Daily Loads of Nutrients, Total Alkalinity, Dissolved Inorganic Carbon and Dissolved Organic Carbon of the European Continental Rivers for the Years 1977 – 2022

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Abstract

The daily nutrient loads of the European continental rivers entering the North Sea are estimated for the years 1977 to 2022. The parameter treated are total nitrogen, nitrate, ammonium, total phosphorus, orthophosphate and silicate. Additonally, for the rivers Elbe, Ems, Nieuwe Waterweg, Haringvliet and Scheldt the loads of Total Alkalinity (TALK), dissolved inorganic carbon (DIC) and dissolved organic carbon (DOC) are presented.

The raw data, in most cases daily values of discharge and nutrient concentrations sampled weekly, biweekly or monthly, are illustrated and statistically discussed. The observations used are: total nitrogen, Kjeldahl nitrogen, nitrate, nitrite+nitrate, ammonium, total phosphorus, orthophosphate and silicate.

Based on the investigations of annual load estimates by De Vries & Klavers (1994) the "double interpolation method" to calculate daily loads is used. Adopting their arguments general problems of load estimates are flagged. These arguments help to understand the advantages and disadvantages of the method used in relation to the individual nutrients. A further description on the method used as well as a discussion on the time series of the resulting river loads is presented in the paper by Radach and Pätsch (2007)

The carbon related loadings of TALK, DIC and DOC result from different measurements by A. Borges (pers. comm) that resulted in one representative concentration for each river and each parameter.

The graphical and statistical tools already used for the discussion of the raw data are also applied to the resulting daily river loads.

Under the restrictions also flagged in this report, the calculated values build a good estimate for the daily nutrient loads for further use in ecosystem models.

This report and all data shown are available under

https://wiki.cen.uni-hamburg.de/ifm/ECOHAM/DATA_RIVER/

1 Introduction

Over the years a range of eutrophication problems have been well documented. The source of these problems is generally understood to be excessive nutrient concentrations (Jickels, 1998). Listing the pathways of nutrients into the North Sea a considerable portion is provided by river nutrient loads and diffusive inputs of nutrients along the coast (Brockmann et al., 1990; Radach & Pätsch, 2007; Lenhart et al., 2010; Lorkowski *et al.*, 2012.)

Even though the dynamical link between nutrient river input into the North Sea and coastal eutrophication problems has been realized, papers like the Quality Status Report 2000 (Ospar, 2000) deal with this topic only on the basis of estimates for annual river loads. In order to investigate the effects of these inputs with an ecosystem model, the information provided clearly lacks the resolution of the seasonal pattern.

The first attempt to provide adequate estimates of river loads was made by the NSTF guiding document (Anonymous, 1992), where monthly values of all major rivers around the North Sea were aggregated for the year 1985. Estimates of daily nutrient loads for the continental rivers were presented by Pätsch & Lenhart (2004) for the years up to 2002.

The present technical report is an update of the former report, providing an extension of the time range to cover the years from 1977 to 2022 for continental rivers entering the North Sea, as presented in Fig. 1.

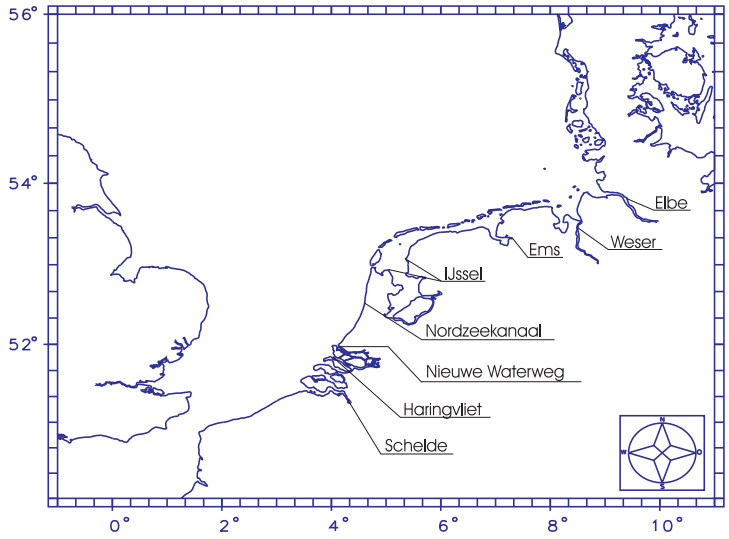


Fig. 1: *The main continental rivers entering the North Sea for which data are provided.*

