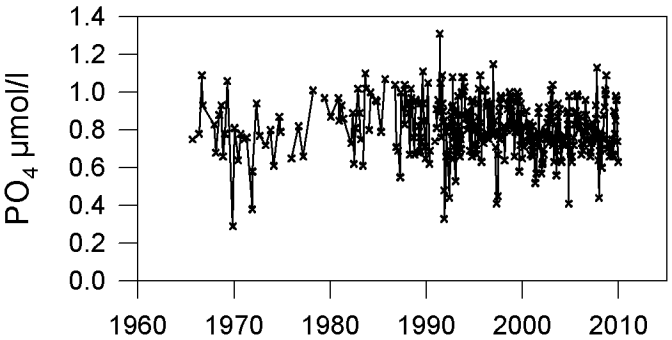


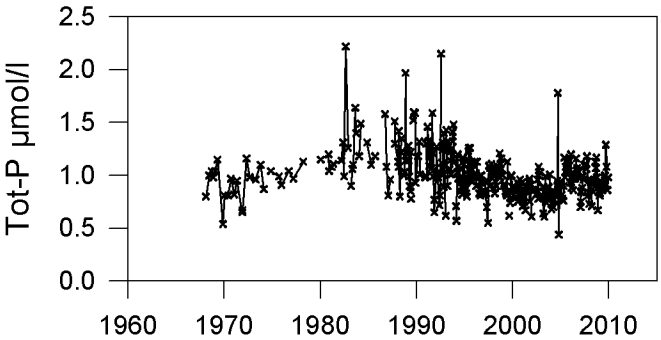


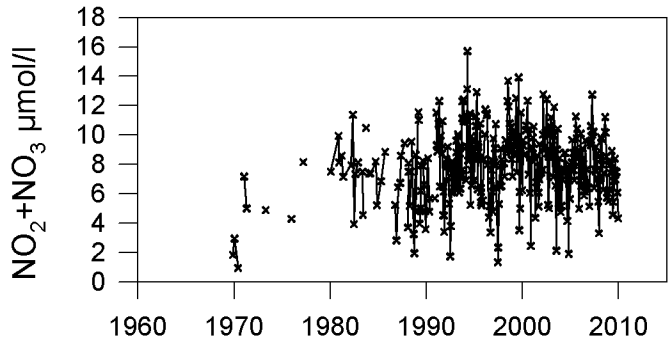
STATION FLADEN DEEP WATER (70m)

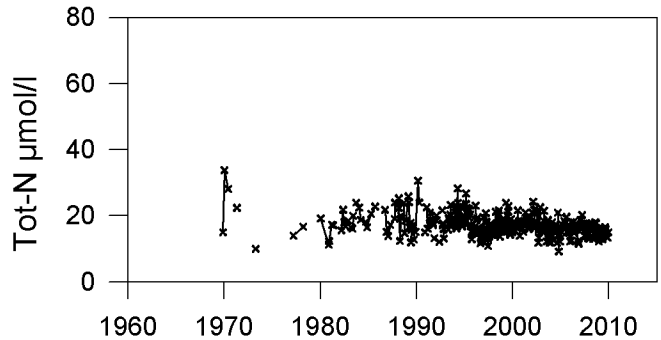


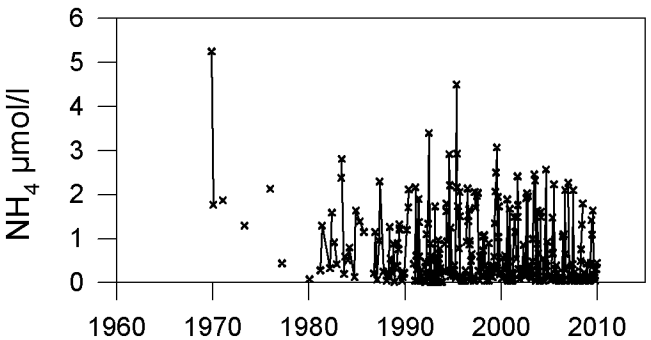


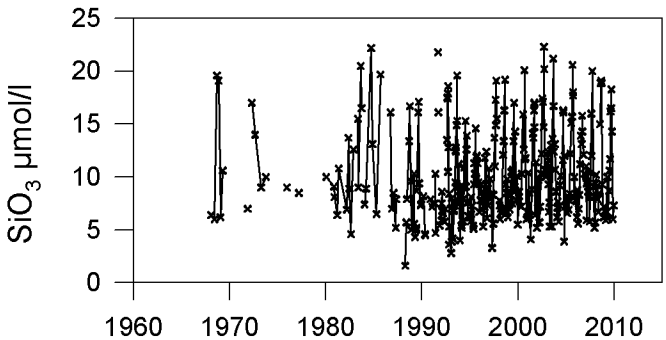


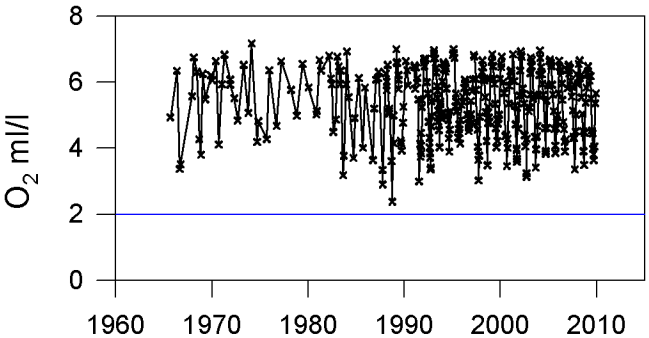






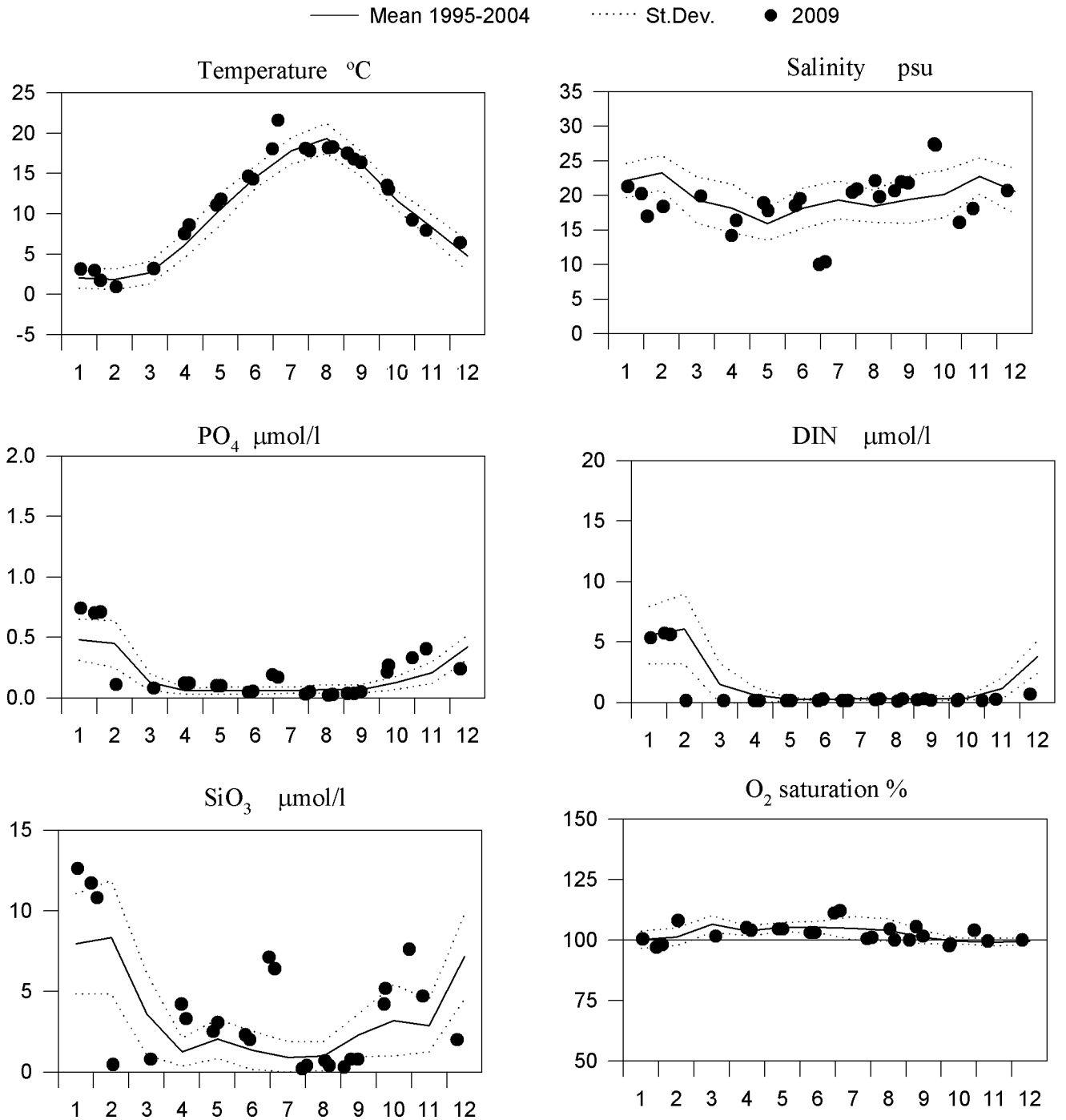




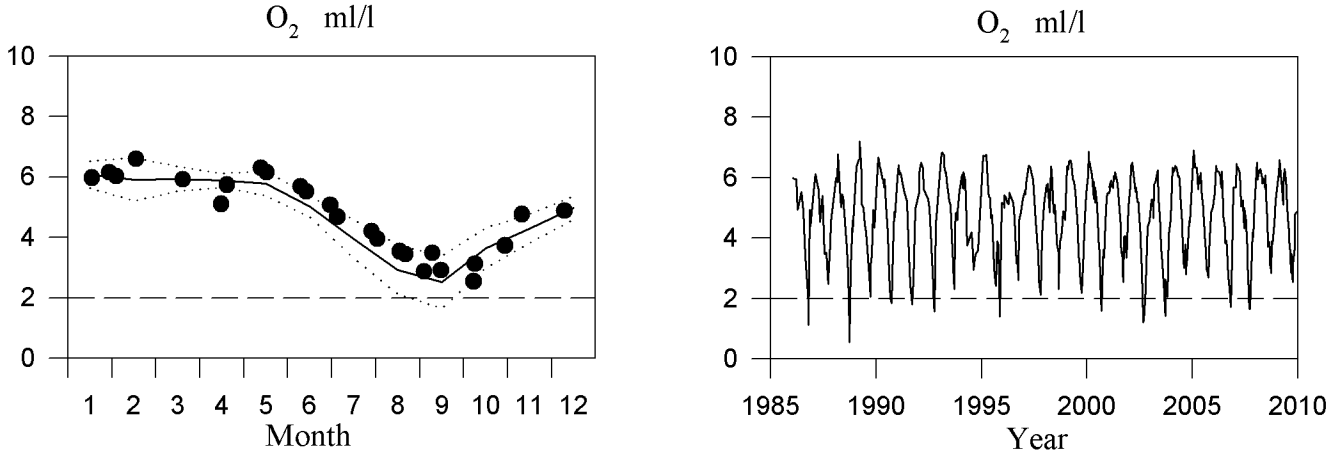


STATION ANHOLT E SURFACE WATER

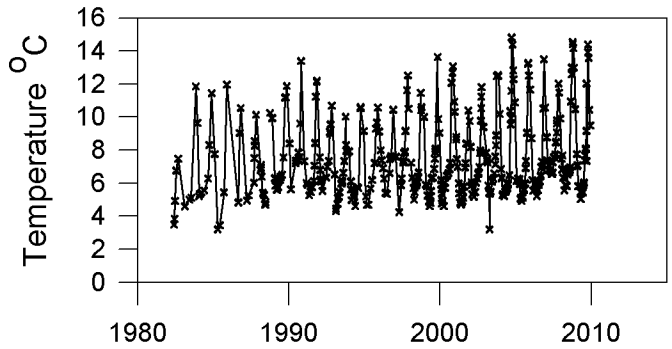
Annual Cycles

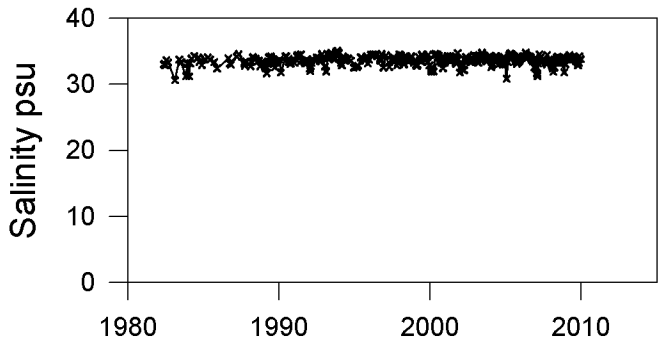


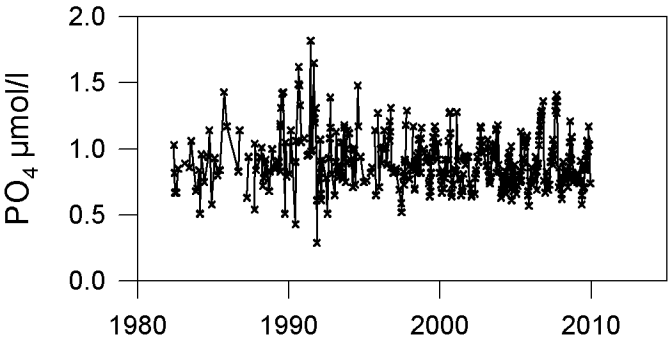
OXYGEN IN BOTTOM WATER

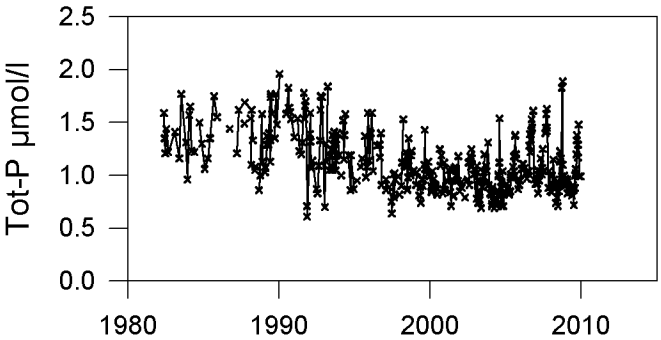


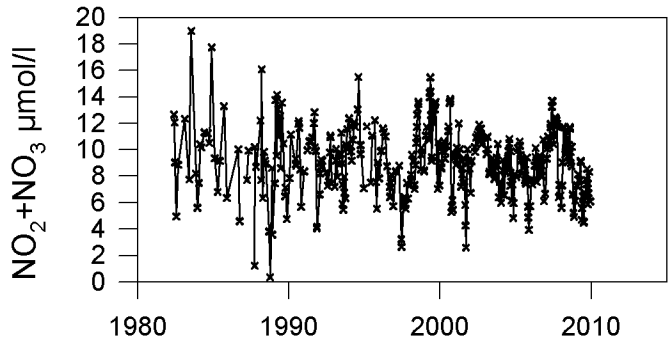
STATION ANHOLT-E DEEP WATER (50m)