The nutrient loads described here build an important piece of information on the nutrient inputs for the North Sea as a whole. They were used in an OSPAR ecological modelling workshop, where the reduction scenarios for the ecosystem model simulation were related to the reduction effort achieved by the individual countries around the North Sea since 1985, the year where the 50 % reduction in the river loads of DIN and DIP was supposed to start. The related year, for which the reduction levels achieved were tested, was 2002, the year where OSPAR provided a first assessemt on the eutrophication status of the North Sea, based on the Comprehensive Procedure. The result of the ecosystem modelling workshop and the discussion on the river loads in the context of the reduction scenarios is presented in Lenhart et al. (2010).

Furthermore, these data build the platform for a method – often referred to as 'Trans-Boundary Nutrient Transports (TBNT)' – which allows for the tracing of elements from individual sources through all physical and biogeochemical processes, and thus provides quantitative information on the influence of these sources e.g. on the N dynamics in the different North Sea regions. A comparative analysis (Lenhart & Große, 2018) of the TBNT results of a WFD reduction scenario vs. the reference simulation allows to quantify the changes induced by the different N reductions on the key eutrophication parameters and the N cycling in the North Sea and brings the "source-oriented approach" advocated by OSPAR (2000) into practice.

In a new approach this TBNT method was expanded by a direct link of the O_2 dynamics to the nutrient inputs from individual sources (Große et al., 2017). The focus of this study was on the relative importance of riverine vs. non-riverine sources of N, and their influence on the O_2 dynamics in the regions most susceptible to O_2 deficiency.

The following institutions kindly provided the data that build the basis for the river load calculations:

- Behörde für Umwelt und Energie, Amt Umweltschutz,
  Hamburg, FRG
- Bundesanstalt für Gewässerkunde, Koblenz, FRG
- Niedersächsischer Landesbetrieb für Wasserwirtschaft, Küsten und Naturschutz, Hildesheim, FRG
- Rijkswaterstaat, Centrale Infomatievoorziening, Delft & Utrecht, NL

2 The raw data: an overview

Table 1 gives an overview of the original data provided by the different river authorities. The numbers within the boxes give the years of the beginning and the end of the available time series for the specific parameter.

Tab. 1a: *List of parameters aggregated for each river*

River	DIS	TN	KjN	NO3	NO2	N23	NH4	TP	PO4	SiO4	Cl
Elbe	77-22	78-22		77-22	90-22		77-22	78-22	77-22	88-22	77-22
Weser	77-23	80-22		77-22	90-05 07-22		77-22	77-22	81-22	93-94	90-22
Ems	77-23	80-22		77-22	90-09 11-22		77-22	77-22	81-22	89-94 20-21	90-22
Kornwederzand	77-22										
Den Oever	77-22										
Vrouwenzand		77-23	77-21	10-23	99-03 10-23	77-23	77-94 98-23	77-23	77-23	77-94 99-23	77-23
NZ Kanaal	77-21	77-23	77-21	10-23	99-03 10-23	77-23	77-94 98-23	77-23	77-23	79-94 99-23	90-94 98-23
N. Waterweg	77-21	77-23	77-21	10-23	99-03 10-23	77-23	77-23	77-23	77-23	77-94 99-23	90-23
Haringvliet	77-22	77-23	77-21	10-23	99-03 10-23	77-23	77-94 98-23	77-23	77-23	77-94 99-23	90-94 98-23
Scheldt	77-22	77-22	77-21	10-22	99-03 10-22	77-22	77-94 98-22	77-22	77-22	77-94 99-22	90-94 98-22

The abbreviations and the units for the parameters are:

DIS	discharge	$[m^3/s]$
TN	Total nitrogen	$[mg/l]$
KjN	Kjeldahl nitrogen	$[mg/l]$
NO2	Nitrite	$[mg/l]$
NO3	Nitrate	$[mg/l]$
N23	Nitrite + Nitrate (NO_2 plus NO_3)	$[mg/l]$
NH4	Ammonium	$[mg/l]$
TP	Total phosphorus	$[mg/l]$
PO4	Orthophosphate	$[mg/l]$
SiO4	Silicate	$[mg/l]$
Cl	Chloride	$[mg/l]$

For some of the raw data, like chloride and NO2, generally no time series of daily loads are calculated. These data are only included as additional information to complete the overall picture of the data. The nitrate loads of the German rivers do not include NO2. As the Dutch and Belgium authorities delivered in most cases only Nitrogen-Oxids which include nitrate and nitrite the corresponding

loads also include both components. This is not the case for the German fivers. One should point out that the timeseries described in Tab. 1 may have gaps which can only be recognized by looking at the presentation of the individual parameter. The data presented here are only a subset of the data available at the authorities, here collected for specific aim of load calculations.

For Lake IJssel the load calculations were performed for the stations Kornwederzand and Den Oever. As no concentration data were available at these stations, these values were taken from Vrouwenzand.

For the Dutch and Belgium rivers total nitrogen is calculated as the sum of Kjeldahl nitrogen, nitrite and nitrate (N23). Kjeldahl nitrogen includes particulate organic nitrogen (PON), dissolved organic nitrogen (DON), and ammonium.

$$KjN = PON + DON + NH_4$$

For the German rivers the values for total nitrogen are not differentiated into Kjeldahl- and nitrite/nitrate-nitrogen. Here the originators delivered values for total nitrogen, nitrate and ammonium.

The abbreviations and the units (assuming density 1 kg/l) for the carbon related parameters are:

TALK	Total Alkalinity;	$[\mu mol/kg]$
DIC	Dissolved Inorganic Carbon	$[\mu mol/kg]$
DOC	Dissolved Organic Carbon	$[\mu mol/kg]$

Only for some of the rivers a constant concentration value for these parameters could be estimated:

Tab. 1b: *List of estimated concentrations ([µmol/kg]) for some rivers*

River	TALK	DIC	DOC
Elbe	2231	2195	456
Ems	2562	2738	1007
N. Waterweg	2580	2678	230
Haringvliet	2580	2678	230
Scheldt	3832	3971	512

Some problems regarding the interpretation of the data should be mentioned. Since the North Sea is a tidally influenced shelf sea the inflowing rivers show typical estuarine characteristics. McLellan (1977) classified these regions as: "The term estuary has been traditionally used by geographers to denote rather loosely the lower reaches of a river where tide and river flow interact". Therefore any measurement monitoring the outflowing river waters has to take into account the phenomena of mixing water masses. In order to get a pure sample of the river water, it should be taken at low tide so that mixing processes can be considered to have a minor influence. A valuable information about the state of mixing within the water mass is given by the chloride content of the sample.

The discharge is usually measured at the last tide-free gauge station. In order to account for the additional contribution of the downstream part of the river, certain factors are provided by the different authorities monitoring the rivers. These factors will be mentioned in the description of the raw data but they did not enter the load estimates within this paper. The idea of providing the load estimates based on the raw data was that someone who wants to use the data can decide himself in the frame of his own application if he wants to apply a drainage factor or other additional factors, like a retention factor.

In contrast to the position of the discharge measurements the position of the concentration measurements are oriented towards the river mouth. In this way the concentration measurement represents as good as possible the state of the river entering the North Sea. Of course this site must allow to identify the outflowing water. Practically the selection of the monitoring station for the load calculation is determined by the frequency of the measurements available and the state of tidal mixing at that station, which may be checked by the chloride contents of the samples. Therefore there is a spatial difference between the position where the discharge is measured and the sampling stations for the nutrient concentrations. This is definitely a drawback for the load estimates, but one has to consider the load calculations from discharge and concentration data as the best estimates possible, given the restrictions by the data as well as the assumptions that have to be applied.

3 Description of raw data : discharge and concentrations

3.1 German Rivers

The discharges of the German rivers were subsequently corrected by the data providers. For each of these rivers, we have analysed the deviations in the overlapping period 2015 - 2019 and presented them in the corresponding subsections. We have adopted the new corrected data from 2020. Data prior to 2020 has not been corrected in this volume.