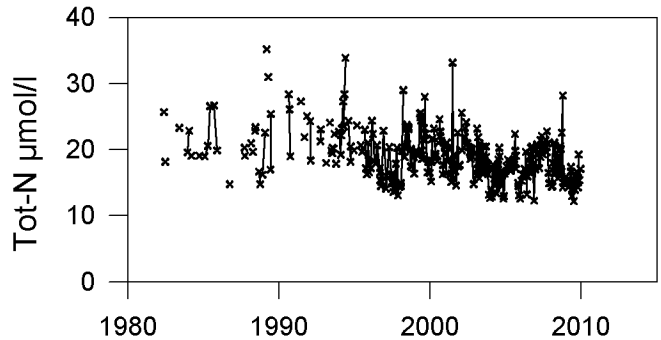


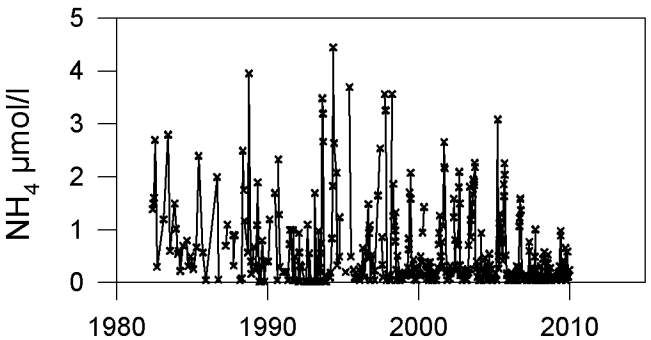


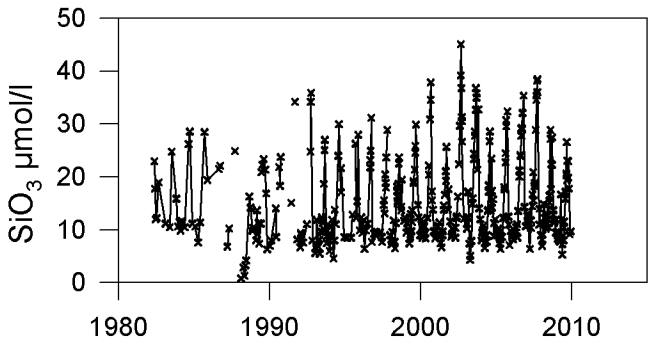


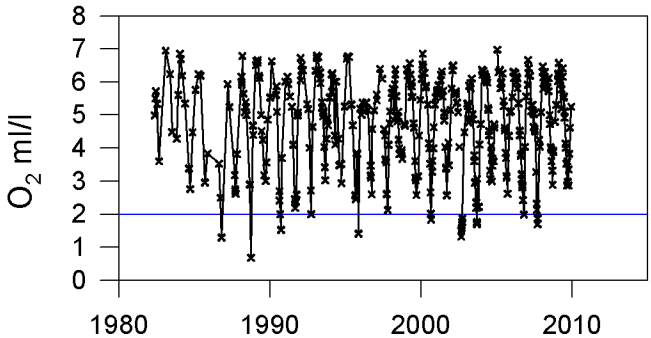






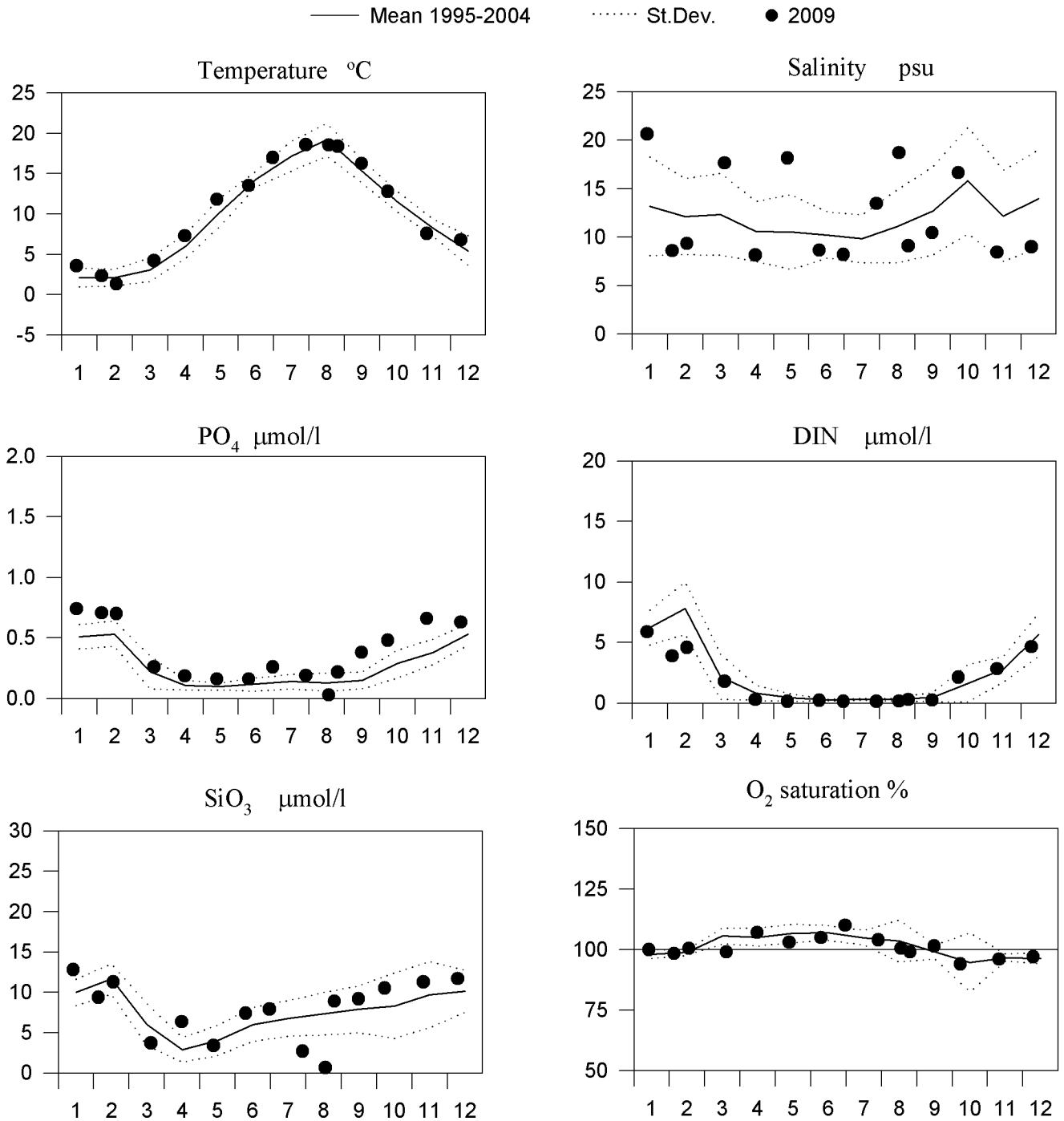




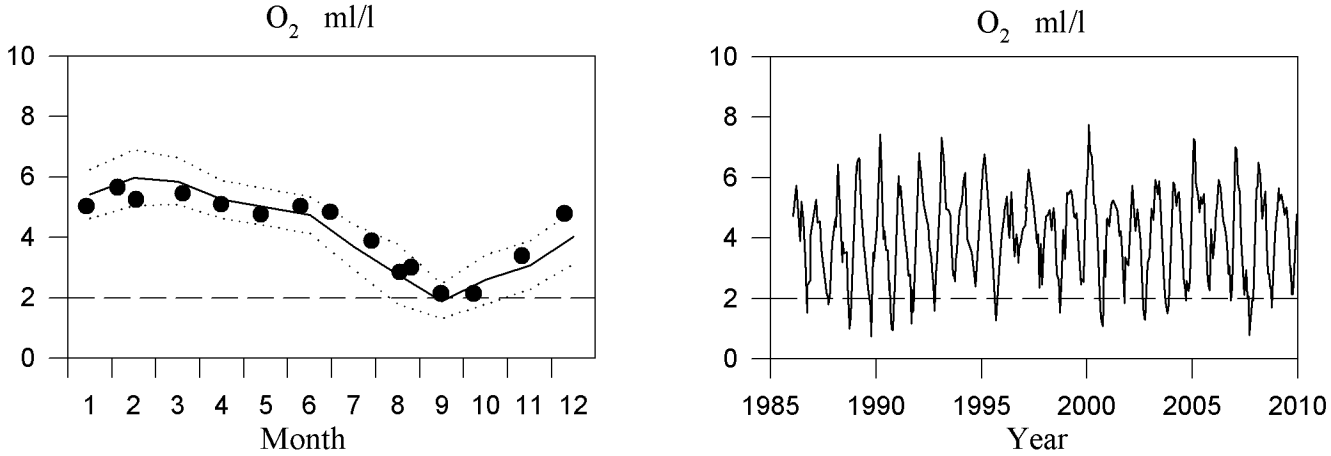


STATION W LANDSKRONA SURFACE WATER

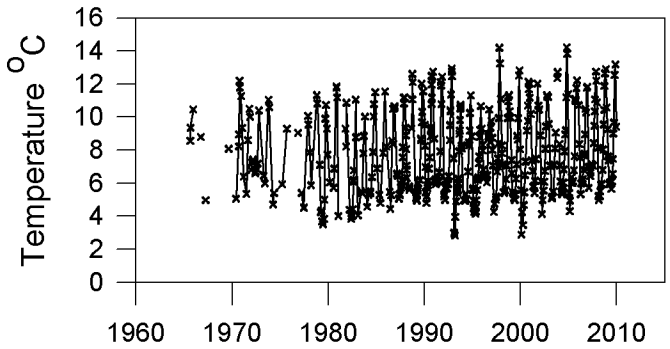
Annual Cycles

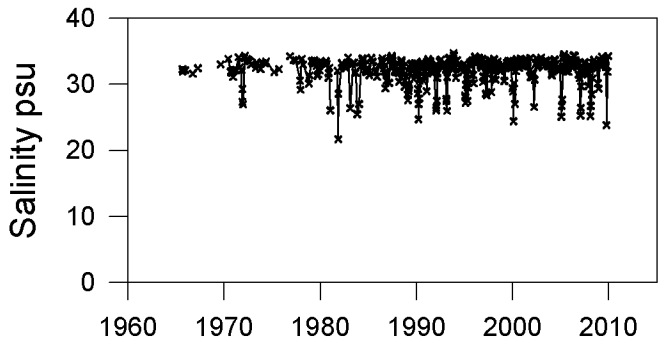


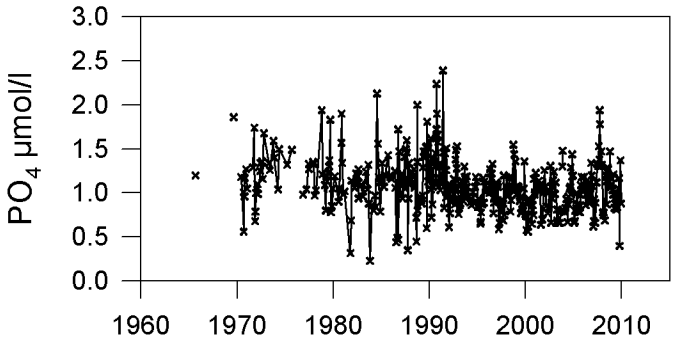
OXYGEN IN BOTTOM WATER

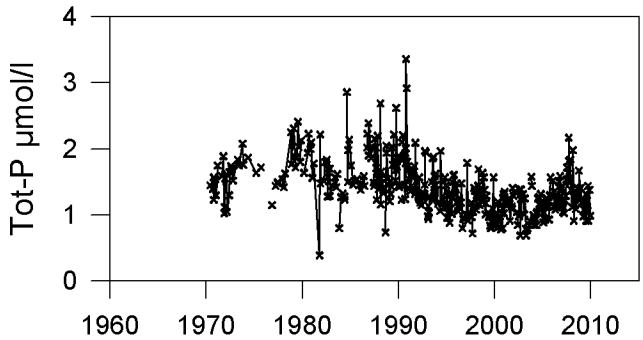


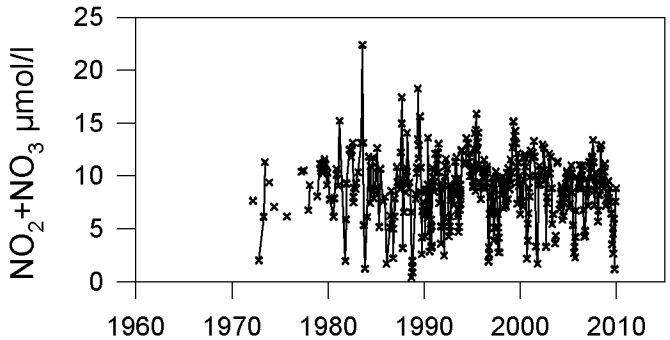
STATION W LANDSKRONA DEEP WATER (40m)

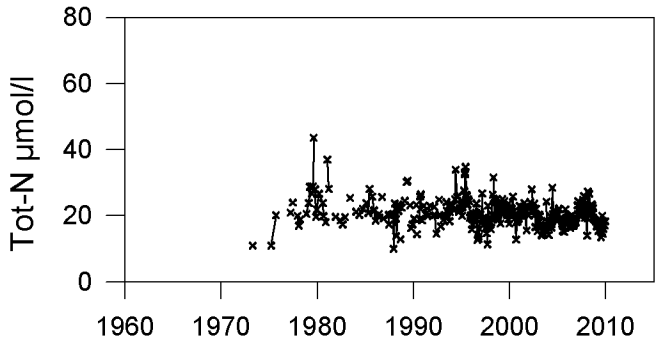


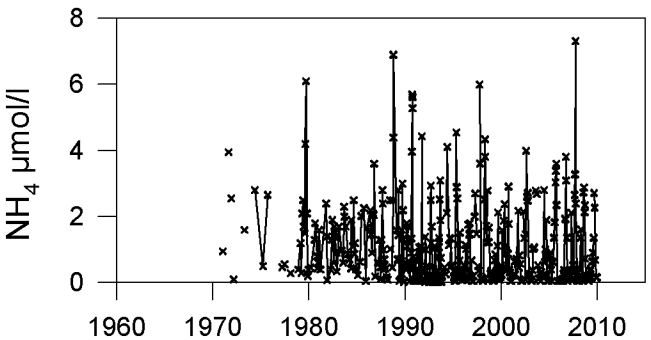


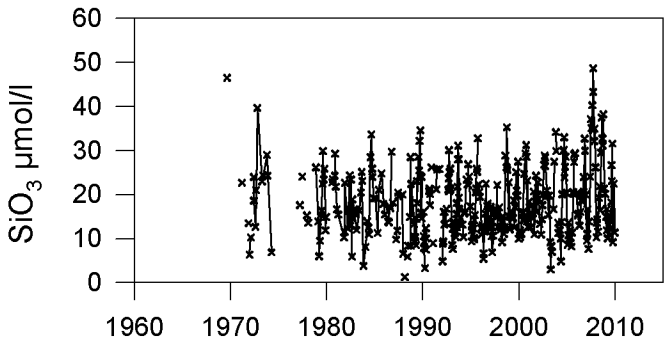


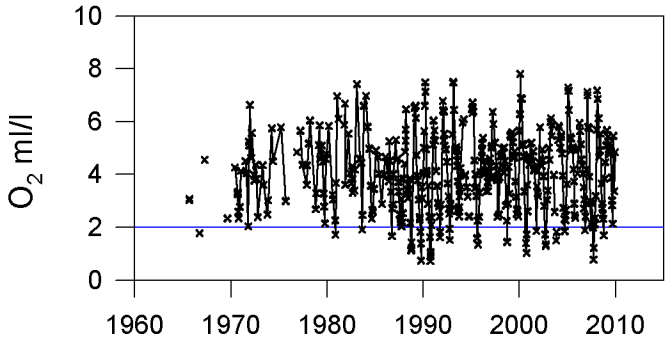








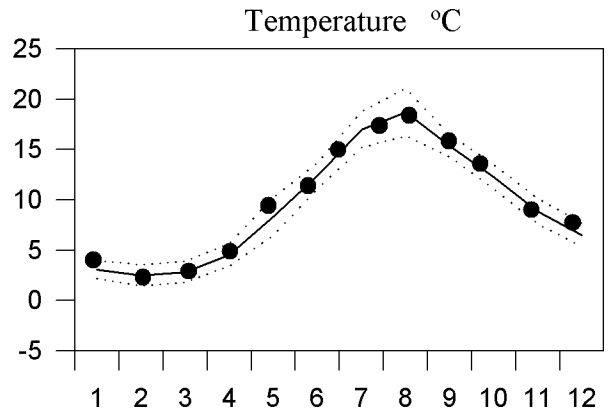


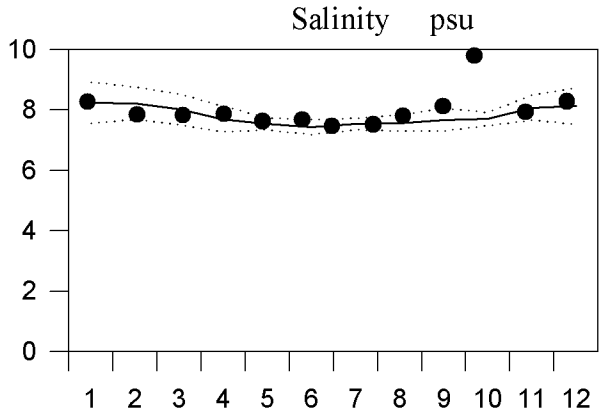


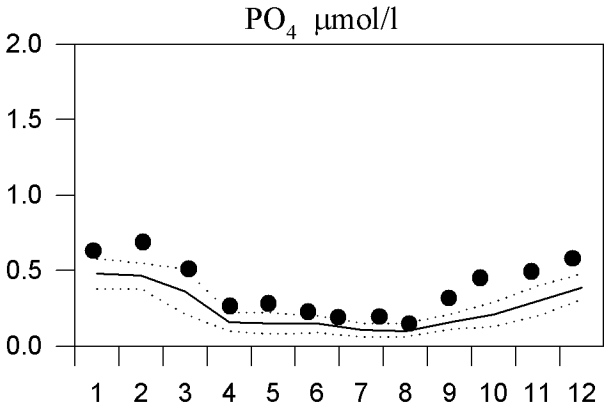
STATION BY1 SURFACE WATER

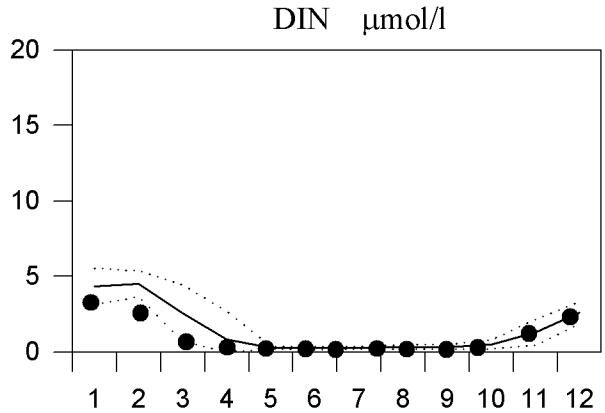
Annual Cycles

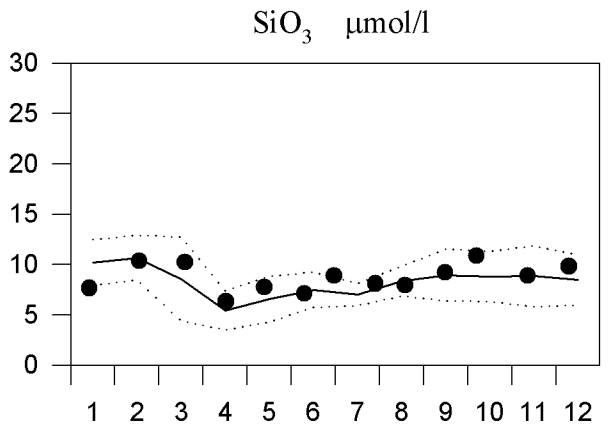
Mean 1995-2004 St.Dev. 2009

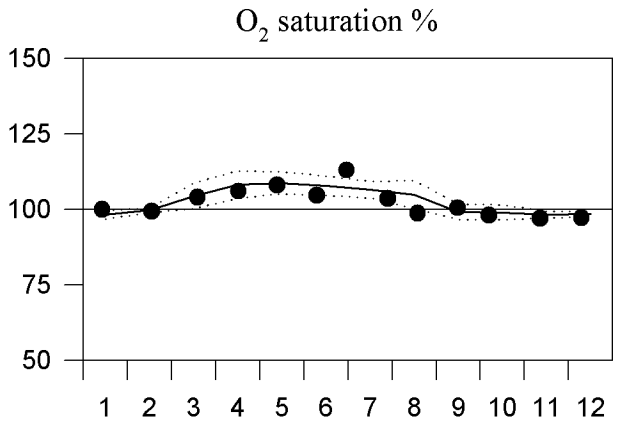




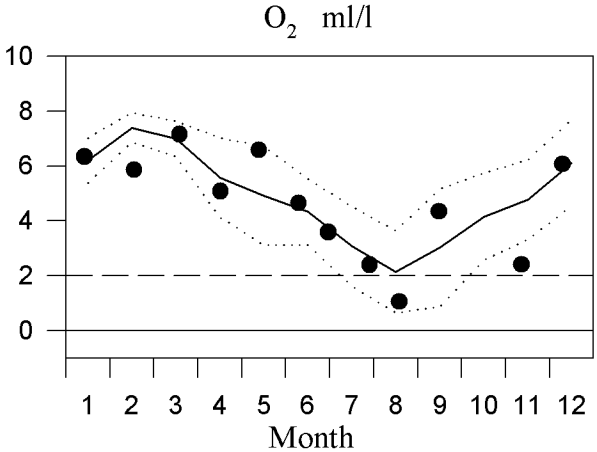


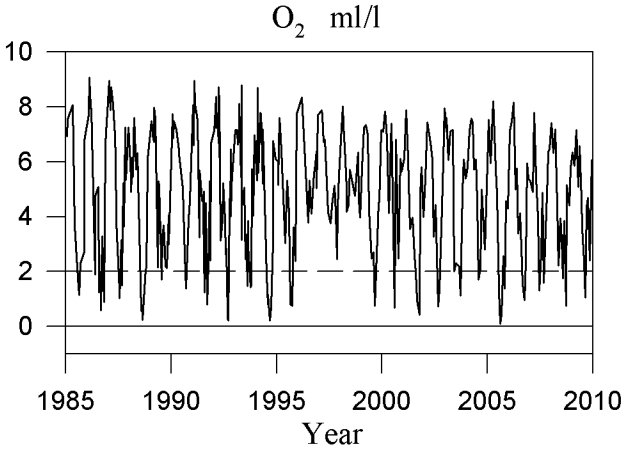




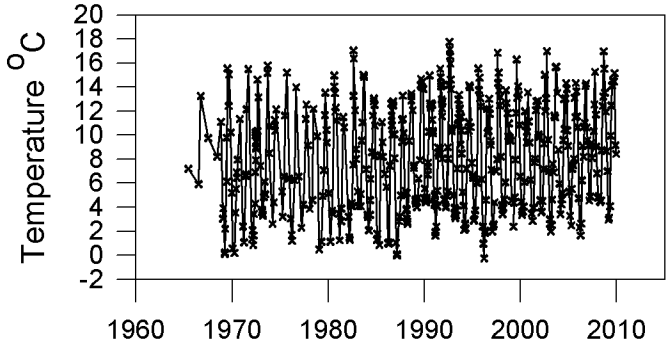


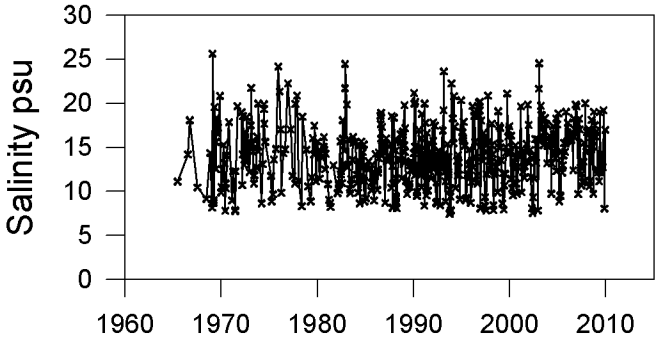
OXYGEN IN BOTTOM WATER

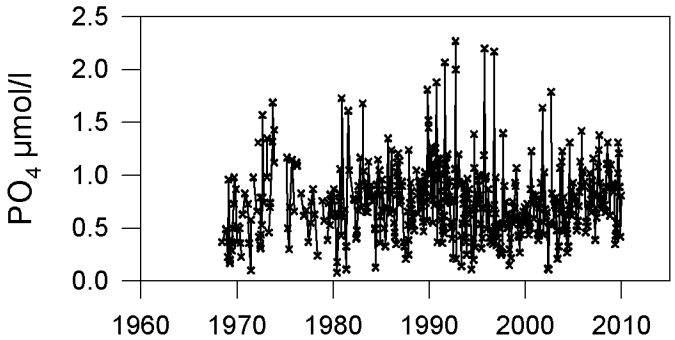


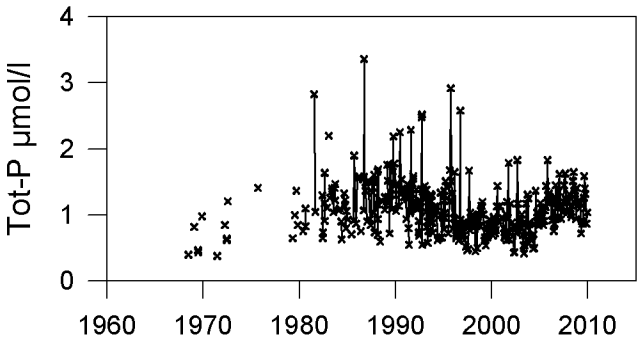


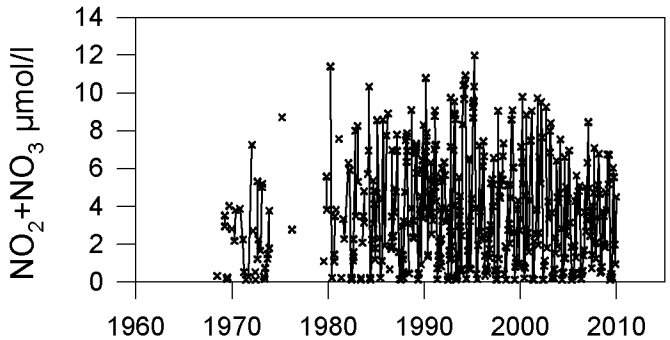
STATION BY1 DEEP WATER (40m)

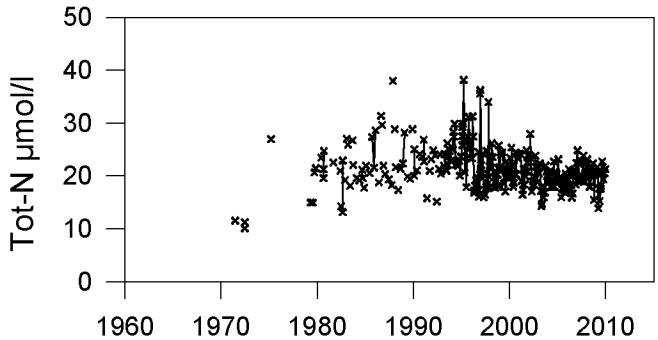


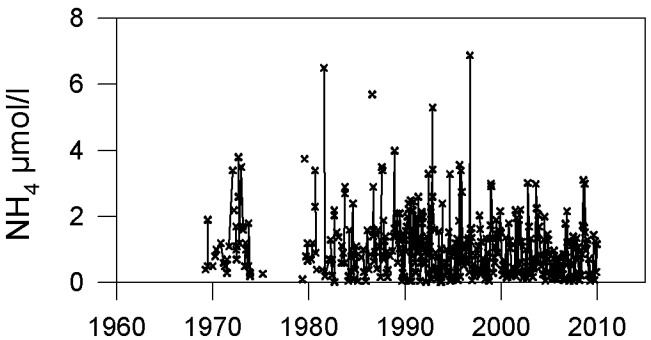


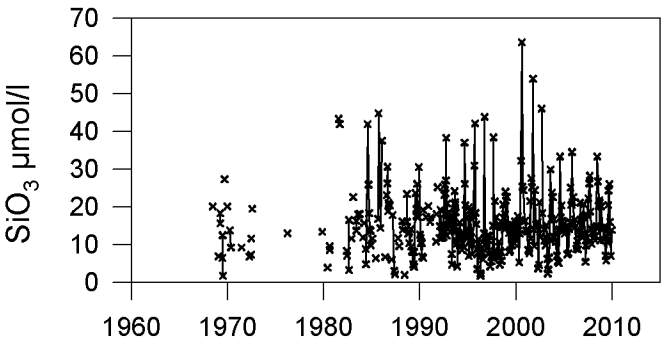


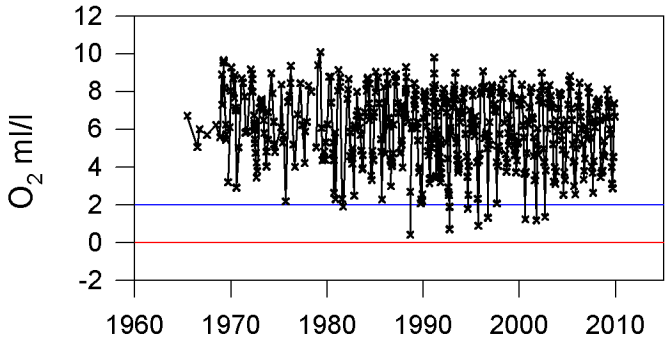








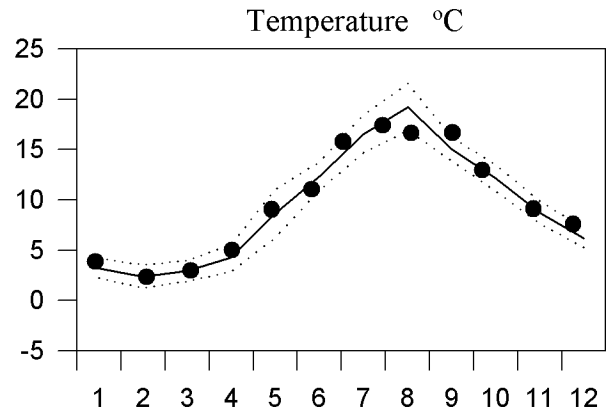


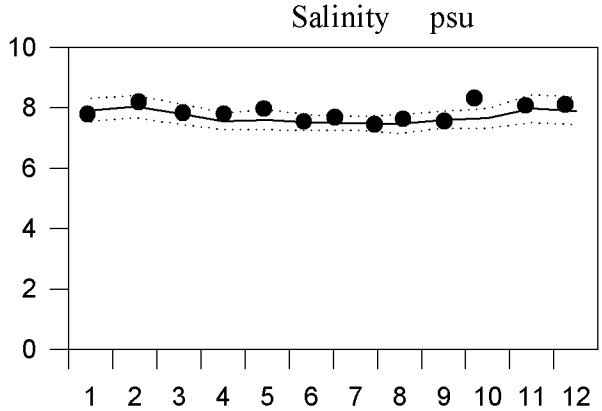


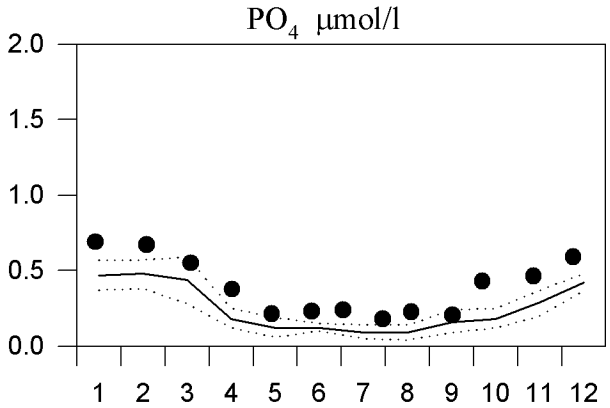
STATION BY2 SURFACE WATER

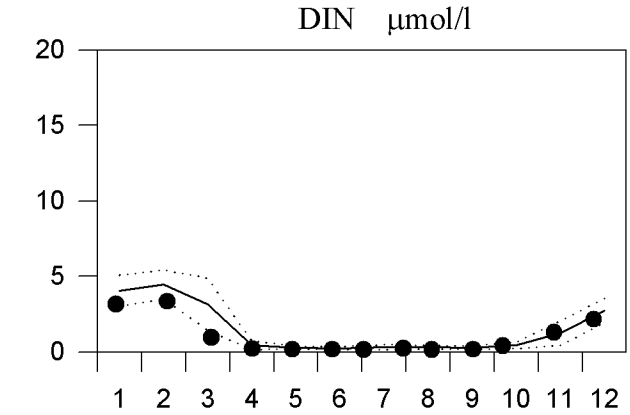
Annual Cycles

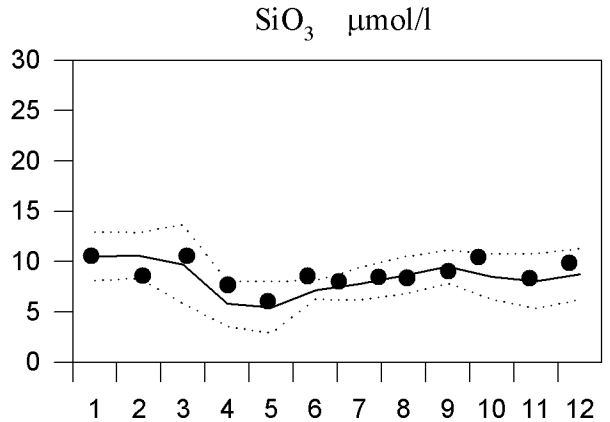
Mean 1995-2004 St.Dev. 2009

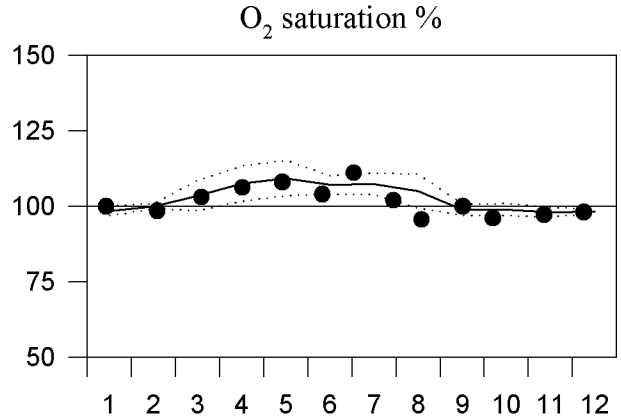




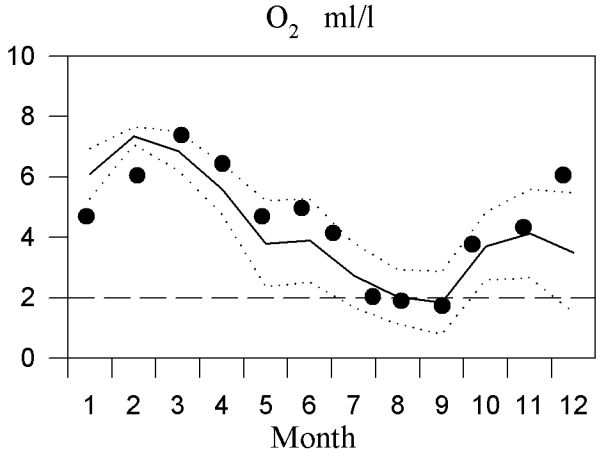


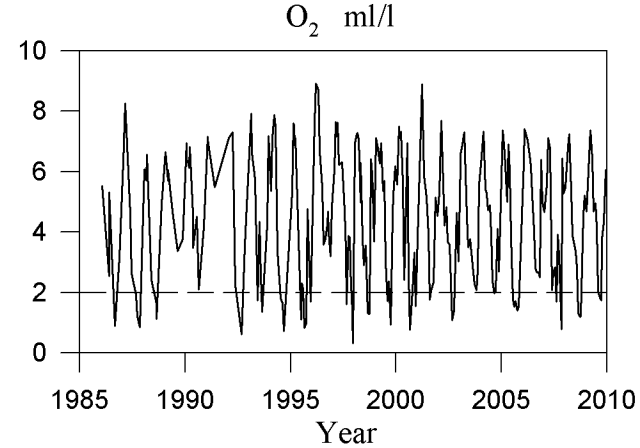




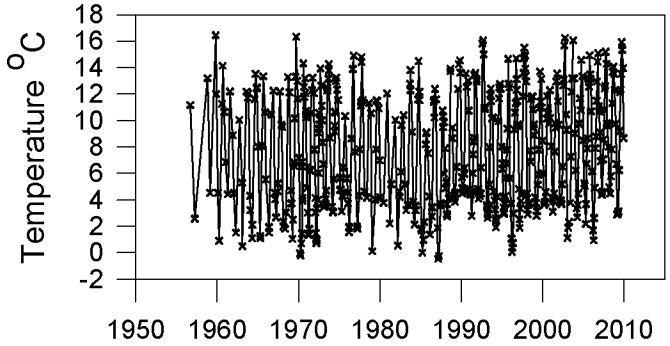


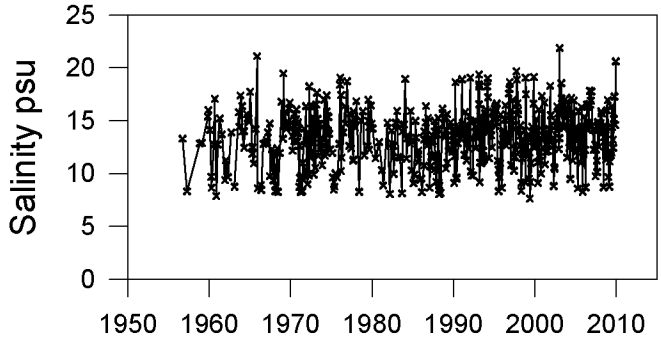
OXYGEN IN BOTTOM WATER

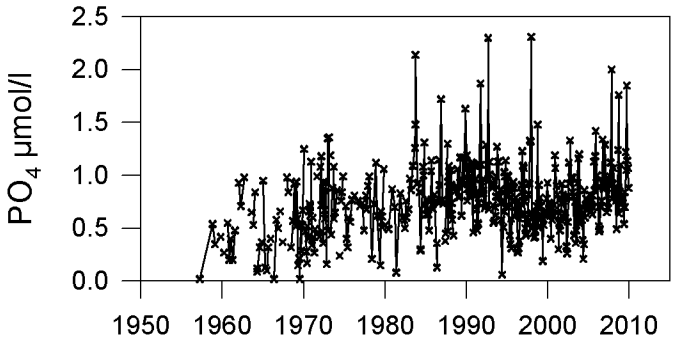


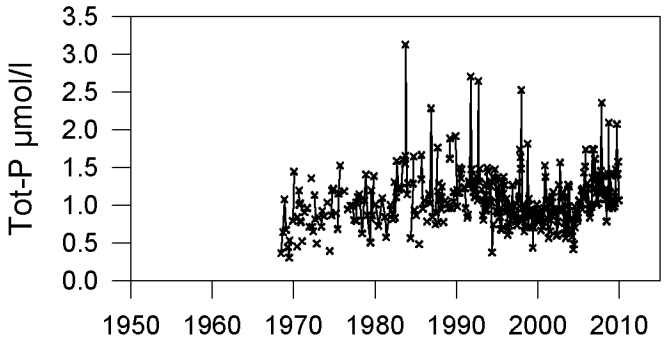


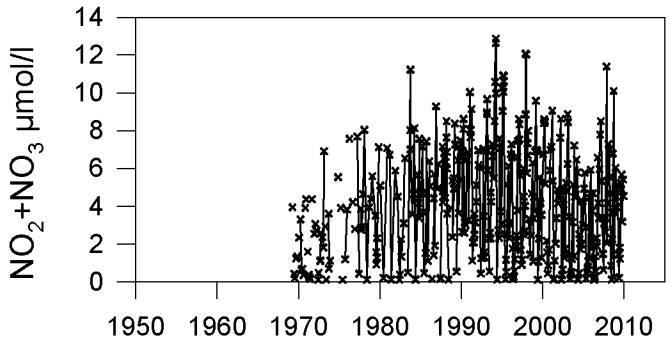
STATION BY2 DEEP WATER (40m)

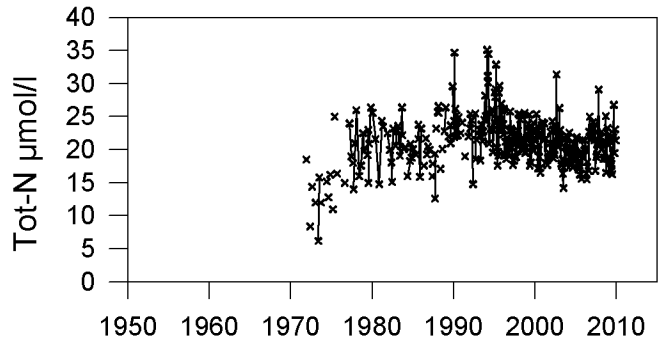


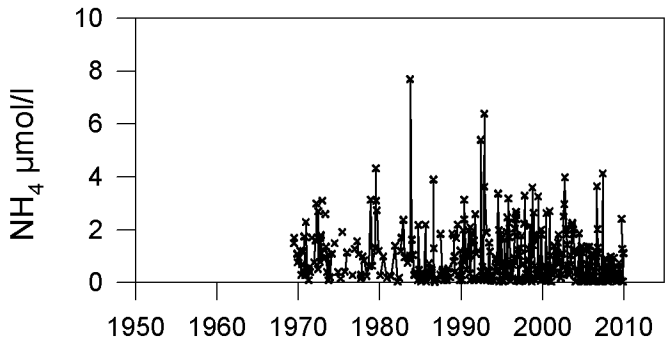


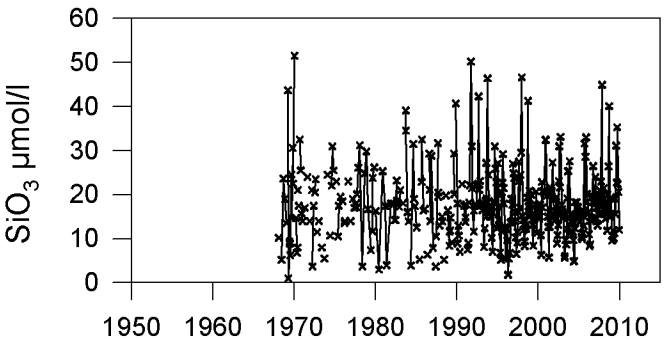


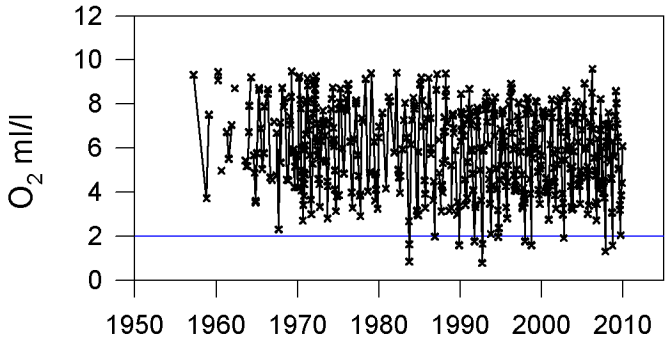








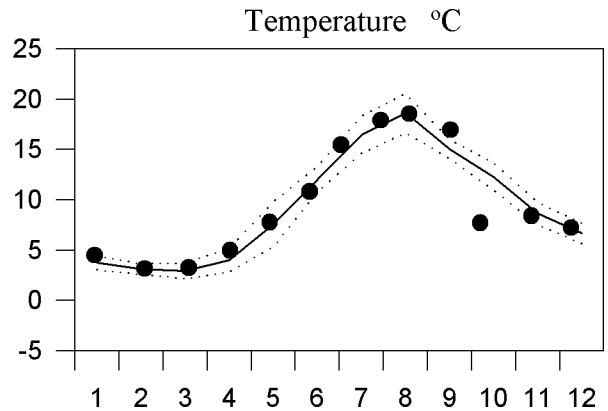


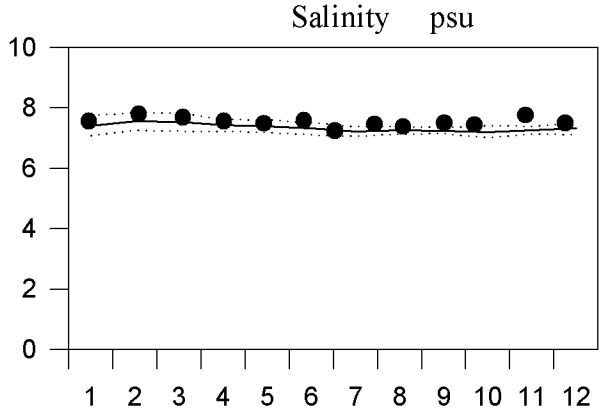


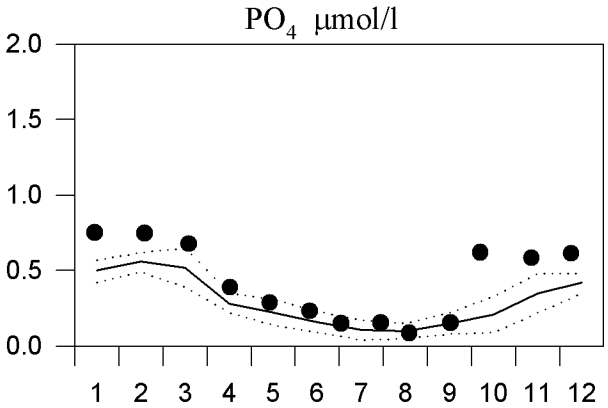
STATION BY4 SURFACE WATER

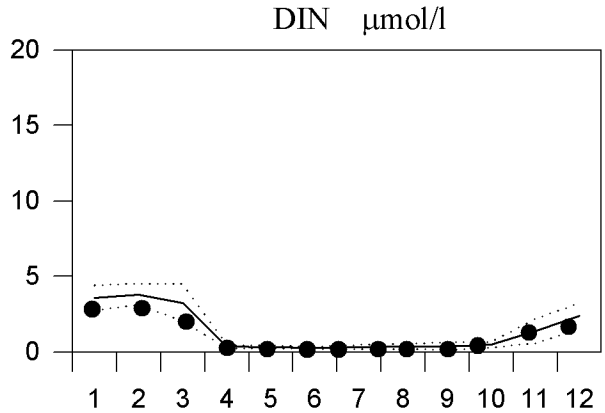
Annual Cycles

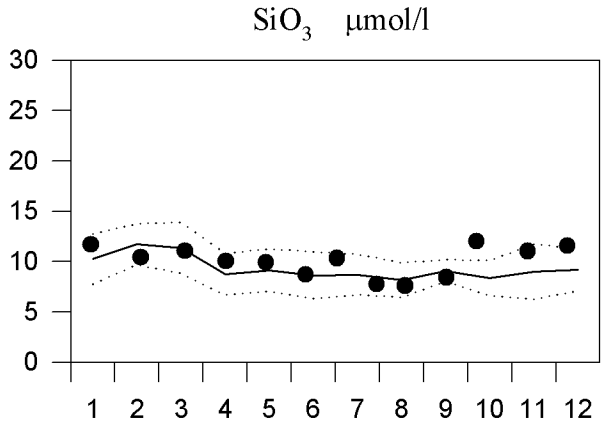
Mean 1995-2004 St.Dev. 2009

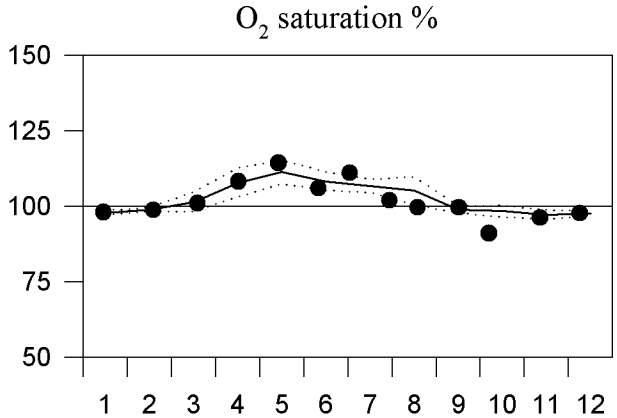




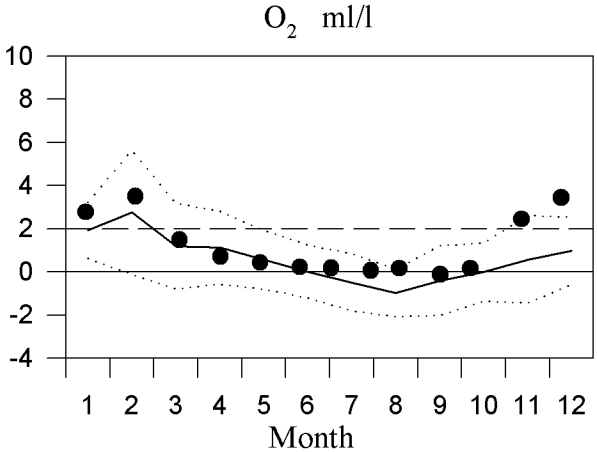


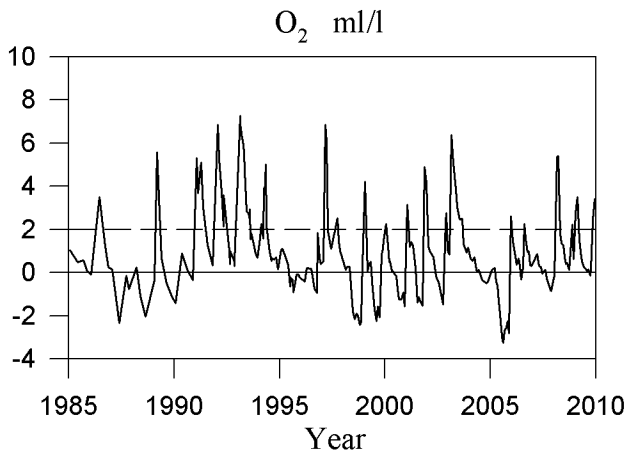




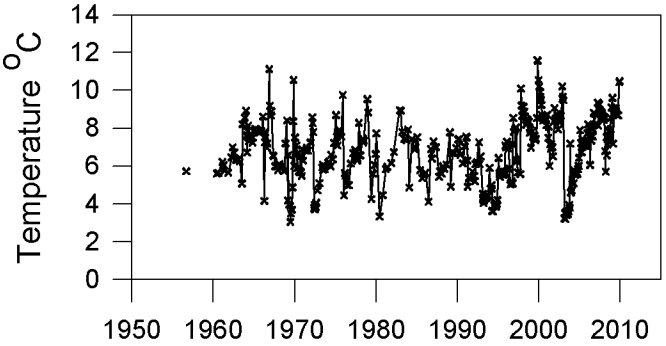


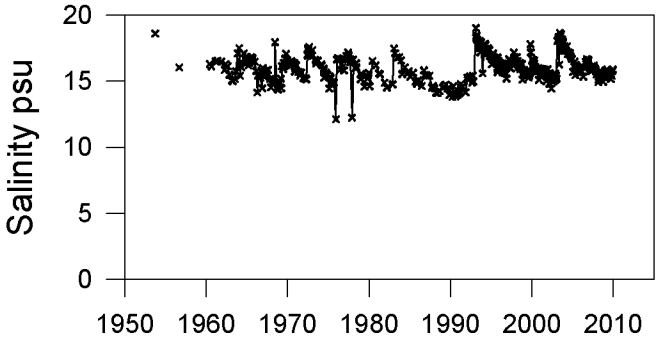
OXYGEN IN BOTTOM WATER

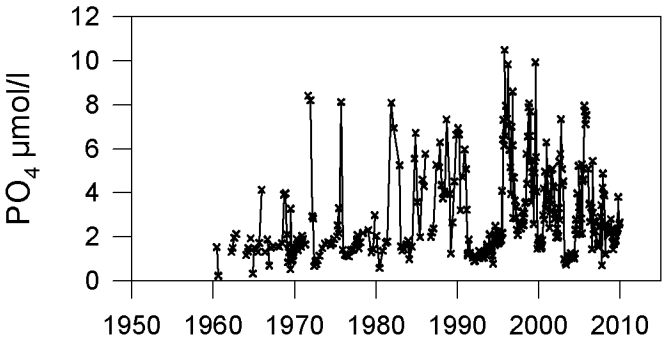


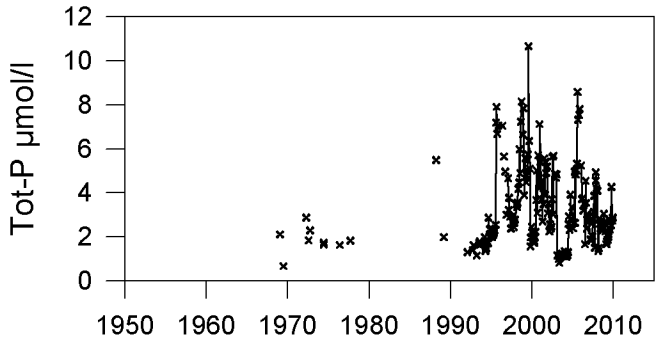


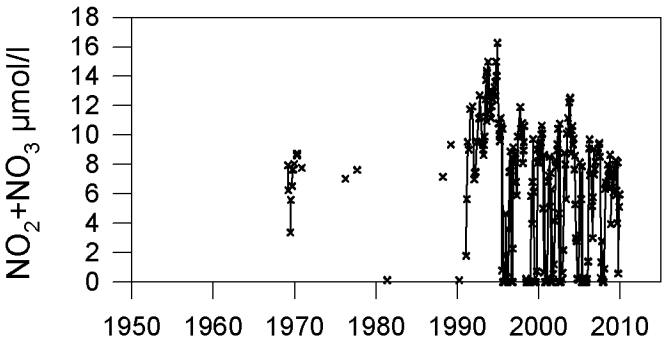
STATION BY4 DEEP WATER (80m)