3.1.1 River Elbe

The data for the river Elbe were provided by the dataportal serviced by the FGG Elbe (https://www.fgg-elbe.de/elbe-datenportal.html). The latest concentration data for 2016 and 2017 for the profile mixing probes were kindly provided by Michael Bergemann (Behörde für Umwelt und Energie, Hamburg) and Ulrich Wiegel from Niedersäsischer Landesbetrieb für Wasserwirtschaft, Küsten- und Naturschutz (NLWKN). The data source for the discharge data was the Wasserstraßen- und Schifffahrtsverwaltung des Bundes (WSV), provided by the Bundesanstalt für Gewässerkunde (BFG;Datenstelle-M1@bafg.de)

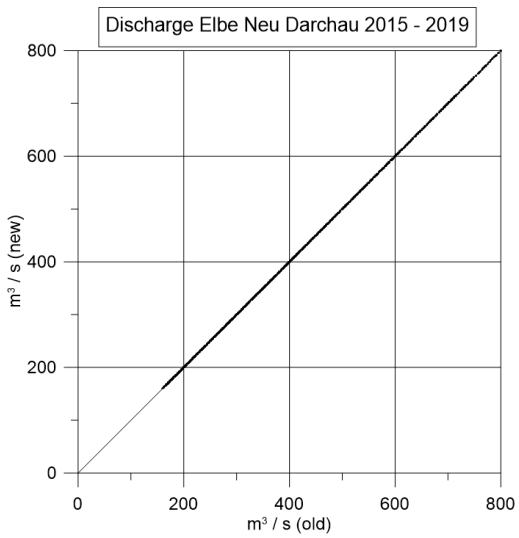
The discharge data represent daily measurements from the last tide-free gauge station at Neu Darchau (km 536). Until 1991 the concentration data were selected from weekly samples at the site Teufelsbrück (km 630) just downstream of the Hamburg harbour; afterwards they stem from weekly samples at the sampling site Seemannshöft (km 628). At these stations the outlets of the big water treatment plant Köhlbrandshöft are not completely mixed with the Elbe water. Both sampling sites are well beyond the starting of the tidal mixing zone near Glückstadt (about km 674), which is characterized by the low chloride content of about 150 mg/l.

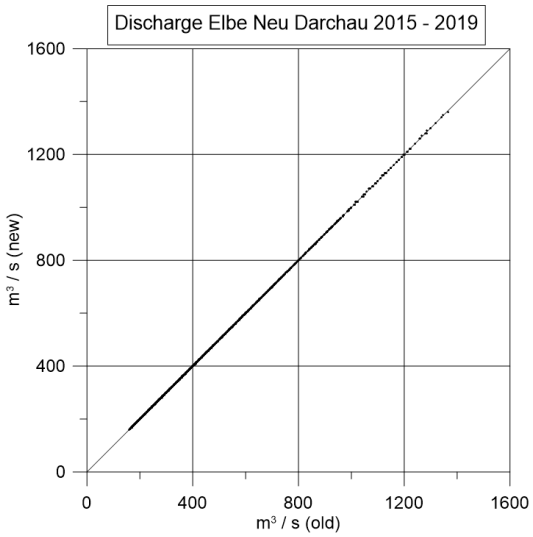
Before 1993 the nutrient data were derived from individual samples, whereas from 1994 onward the data are taken from horizontal profile mixing probes (Querprofilmischproben). The data for total phosphorus and total nitrogen start with the year 1978. Furthermore the technique of measuring Kjeldahl nitrogen was changed towards the measurement of Koroleff nitrogen which should lead to higher nitrogen values than the previous technique. However, no inhomogenity can be detected within the data presented here. Nitrite data were measured by the river authority also before 1990 but are not taken into account in this updated report. Silicate data were provided by the river authority for the sampling station Grauerort (km 660) starting in February 1988; since 2013 the silicate data stem from Seemannshöft (km 628).

To the river discharge given at the tide-free gauge station Neu Darchau an amount of 21 % (pers. comm. Bergemann) has to be added in order to take into account the additional drainage from the area downstream of Neu Darchau. As mentioned before this factor has not yet been used for the presented data

within this volume.

As reported above, the discharge data from the suppliers differ from the previous data. In the case of the Elbe, the deviation for the years 2015 - 2019 is on average 2.41 m^3/s (mean of the absolute differences).