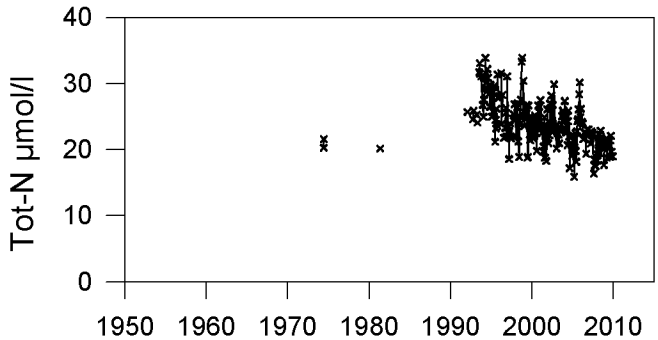


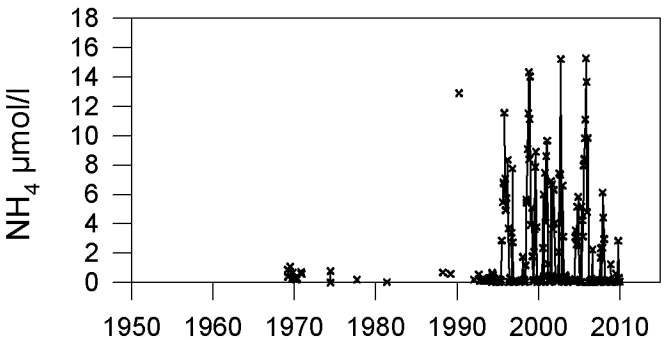


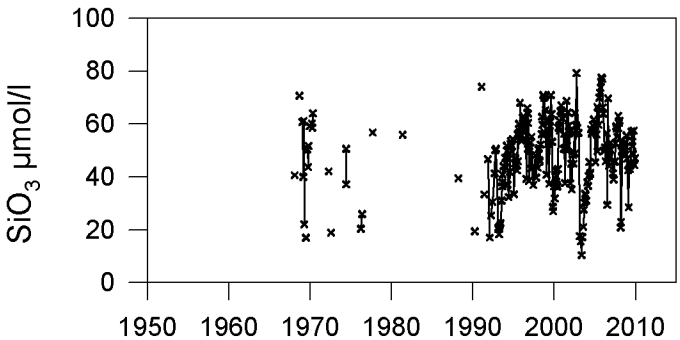


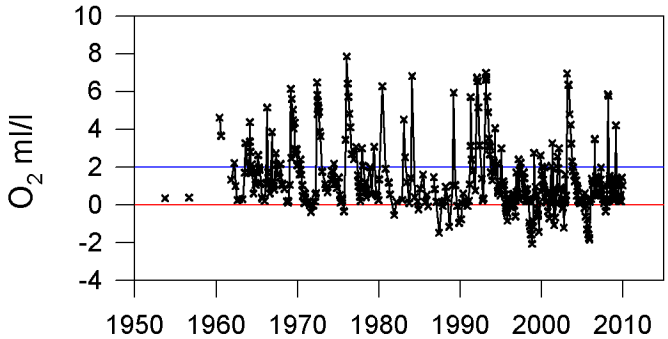








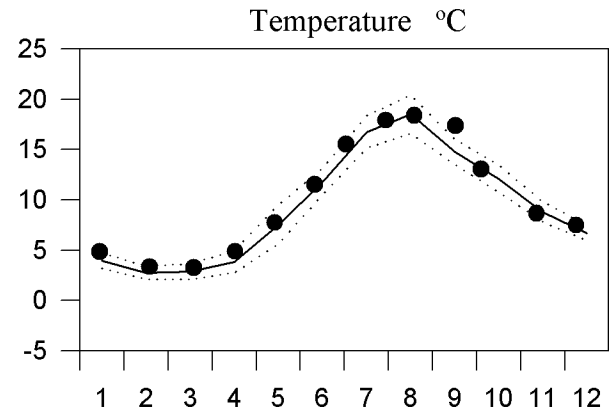


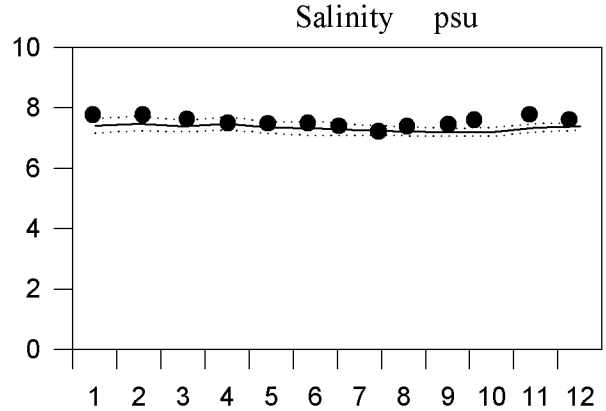


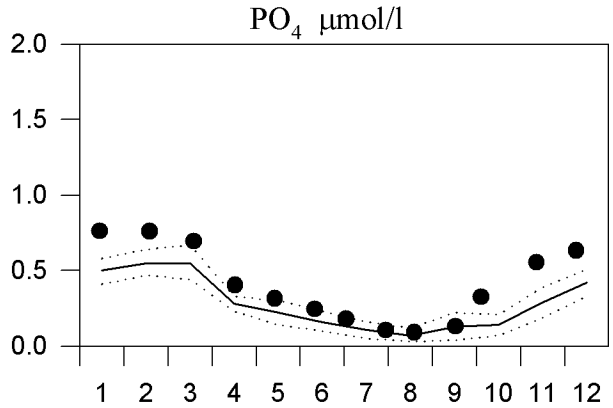
STATION BY5 SURFACE WATER

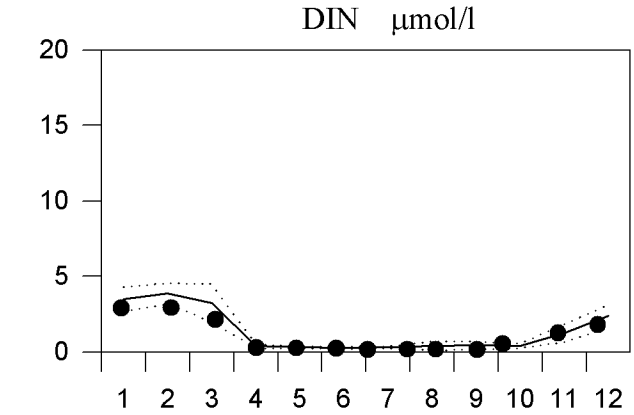
Annual Cycles

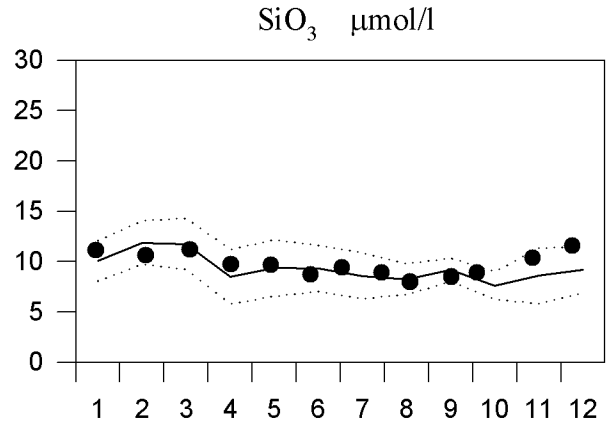
Mean 1995-2004 St.Dev. 2009

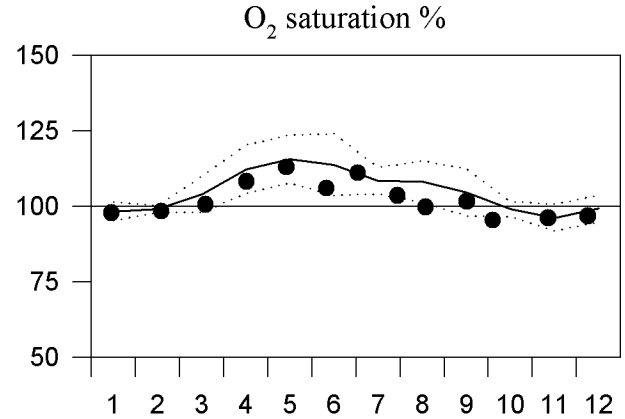




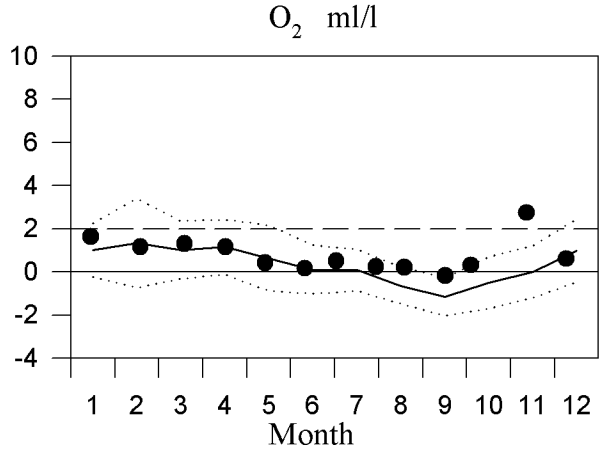


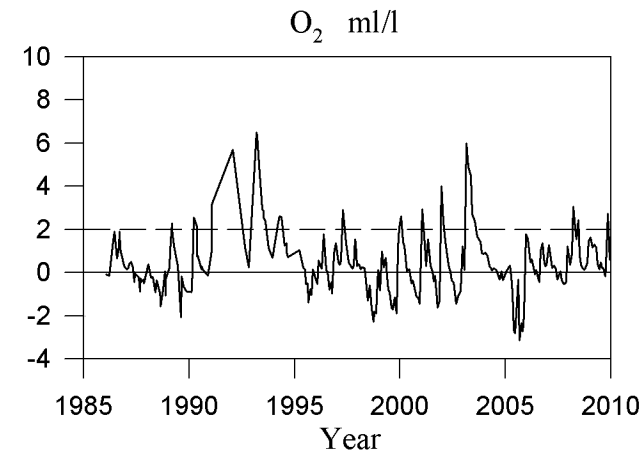




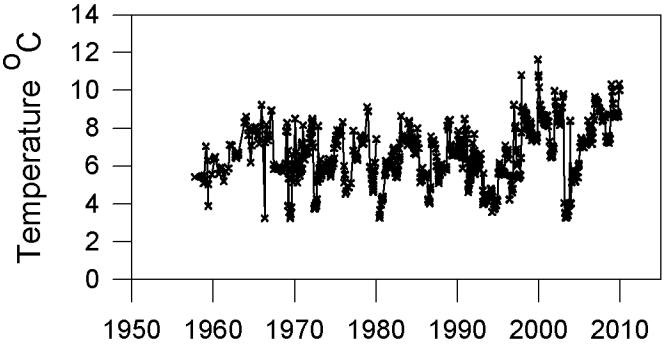


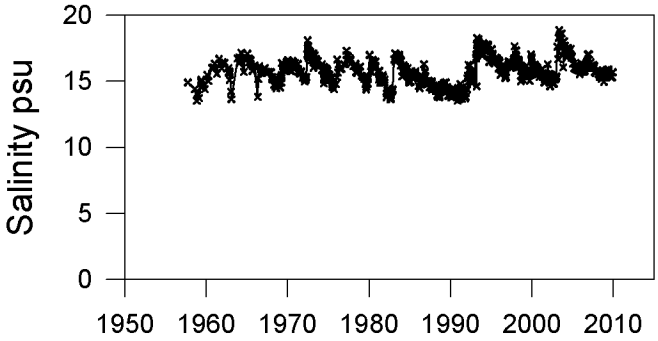
OXYGEN IN BOTTOM WATER

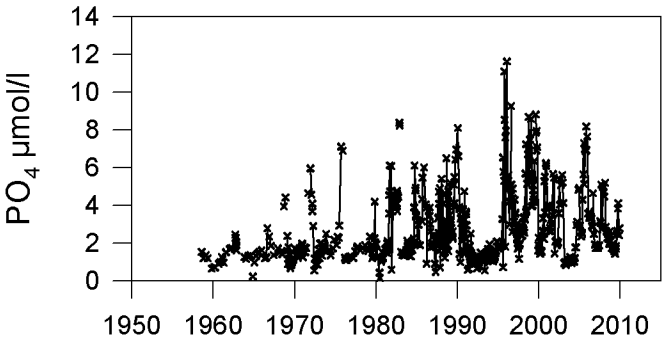


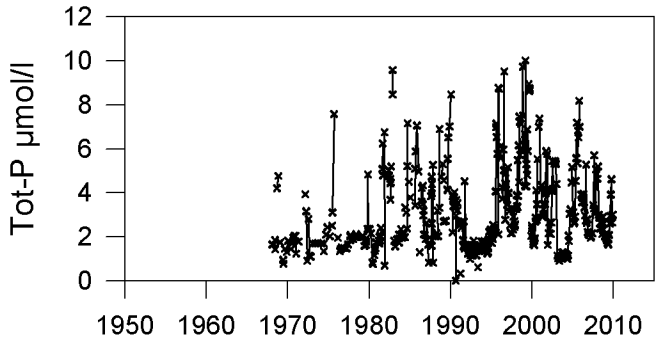


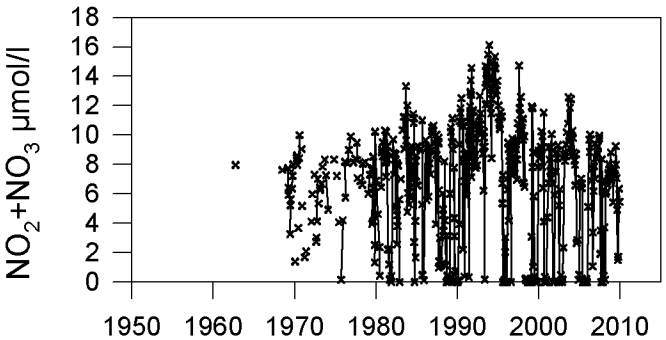
STATION BY5 DEEP WATER (80m)

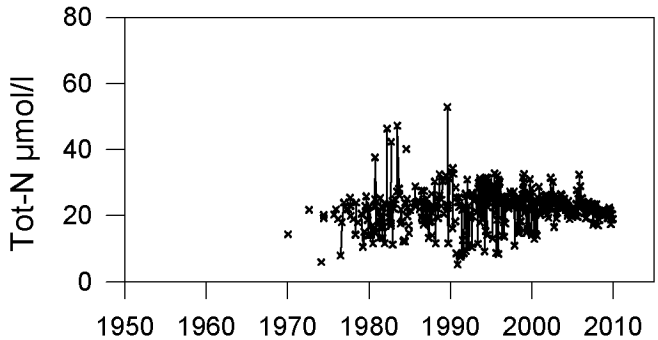


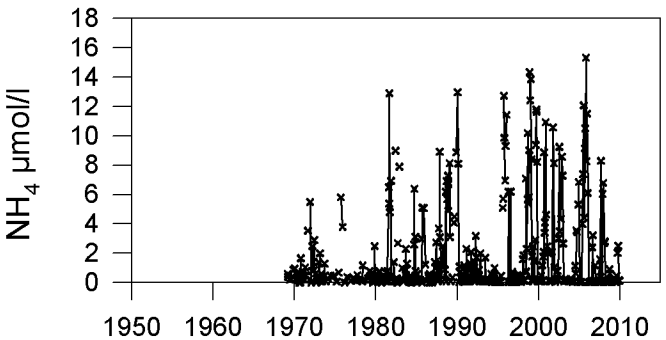


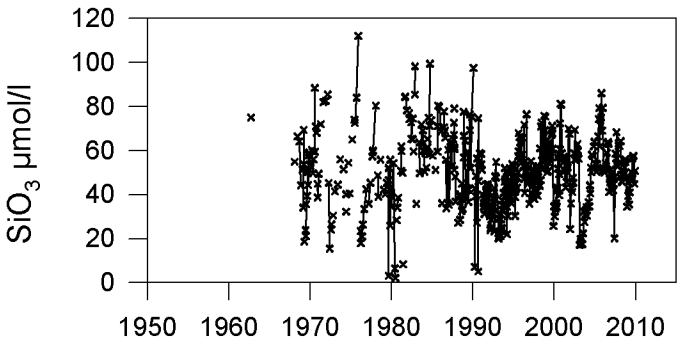


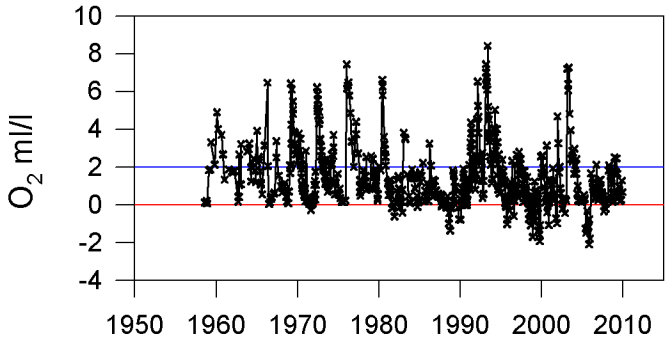






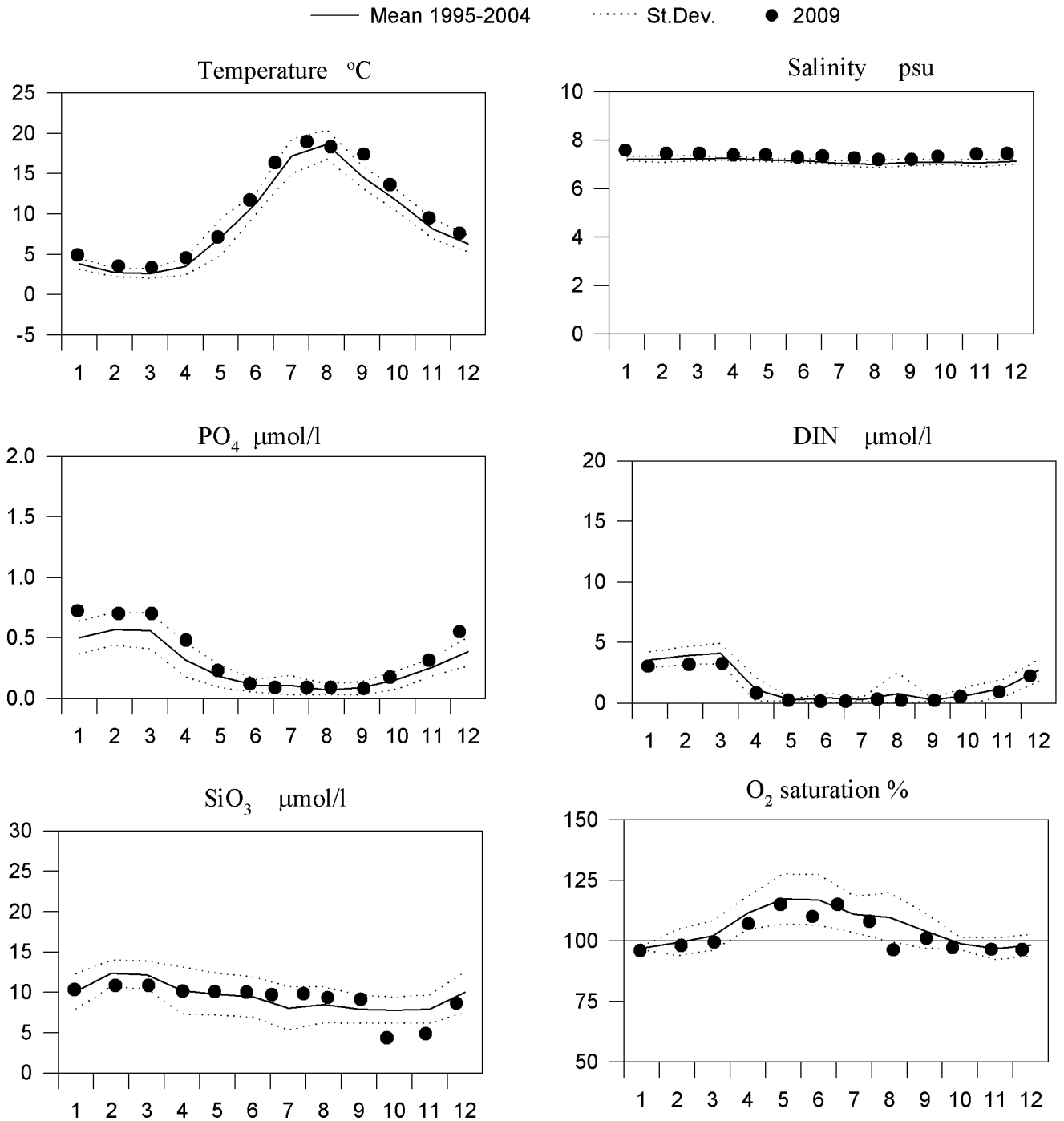




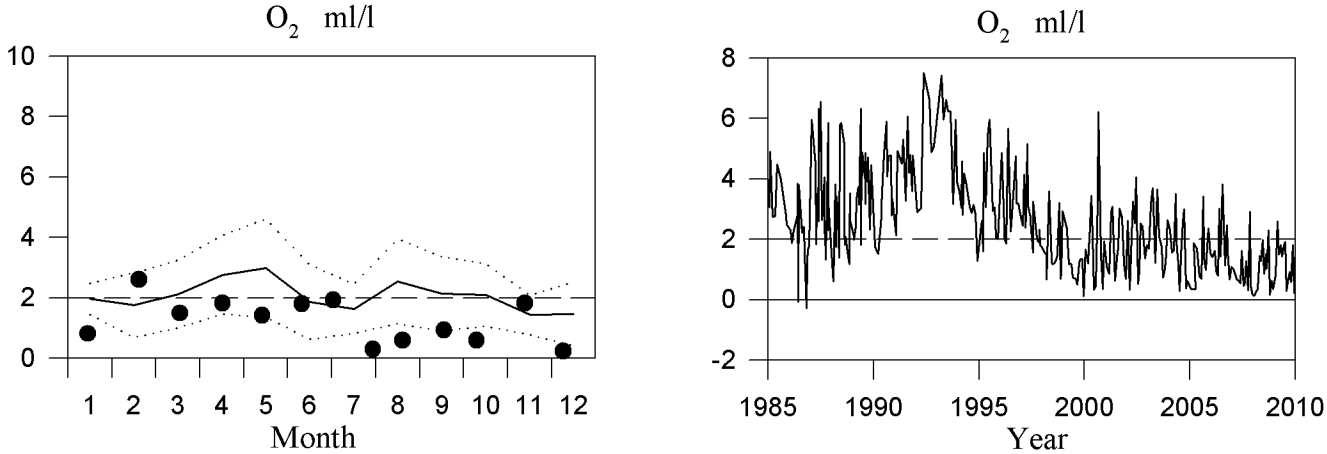


STATION BCS III-10 SURFACE WATER

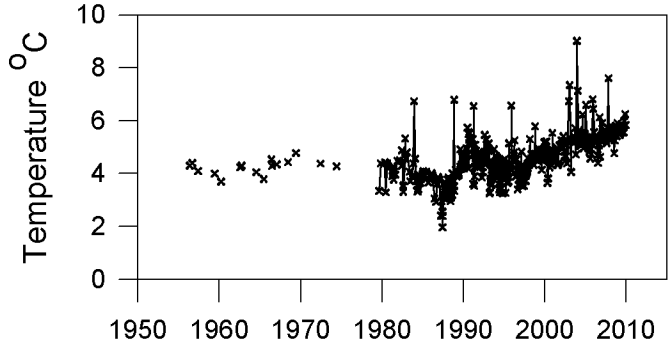
Annual Cycles

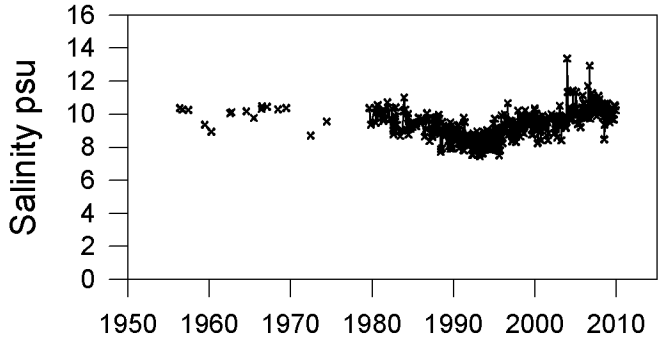


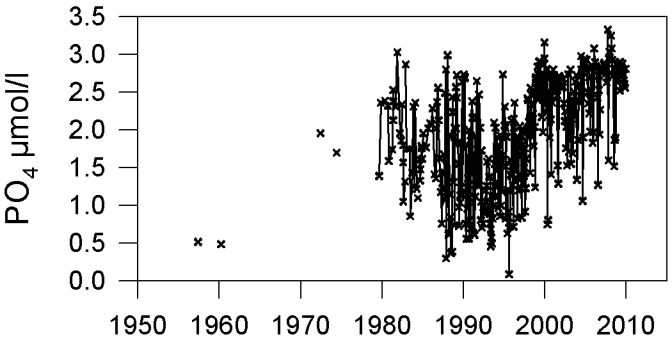
OXYGEN IN BOTTOM WATER

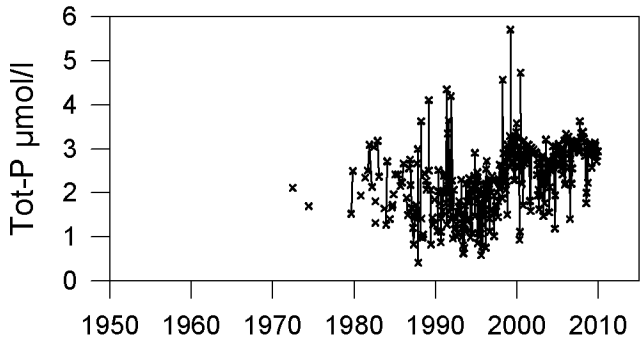


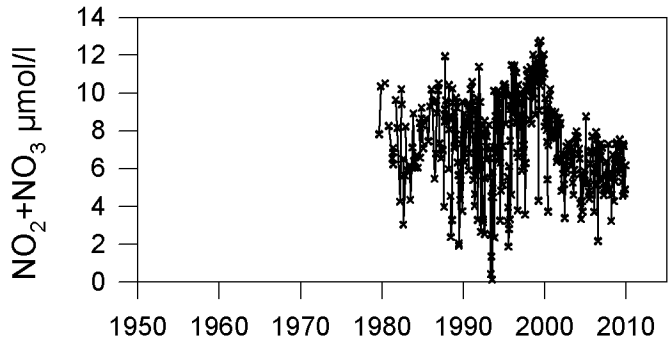
STATION BCS III-10 DEEP WATER (80m)

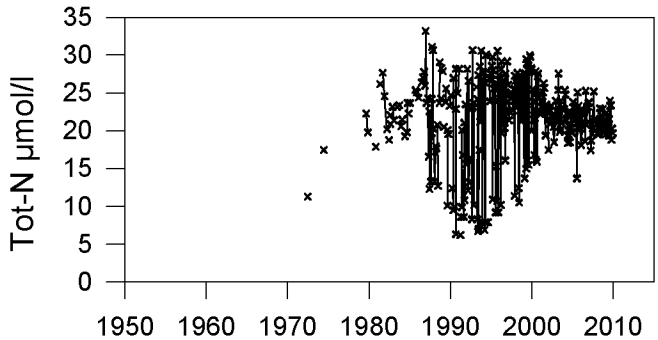


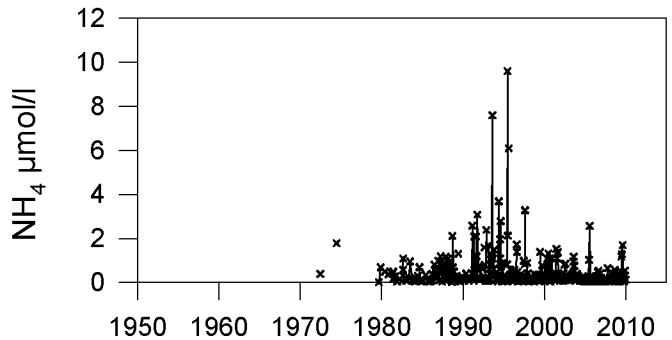


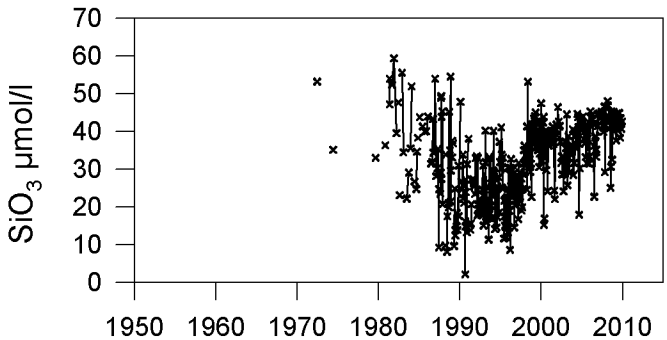


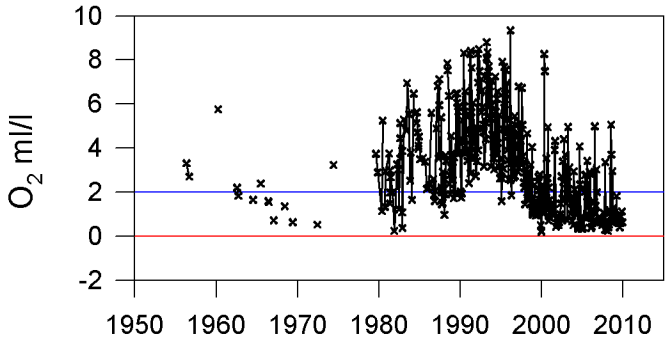








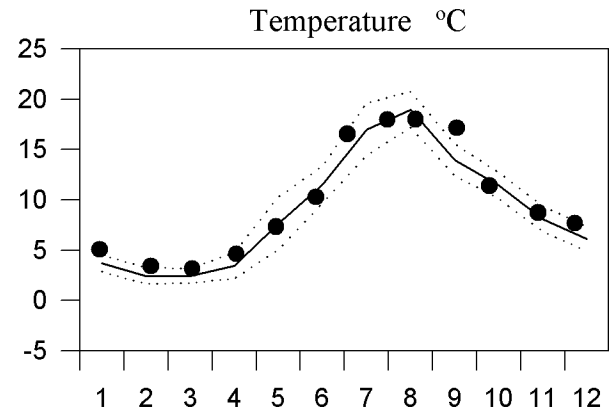


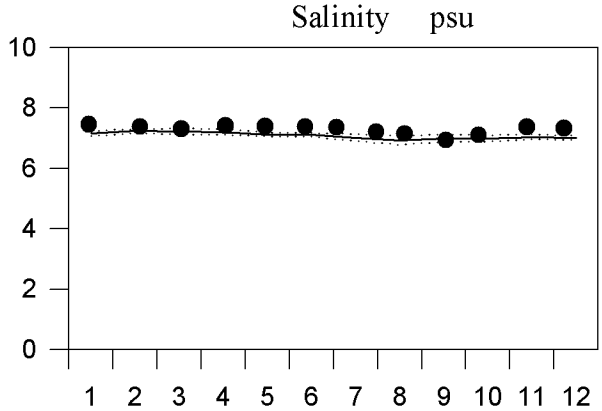


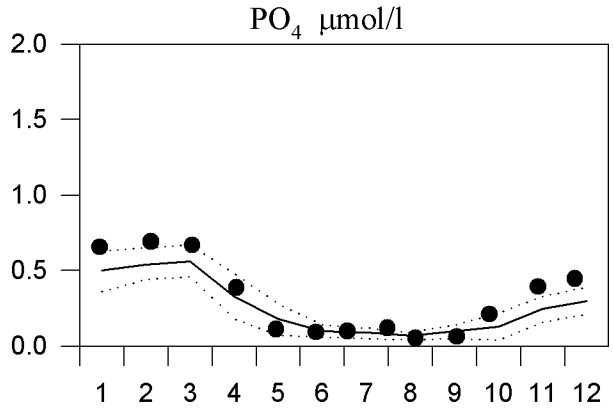
STATION BY10 SURFACE WATER

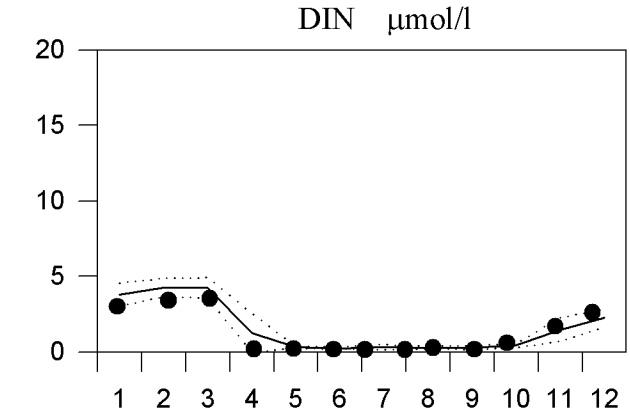
Annual Cycles

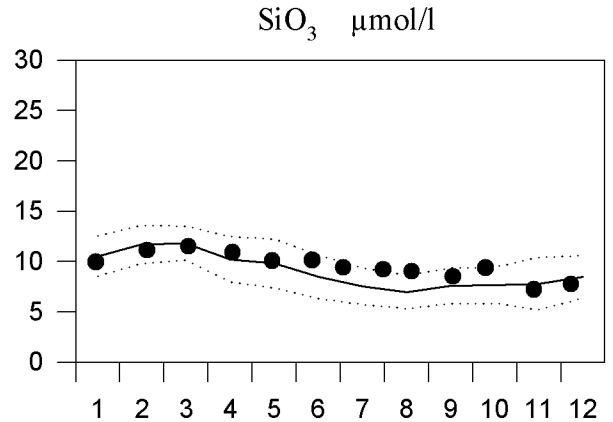
Mean 1995-2004 St.Dev. 2009

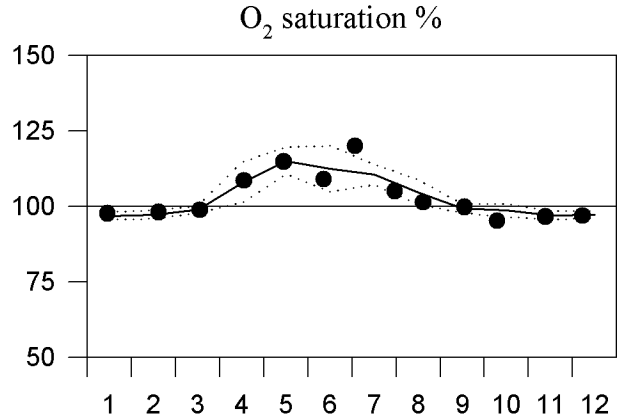




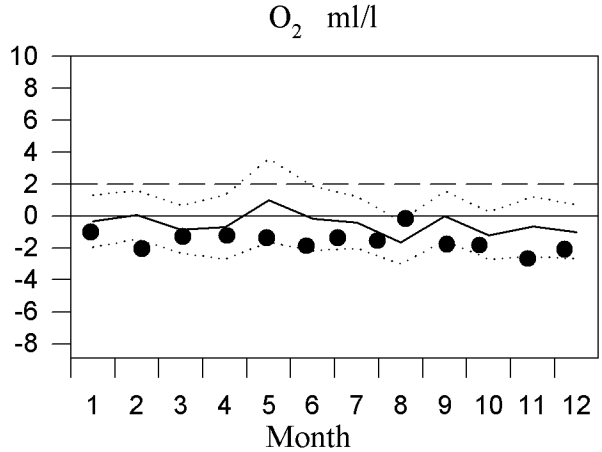


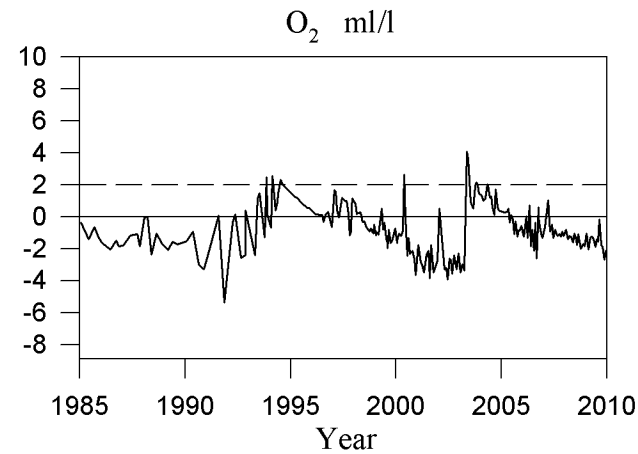




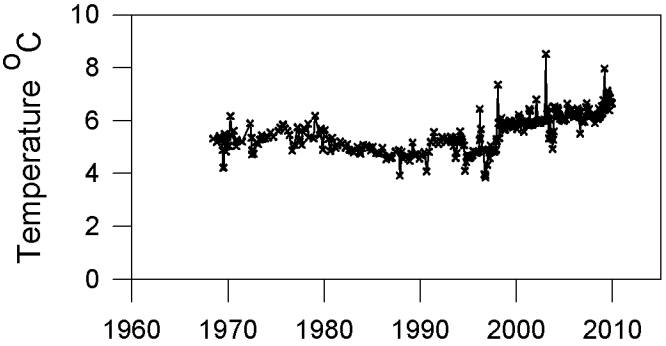


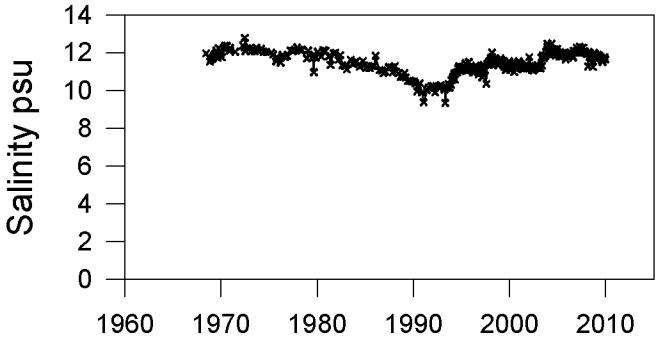
OXYGEN IN BOTTOM WATER

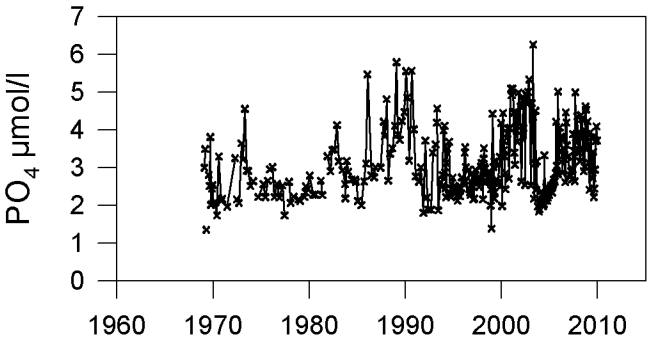


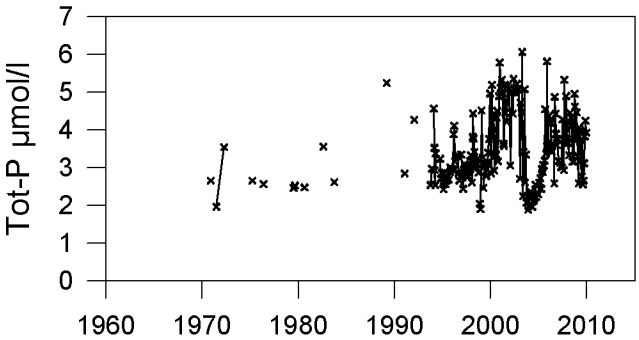


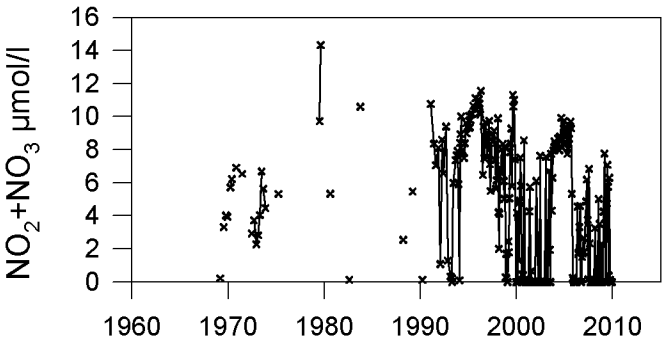
STATION BY10 DEEP WATER (125m)