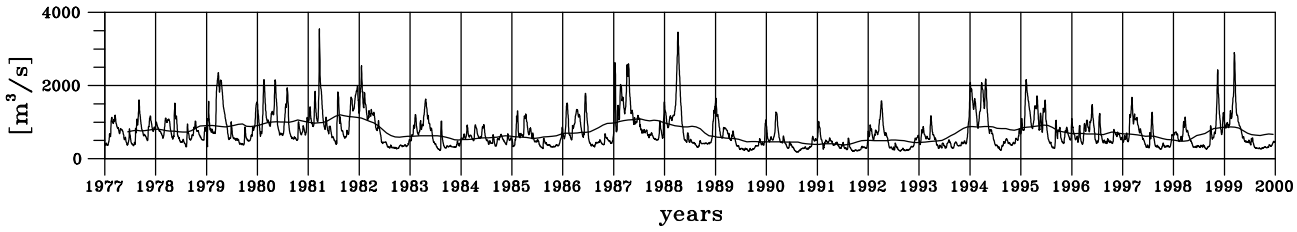


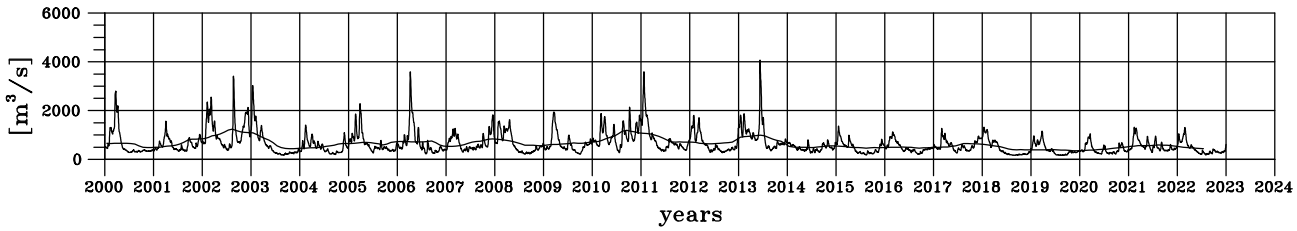
Discharge from River Elbe

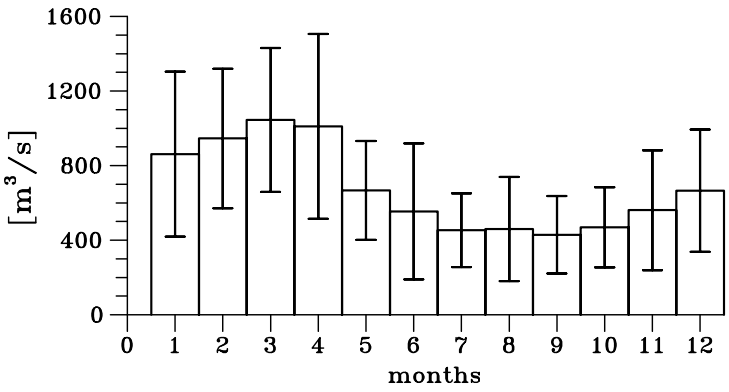
TIME SERIES
number of data: 16800
mean: 675 m^3/s
relative standard deviation: 0.65
minimum: 160 m^3/s September 8, 2019
maximum: 4070 m^3/s June 11, 2013

LOW PASS
minimum: 347 m^3/s December 2019
maximum: 1229 m^3/s August 2002

ANNUAL CYCLE
minimum: 429 m^3/s September, rel. stdev: 0.48
maximum: 1045 m^3/s March, rel. stdev: 0.37