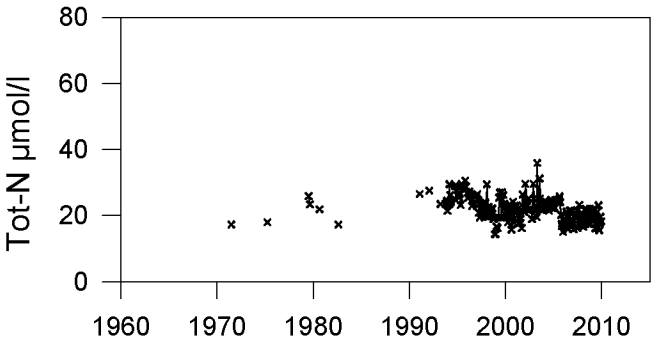


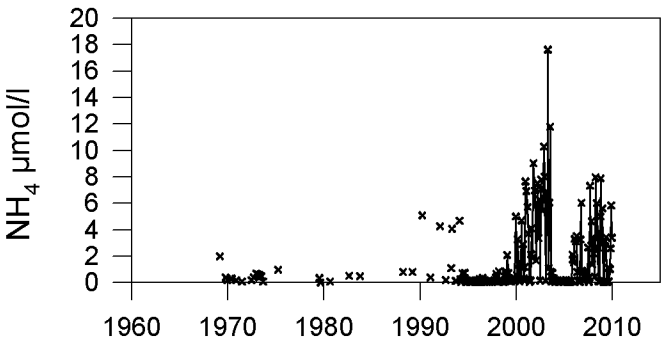


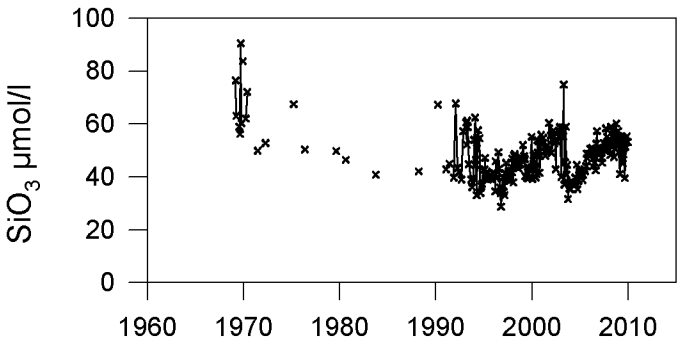


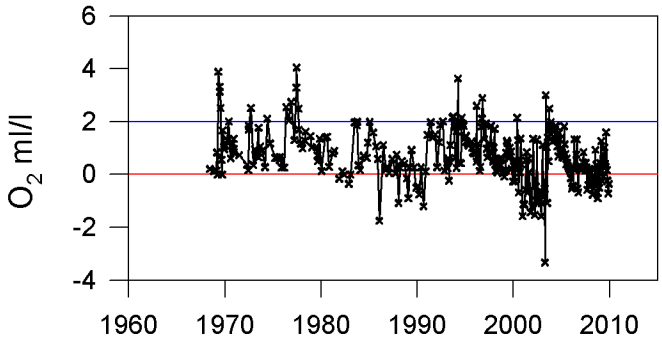








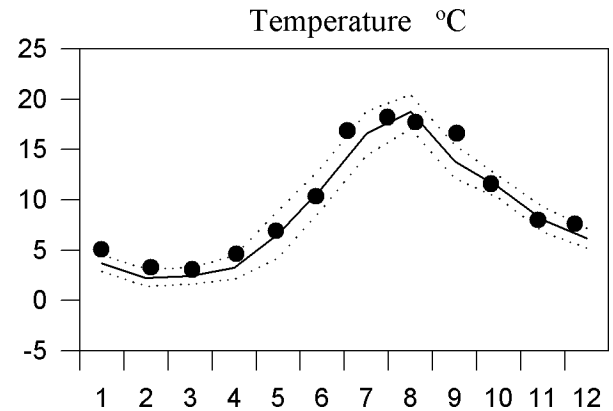


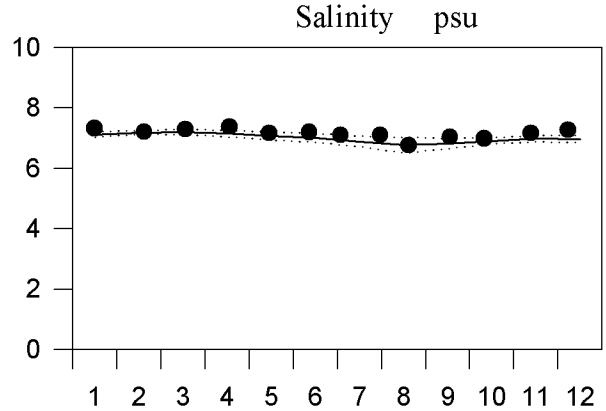


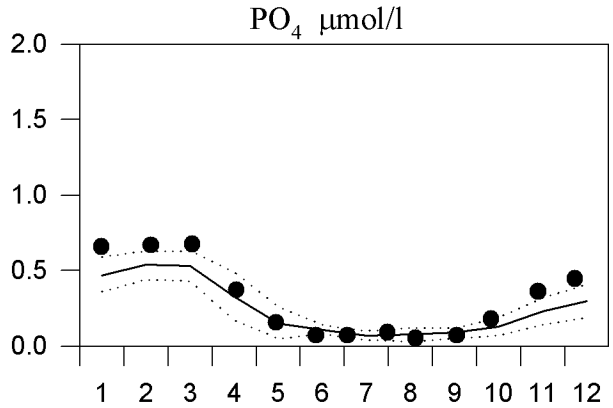
STATION BY15 SURFACE WATER

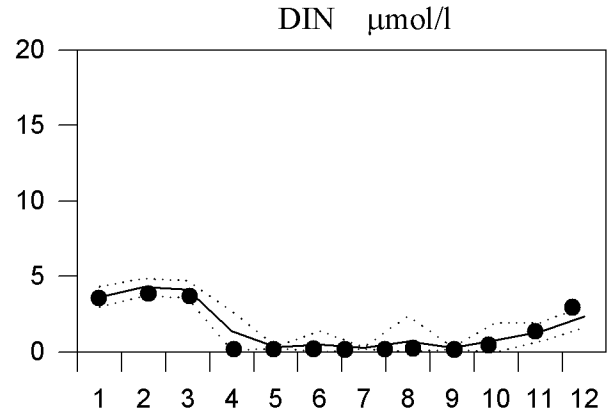
Annual Cycles

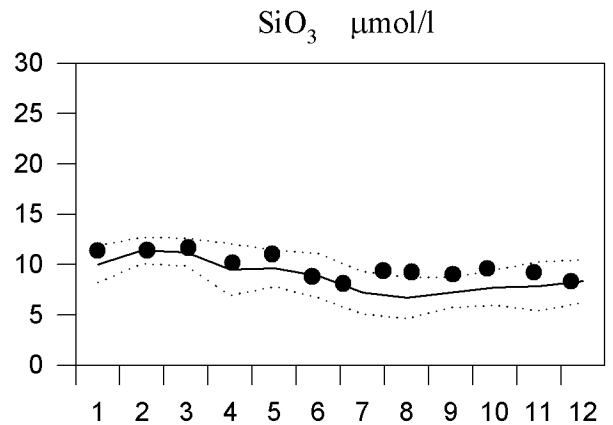
Mean 1995-2004 St.Dev. 2009

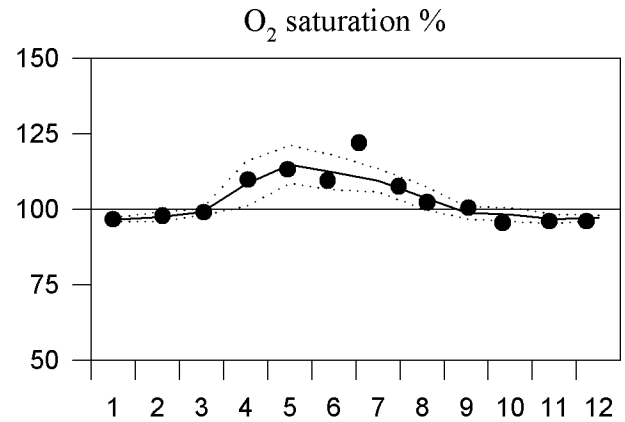




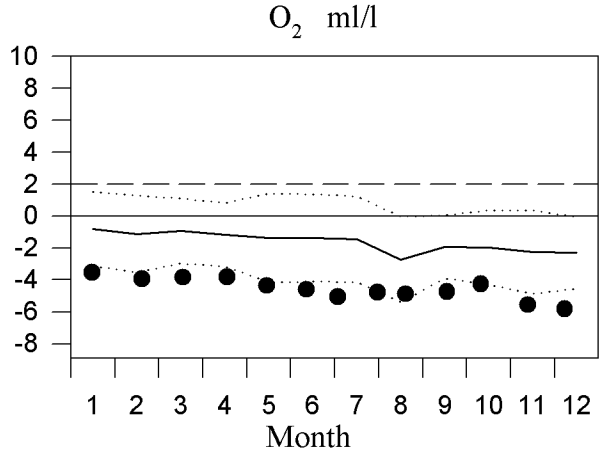


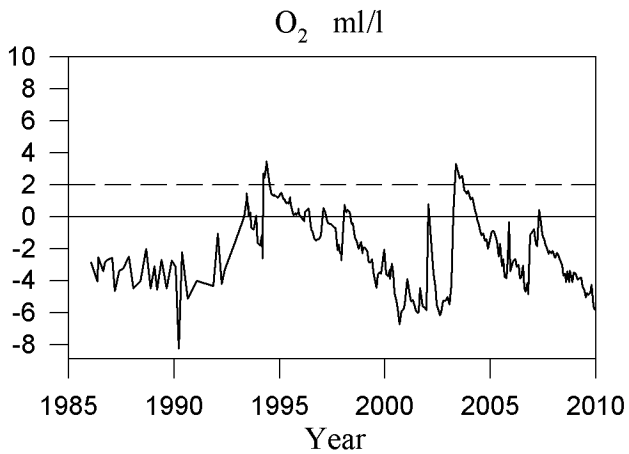




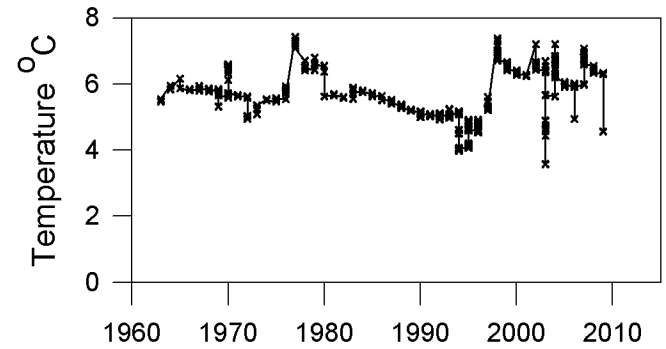


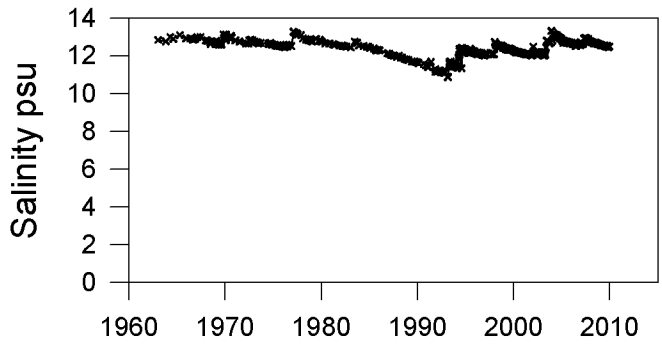
OXYGEN IN BOTTOM WATER

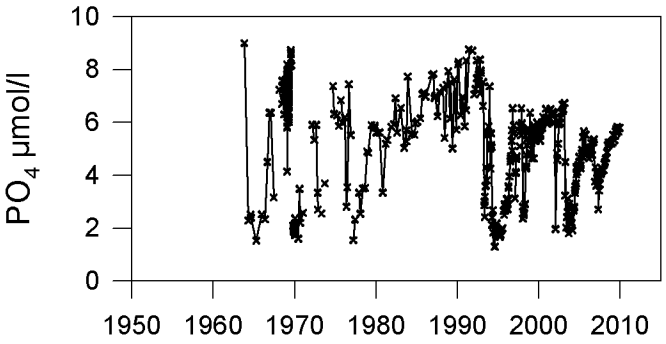


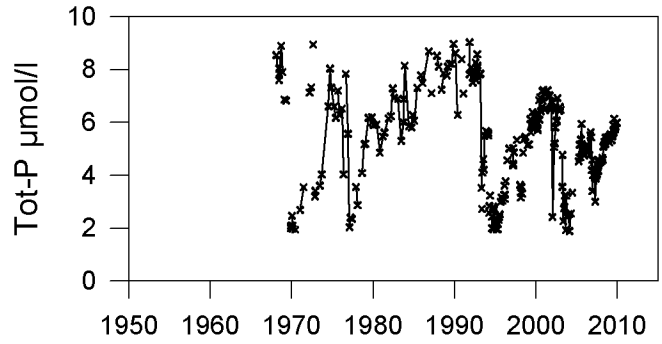


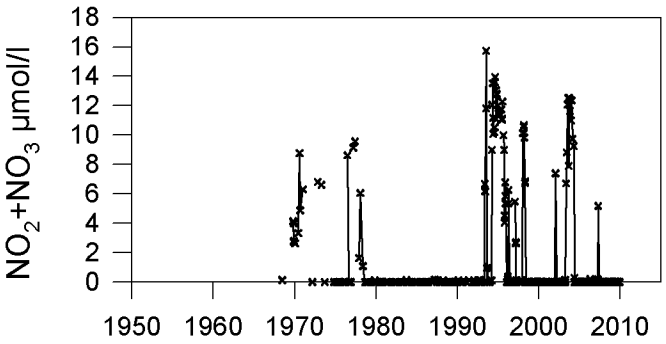
STATION BY15 DEEP WATER (240m)

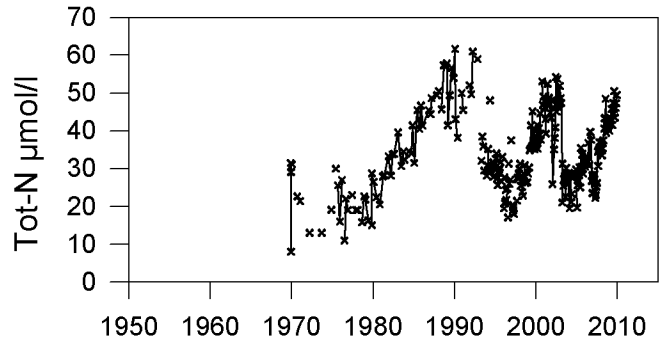


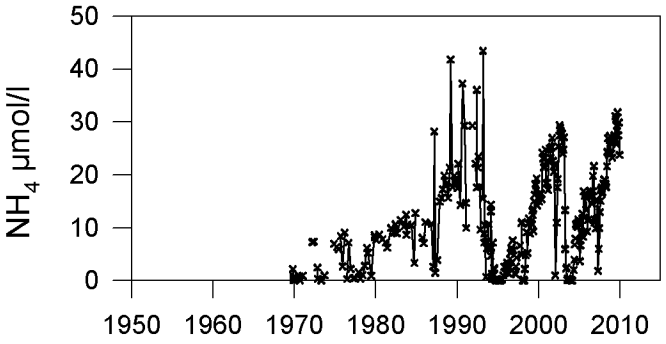


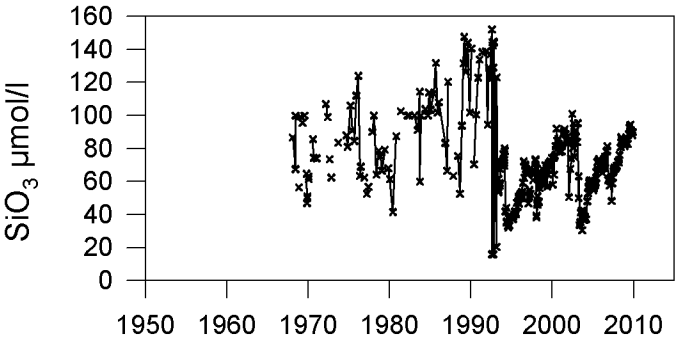


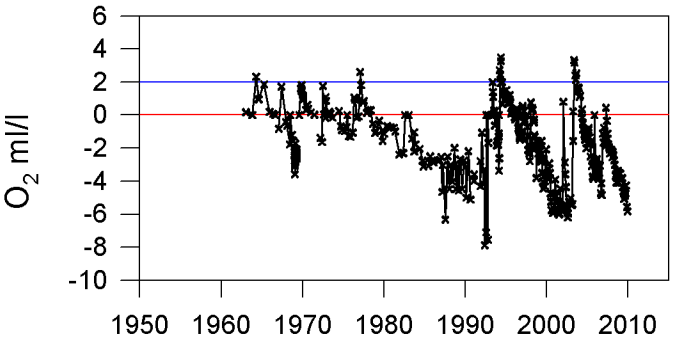








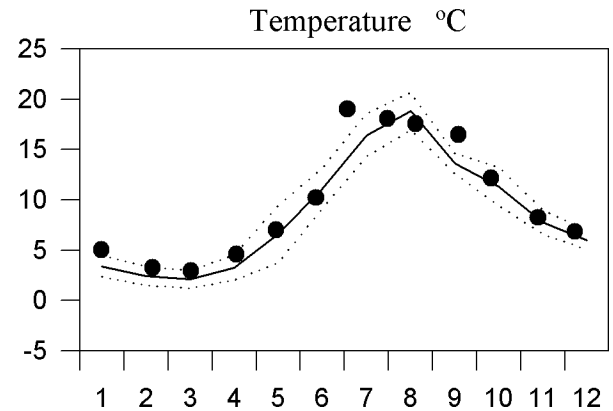


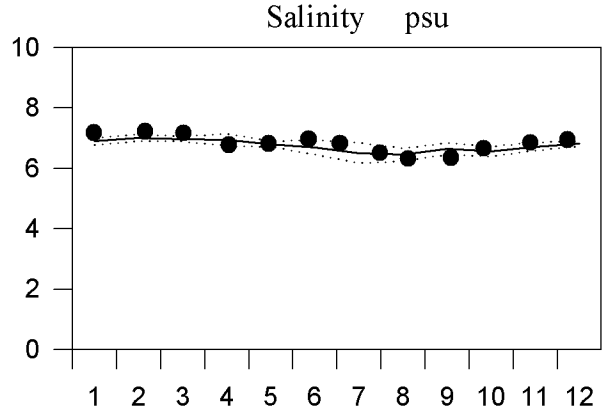


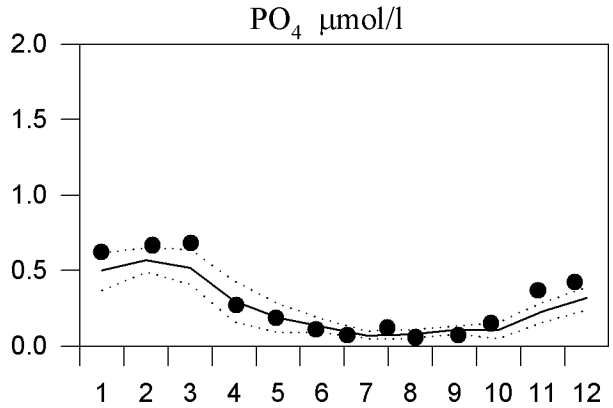
STATION BY20 SURFACE WATER

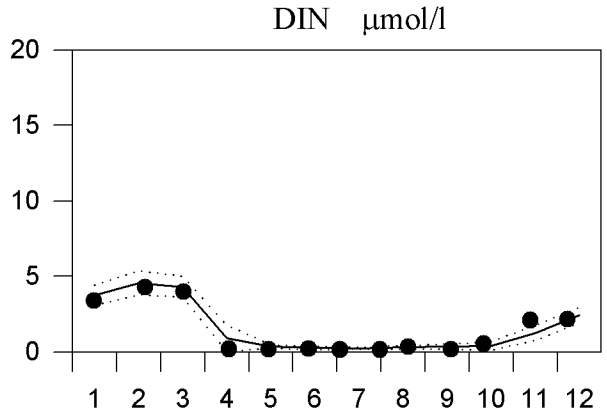
Annual Cycles

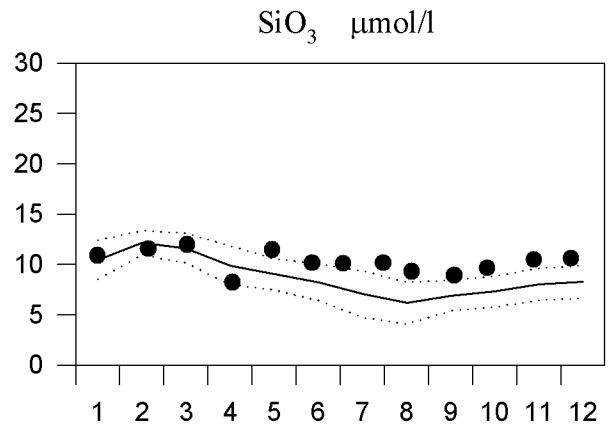
Mean 1995-2004 St.Dev. 2009

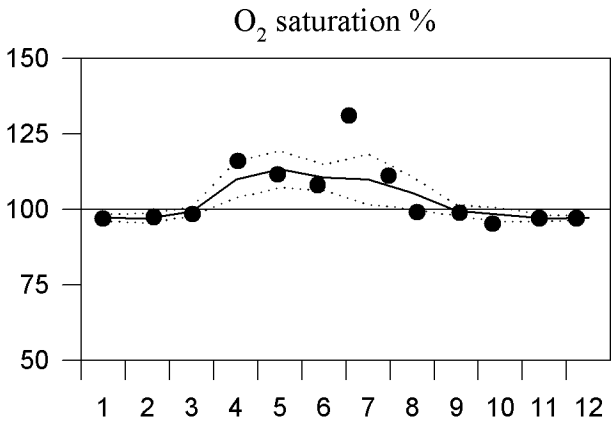




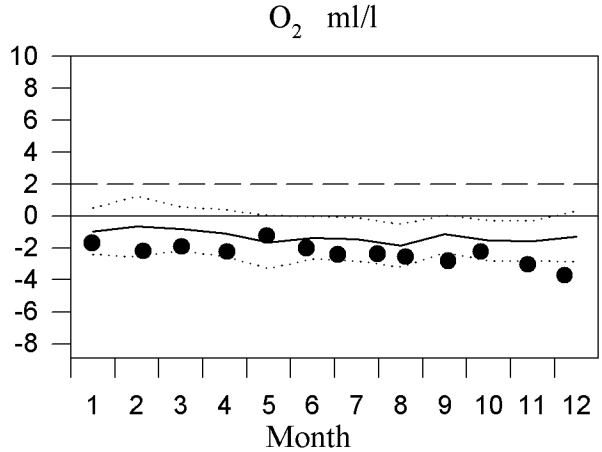


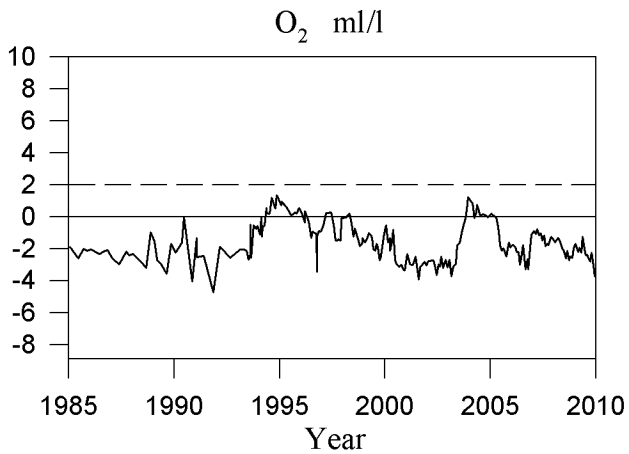




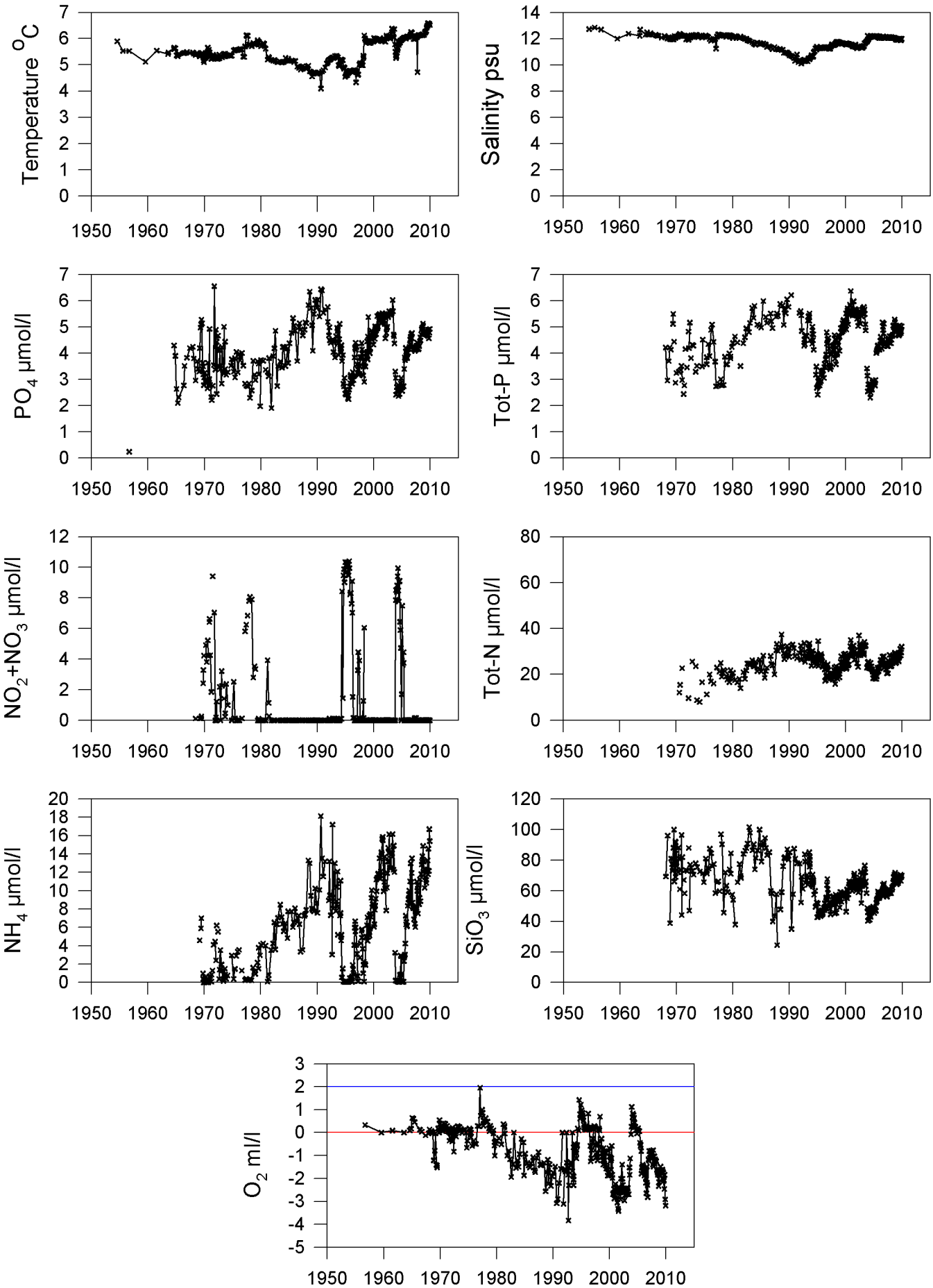


OXYGEN IN BOTTOM WATER





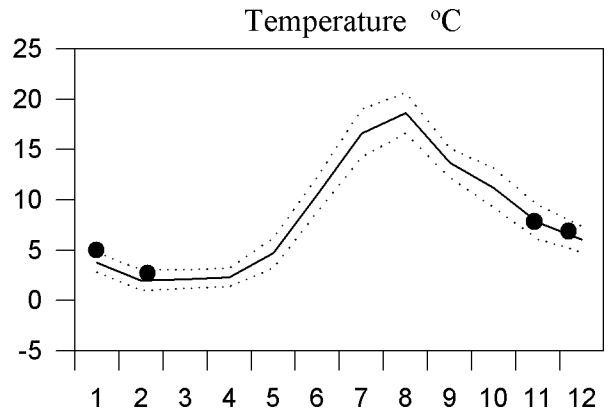
STATION BY20 DEEP WATER (175m)

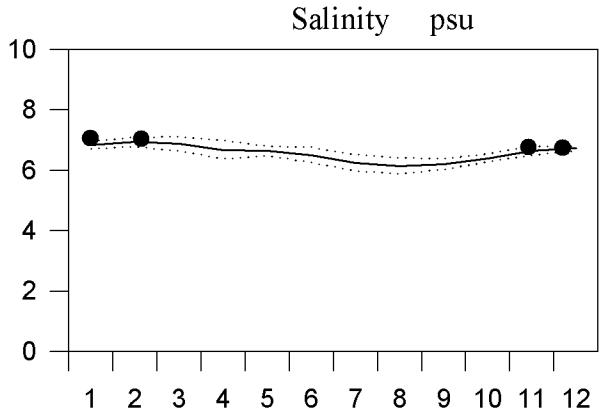


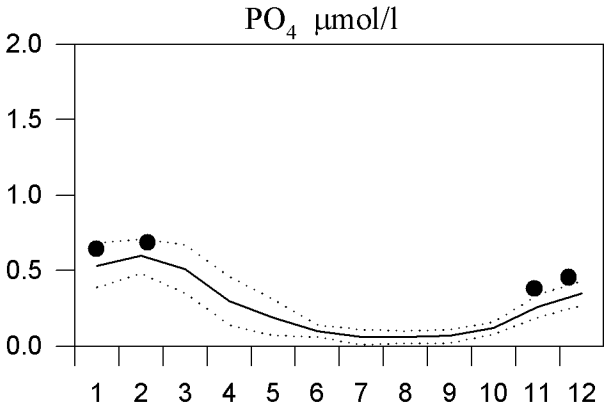
STATION BY29 SURFACE WATER

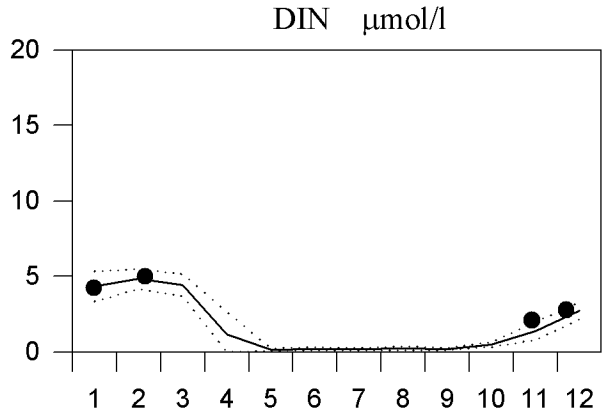
Annual Cycles

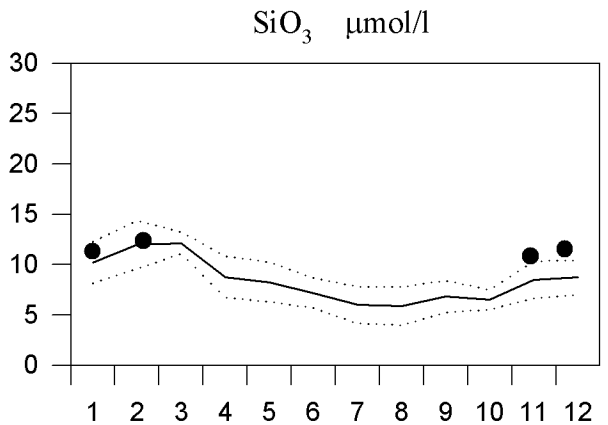
Mean 1995-2004 St.Dev. 2009

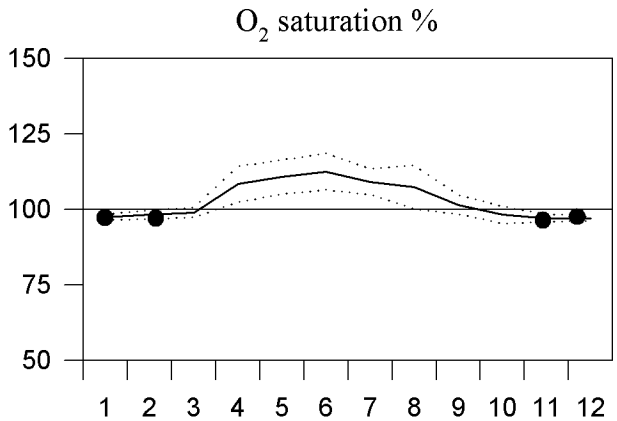




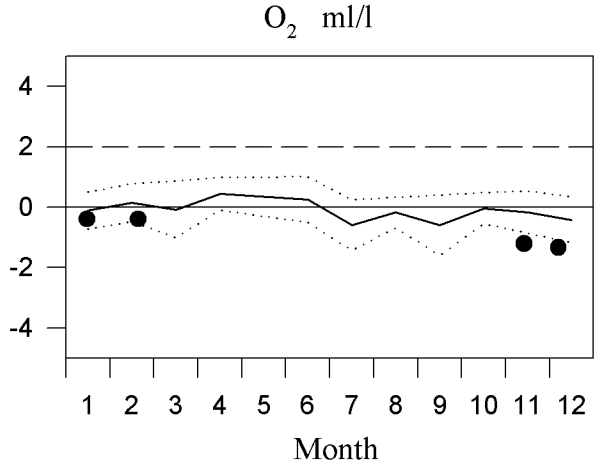


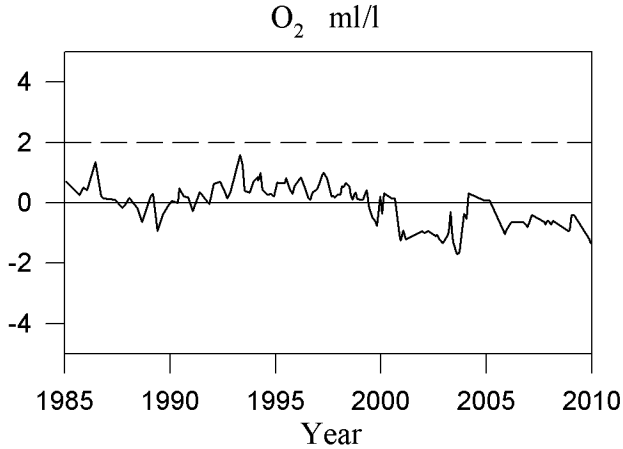




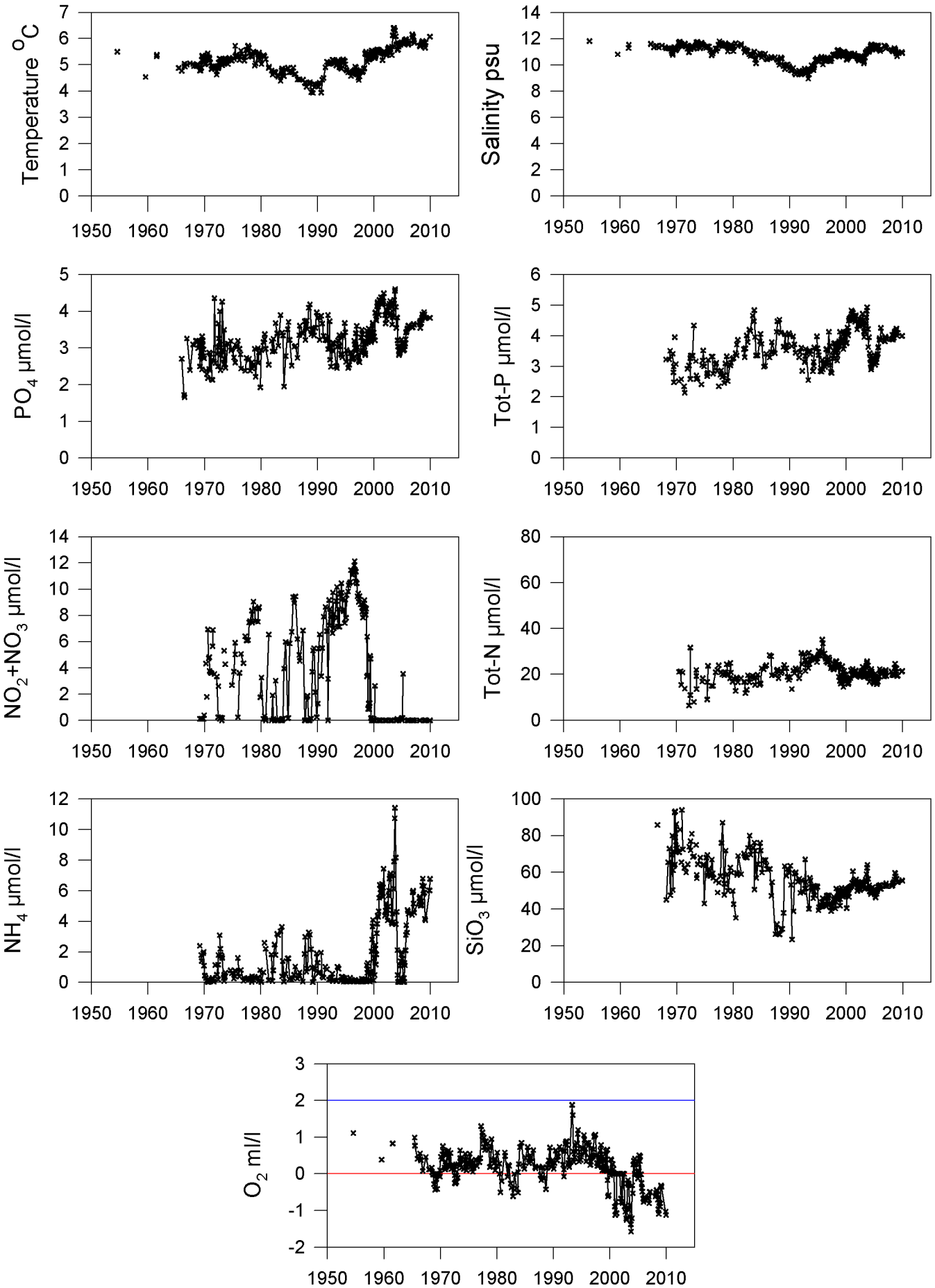


OXYGEN IN BOTTOM WATER





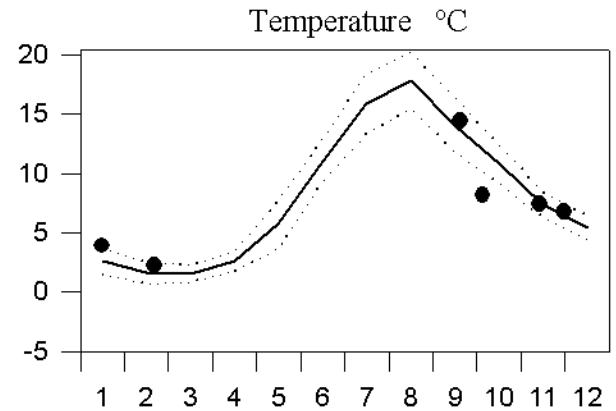
STATION BY29 DEEP WATER (150m)

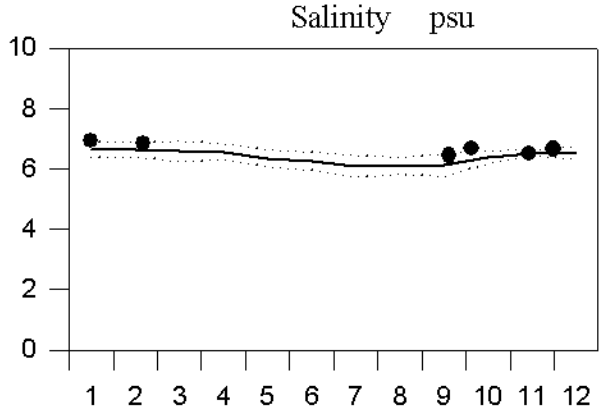


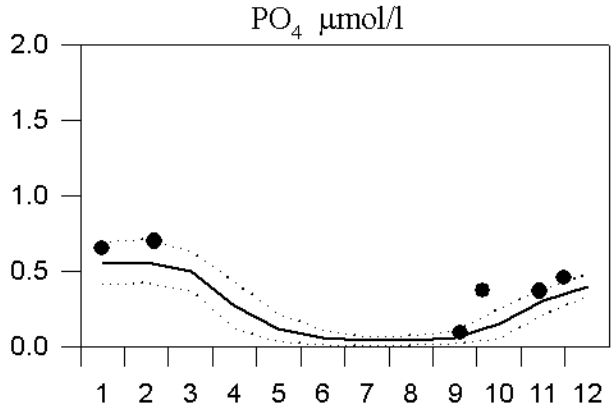
STATION BY31 SURFACE WATER

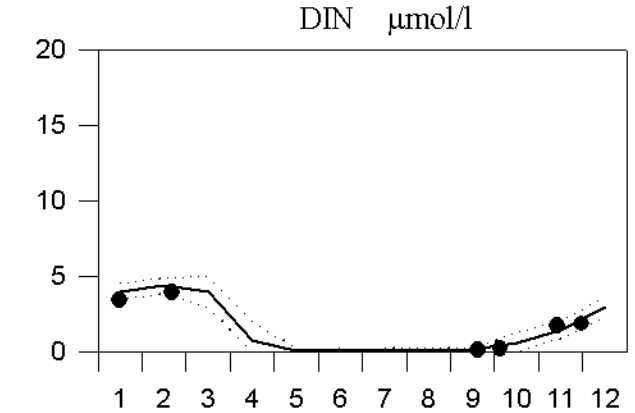
Annual Cycles

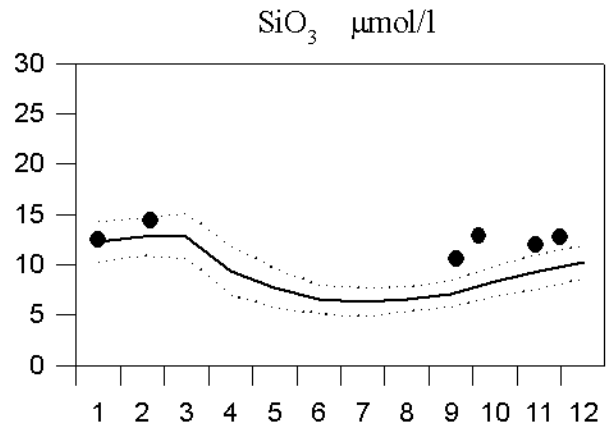
Mean 1995-2004 St.Dev. 2009

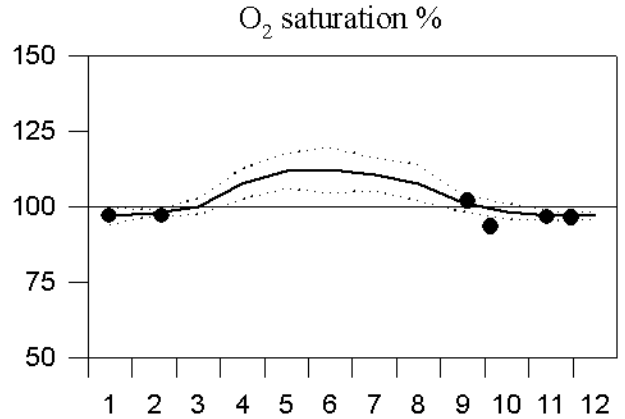




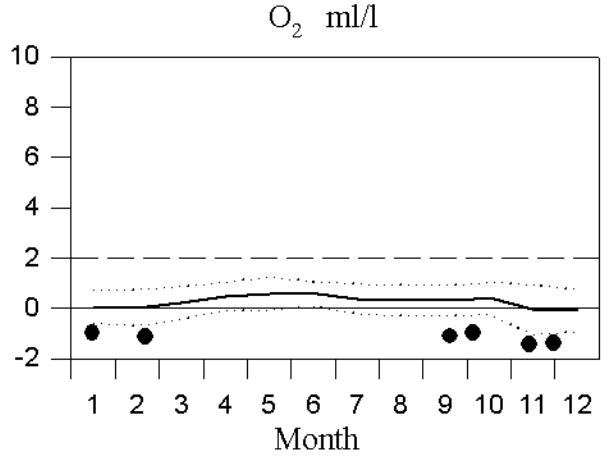


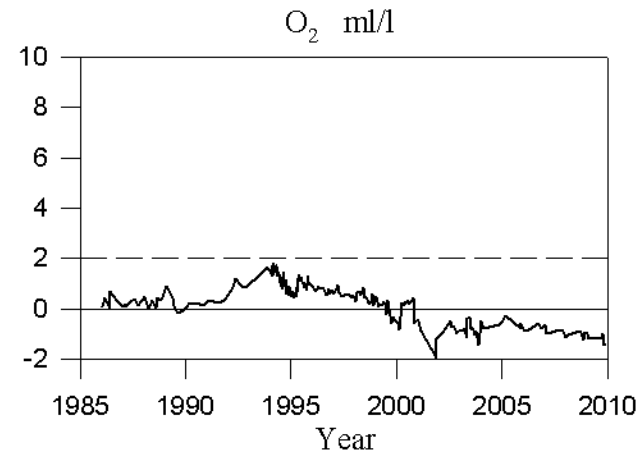




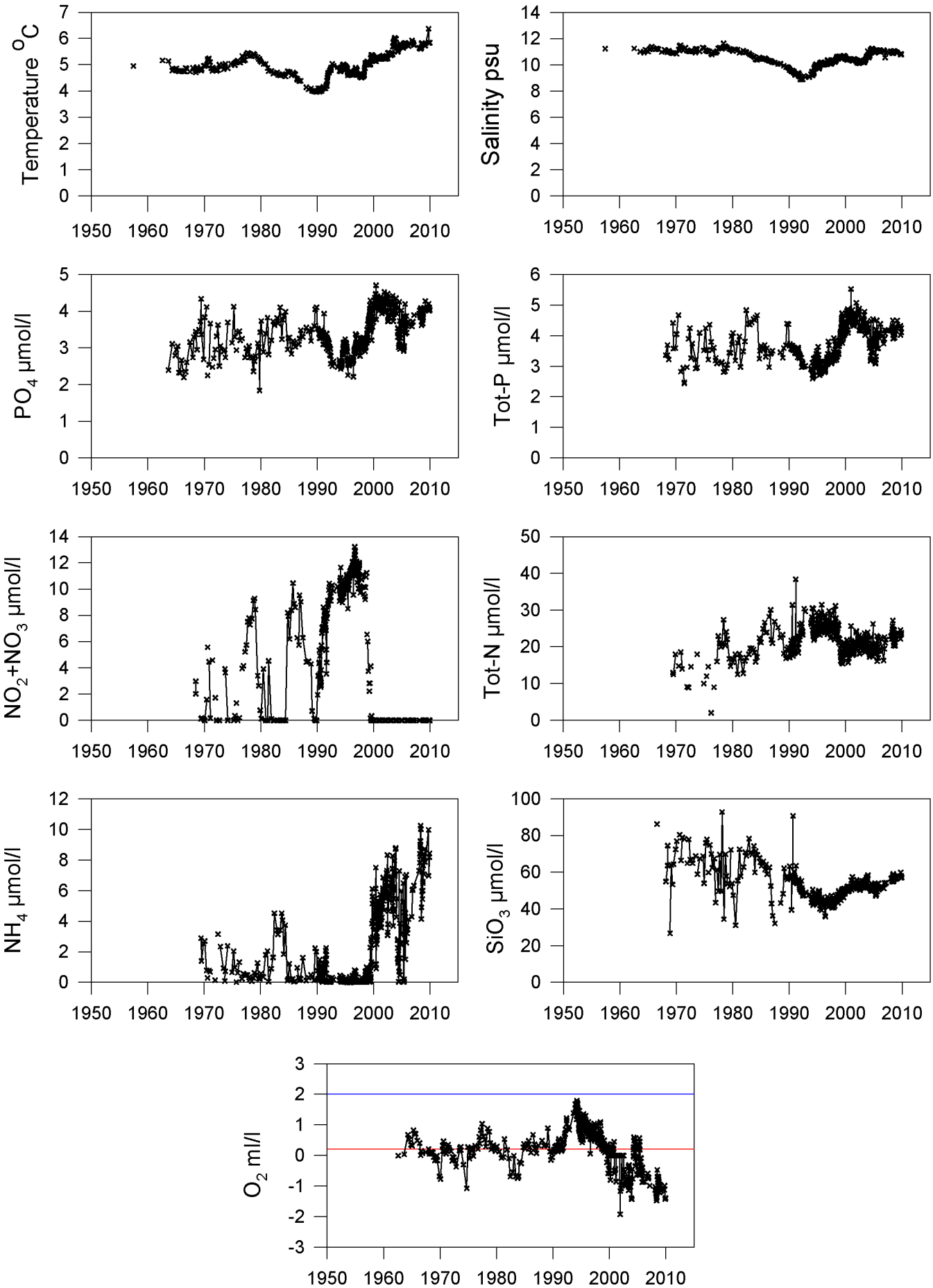


OXYGEN IN BOTTOM WATER



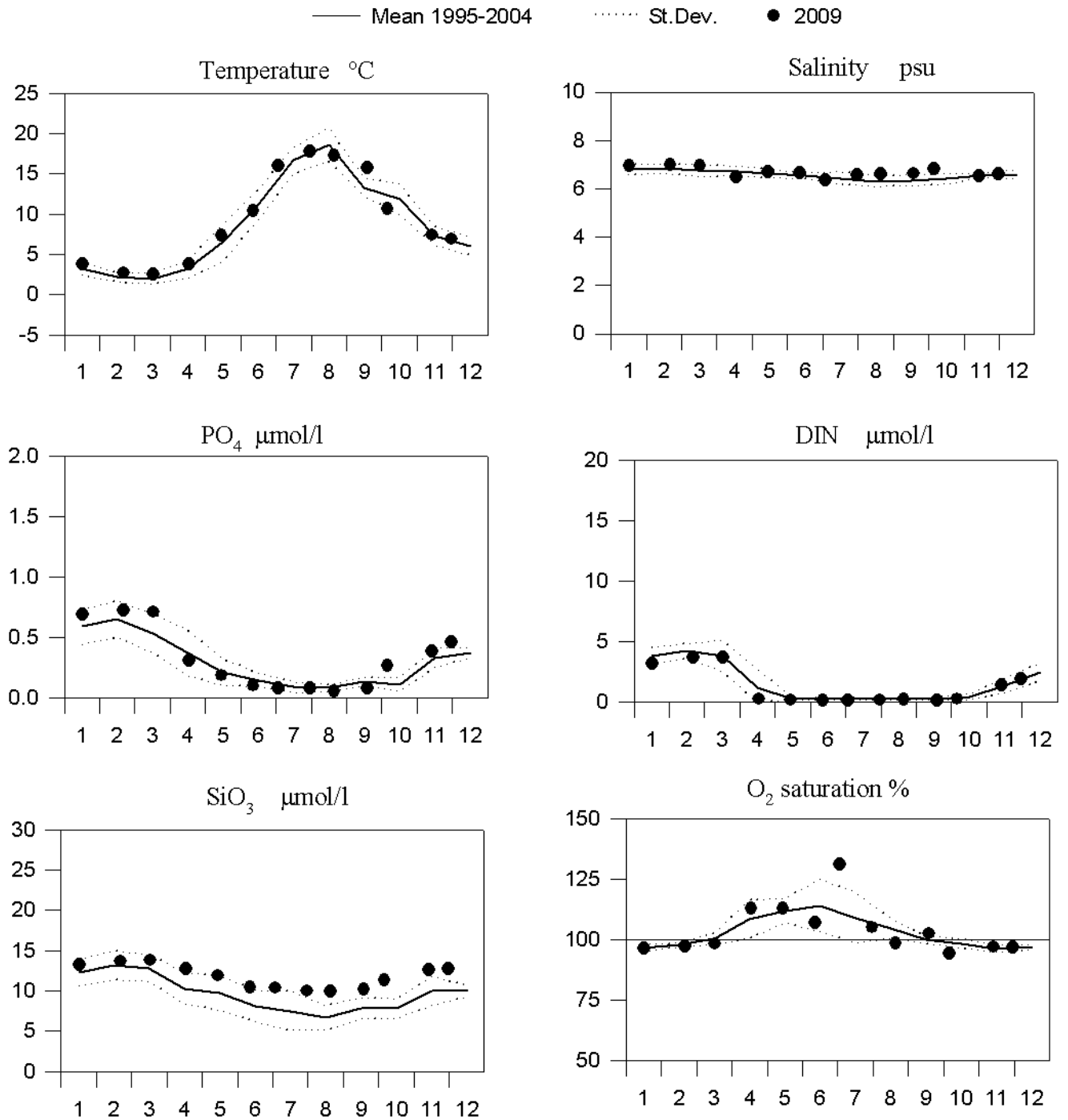


STATION BY31 DEEP WATER (440m)