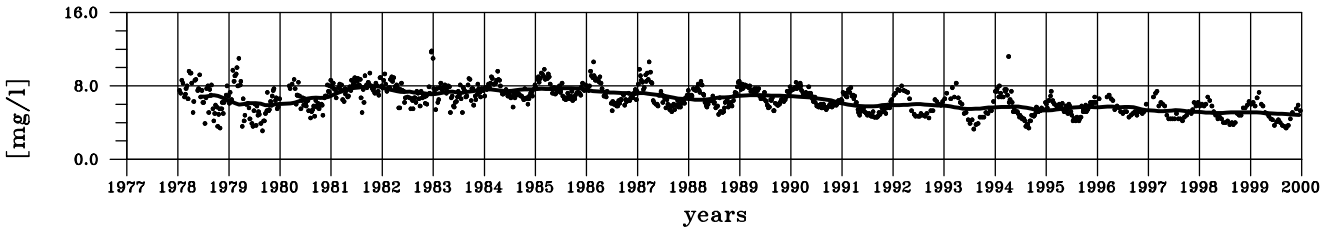


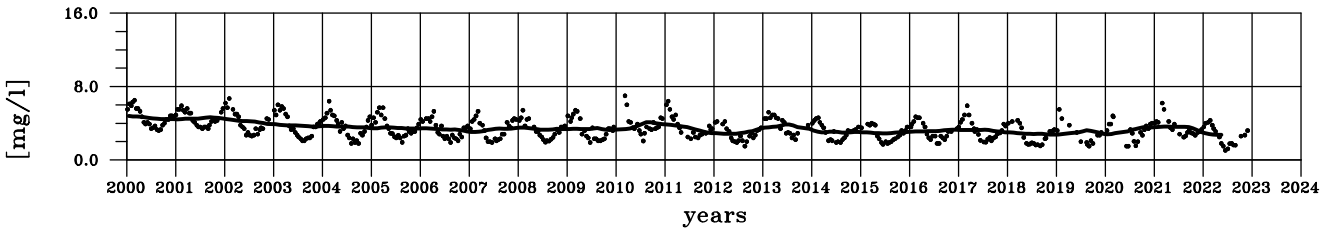
Total Nitrogen from River Elbe

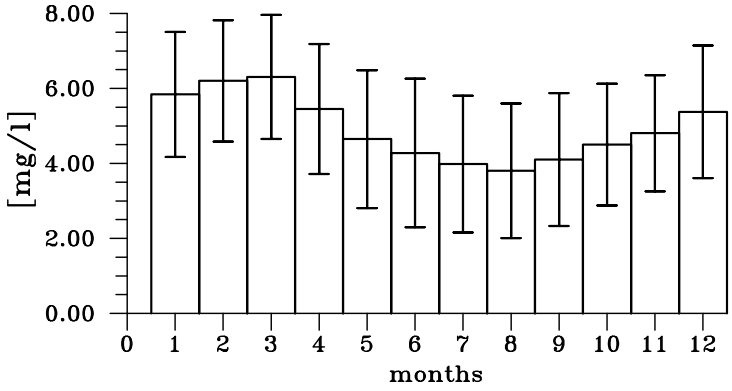
TIME SERIES
number of data: 1464
mean: 5.48 mg/l
relative standard deviation: 0.36
minimum: 1.04 mg/l June 15, 2022
maximum: 11.80 mg/l December 21, 1982

LOW PASS
minimum: 2.74 mg/l May 2022
maximum: 7.99 mg/l October 1981

ANNUAL CYCLE
minimum: 3.81 mg/l August, rel. stdev: 0.47
maximum: 6.31 mg/l March, rel. stdev: 0.26





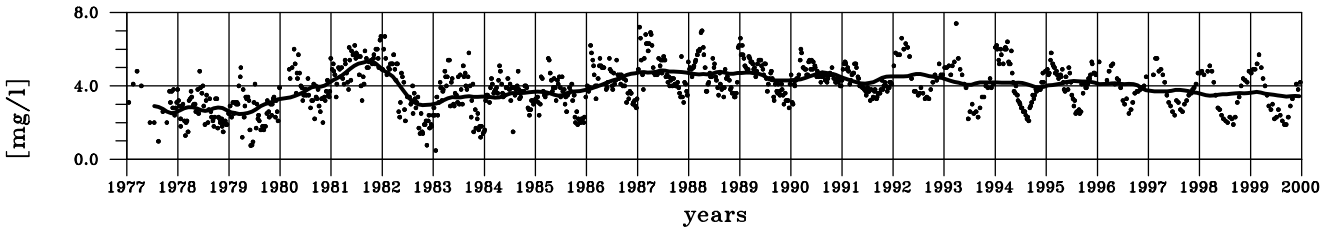


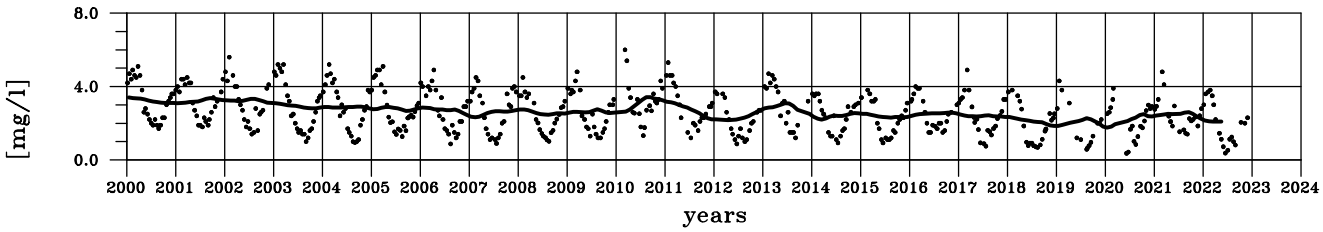
Nitrate from River Elbe

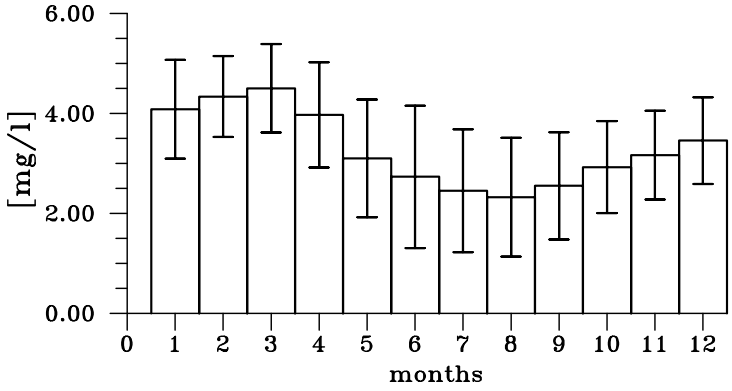
TIME SERIES
number of data: 1489
mean: 3.49 mg/l
relative standard deviation: 0.38
minimum: 0.36 mg/l June 8, 2020
maximum: 7.40 mg/l March 29, 1993

LOW PASS
minimum: 1.76 mg/l January 2020
maximum: 5.34 mg/l October 1981

ANNUAL CYCLE
minimum: 2.32 mg/l August, rel. stdev: 0.51
maximum: 4.50 mg/l March, rel. stdev: 0.20