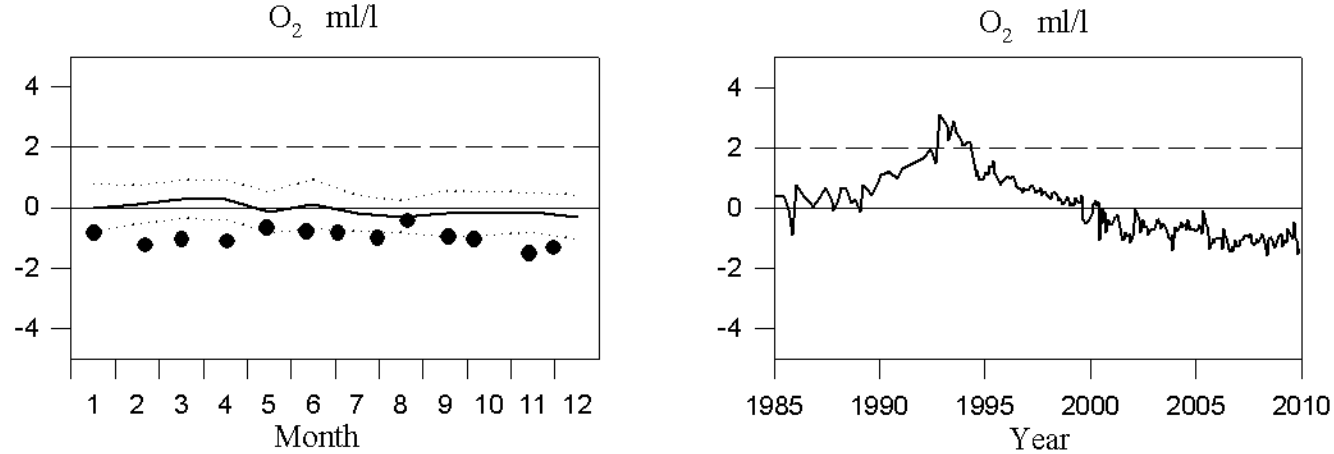


STATION BY32 SURFACE WATER

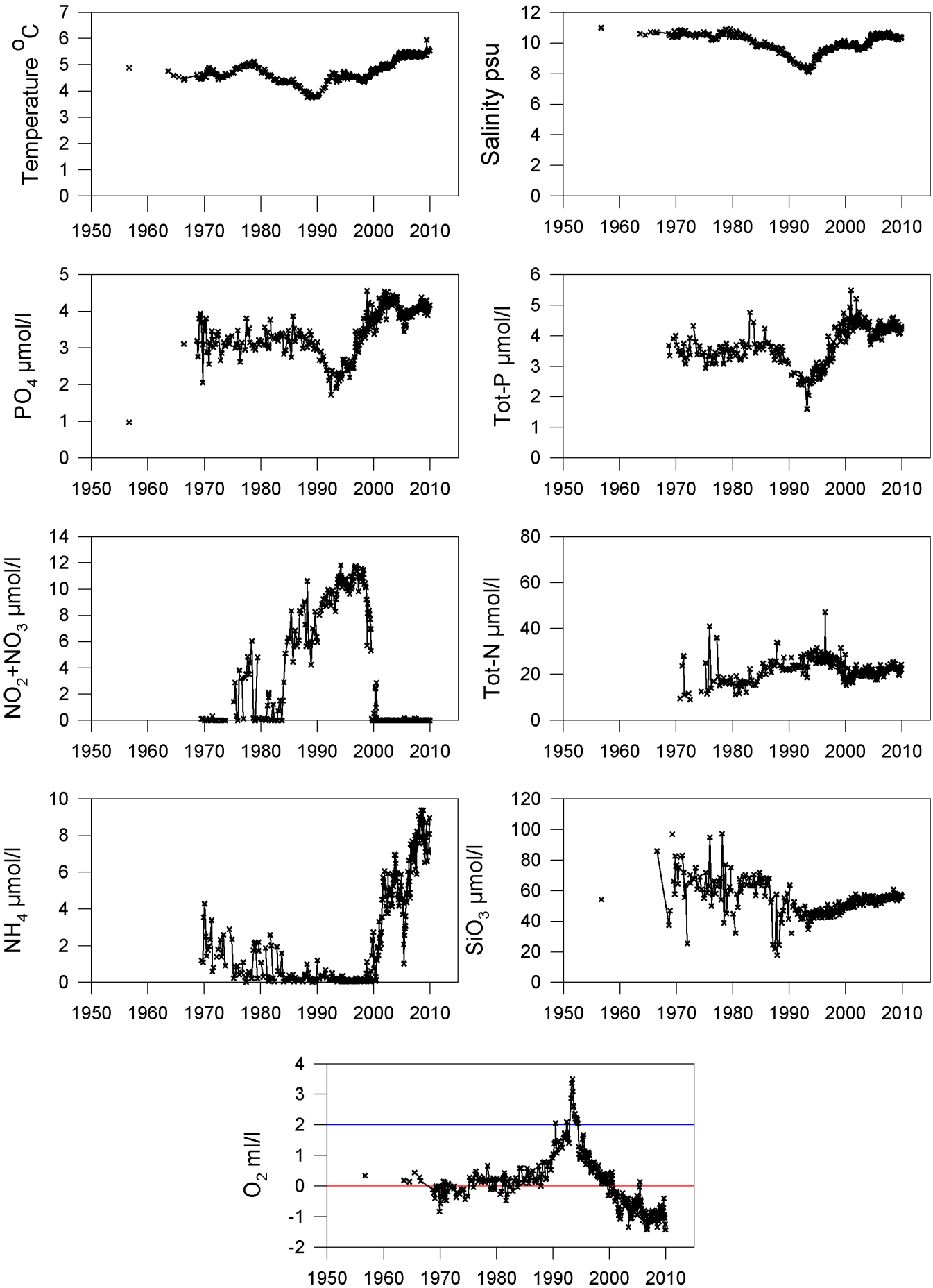
Annual Cycles



OXYGEN IN BOTTOM WATER

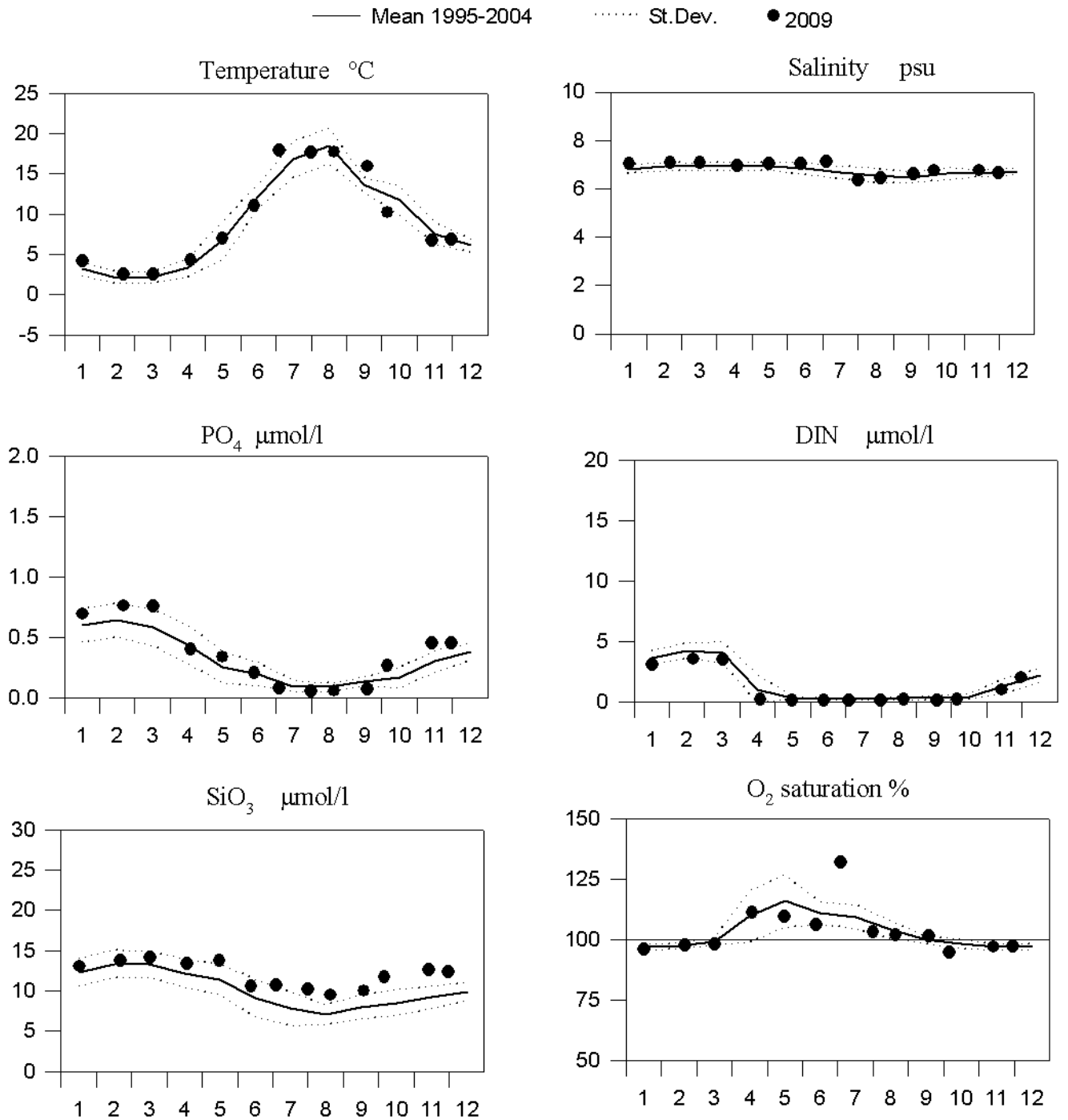


STATION BY32 DEEP WATER (175m)

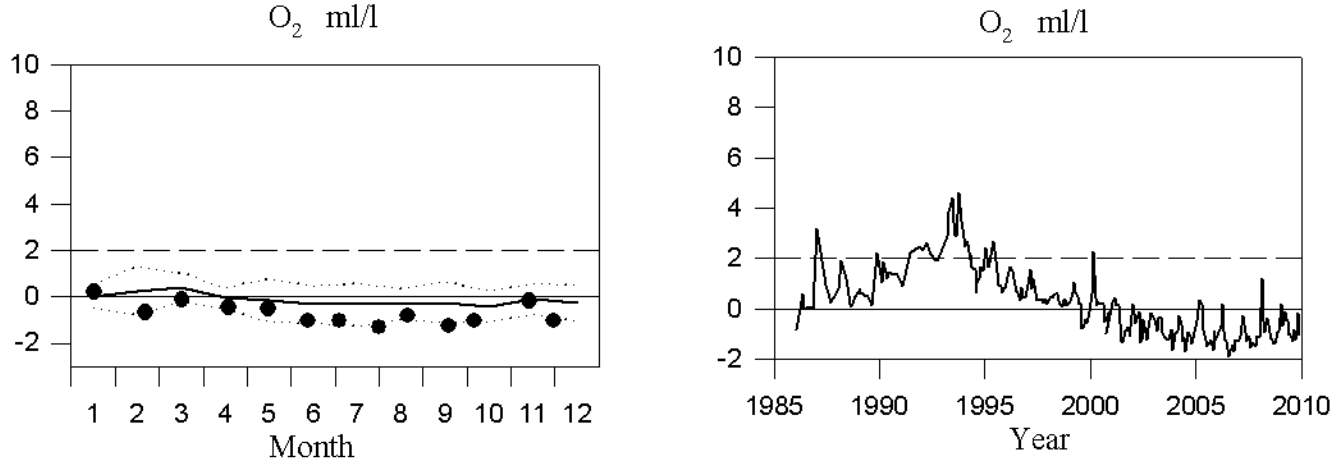


STATION BY38 SURFACE WATER

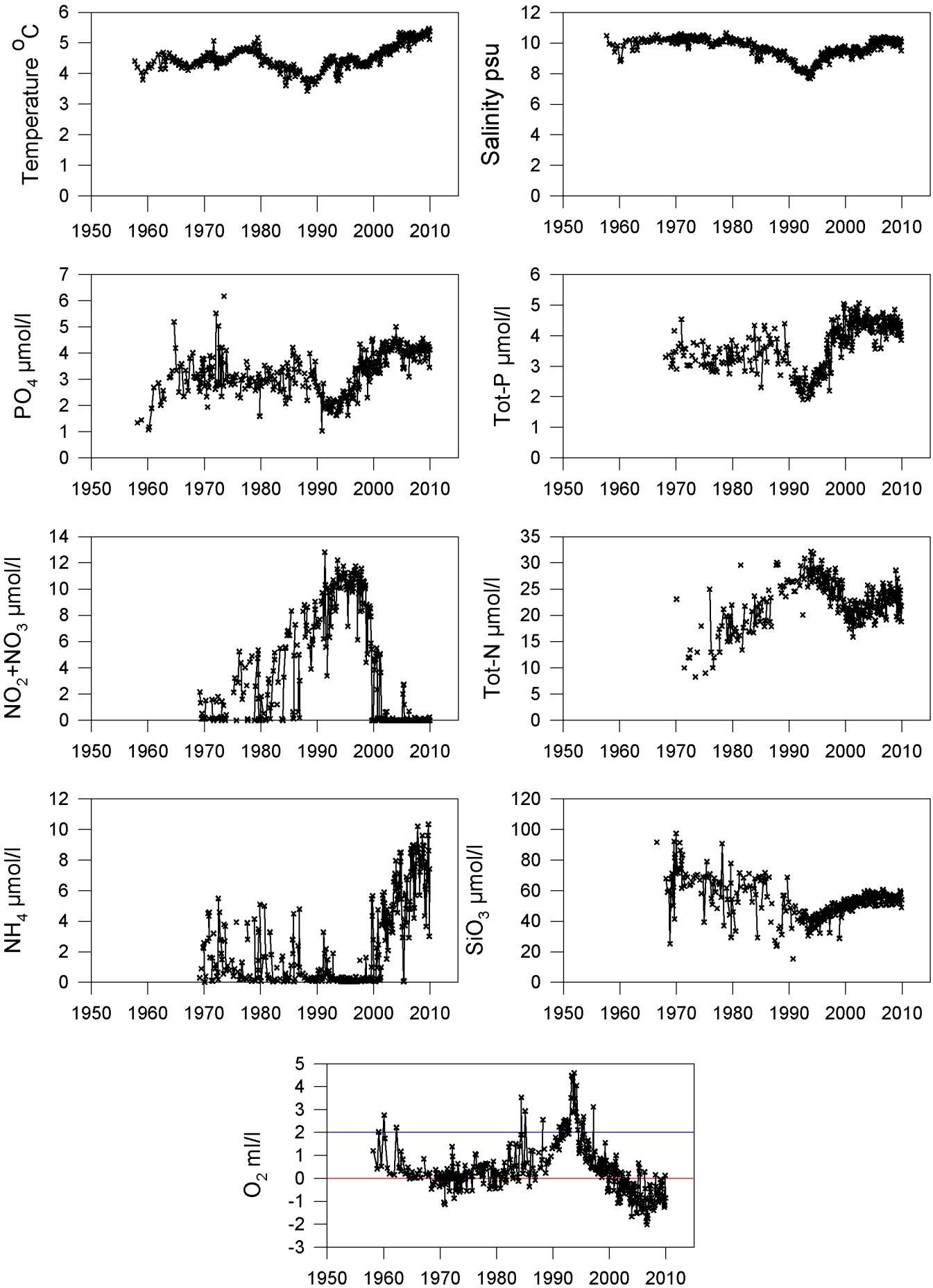
Annual Cycles



OXYGEN IN BOTTOM WATER



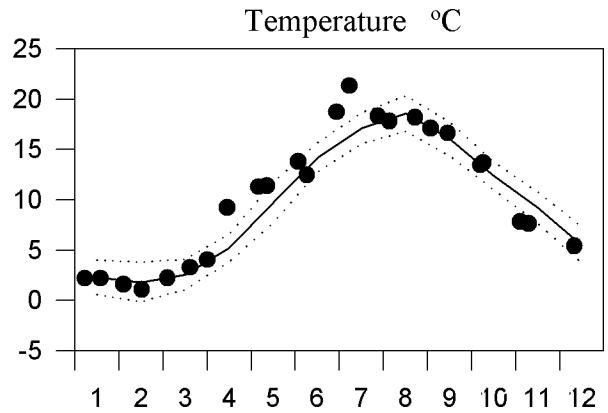
STATION BY38 DEEP WATER (100m)

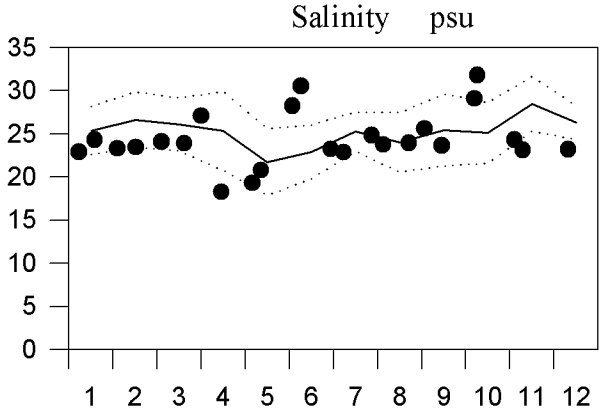


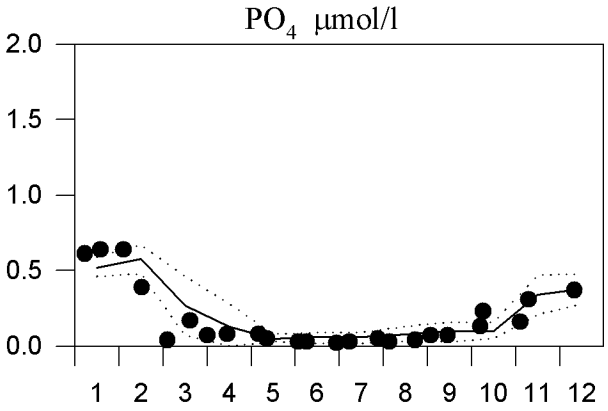
STATION SLÄGGÖ SURFACE WATER

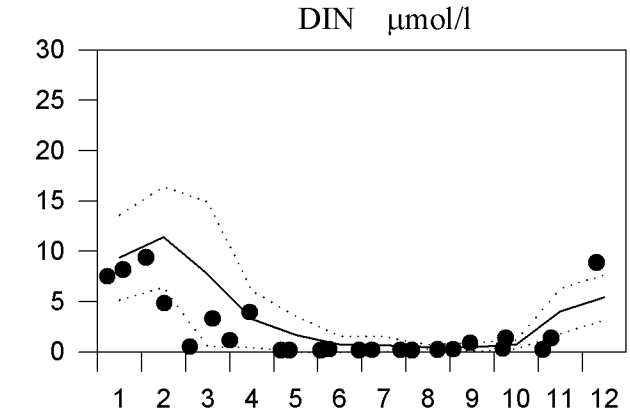
Annual Cycles

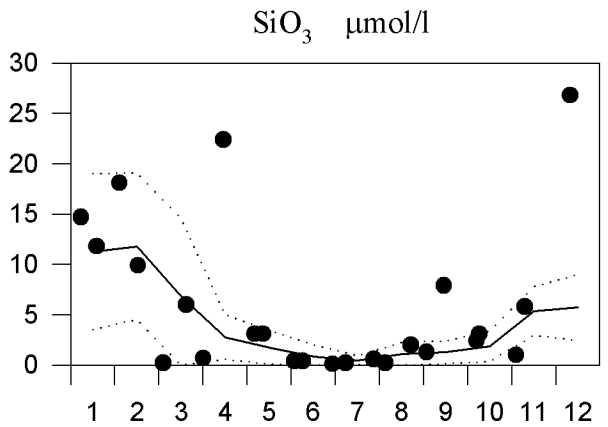
Mean 1995-2004 St.Dev. 2009

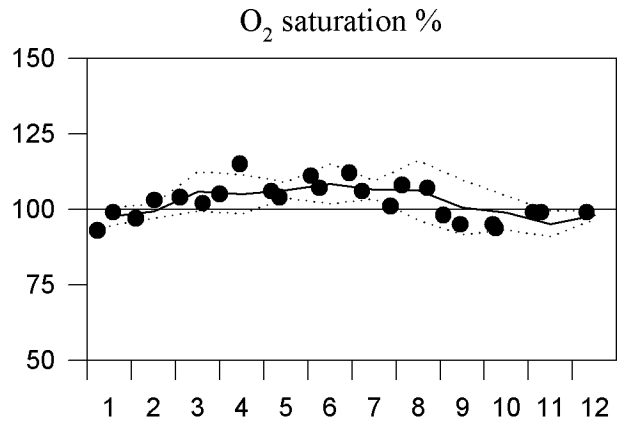




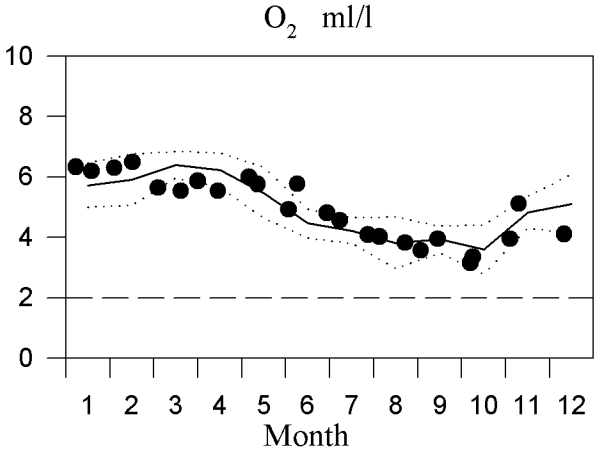


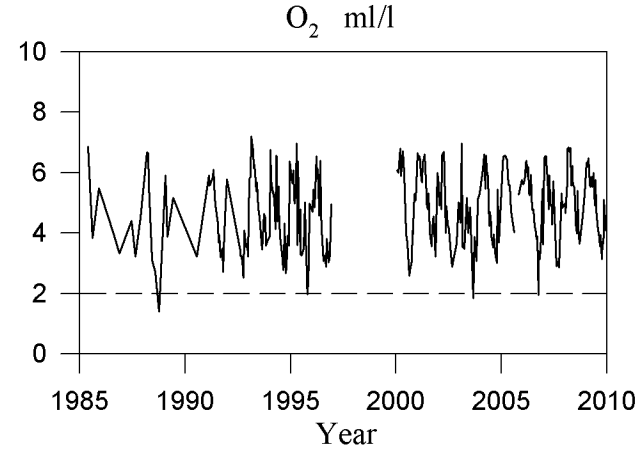






OXYGEN IN BOTTOM WATER





STATION SLÄGGÖ DEEP WATER (50m)