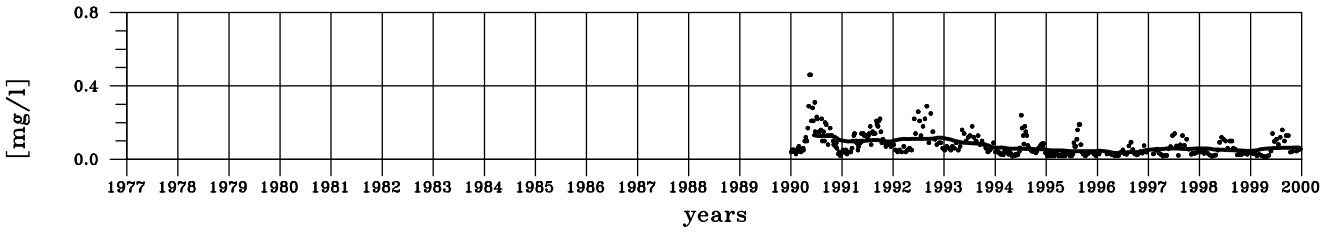


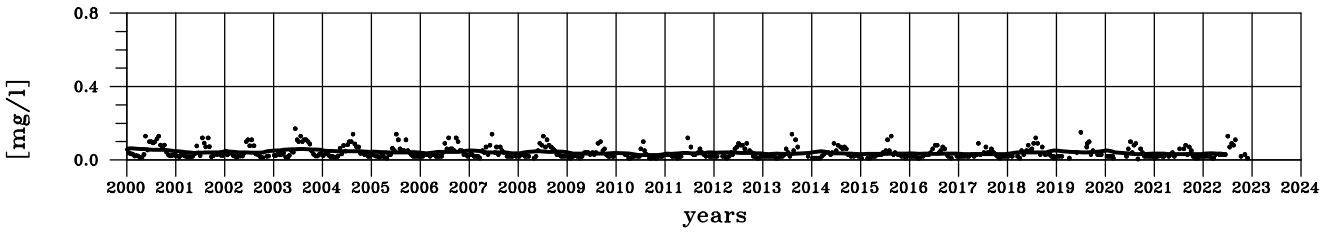
Nitrite from River Elbe

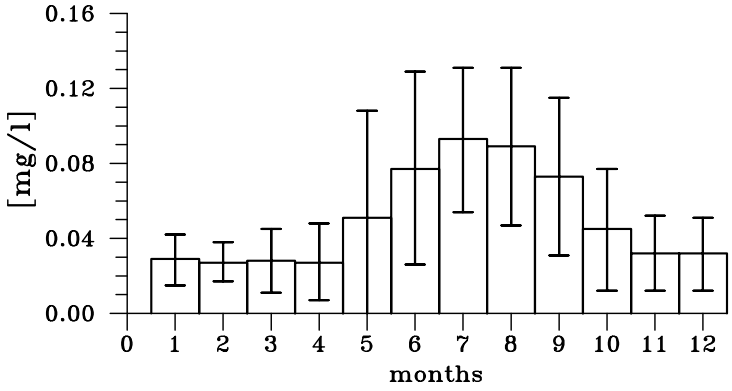
TIME SERIES
number of data: 866
mean: 0.06 mg/l
relative standard deviation: 0.91
minimum: 0.00 mg/l August 31, 2020
maximum: 0.46 mg/l May 15, 1990

LOW PASS
minimum: 0.03 mg/l July 2010
maximum: 0.13 mg/l June 1990

ANNUAL CYCLE
minimum: 0.03 mg/l February, rel. stdev: 0.39
maximum: 0.09 mg/l July, rel. stdev: 0.42





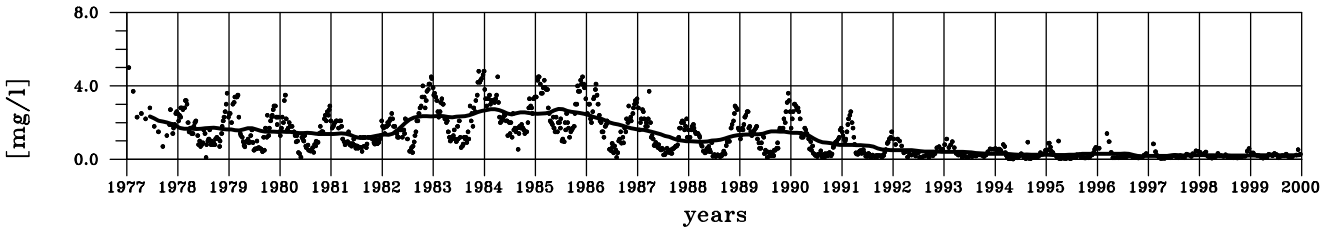


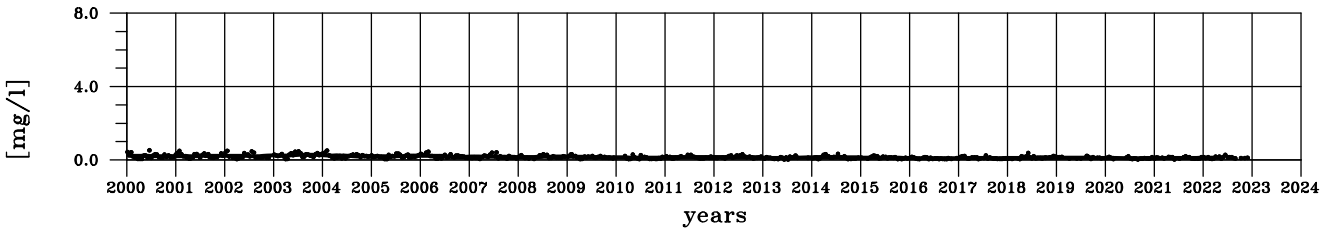
Ammonium from River Elbe

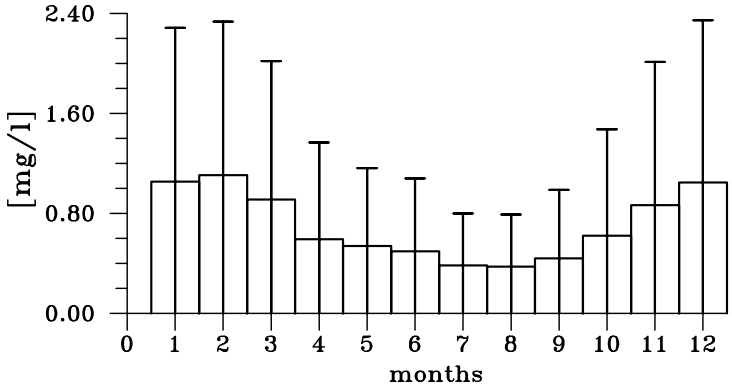
TIME SERIES
number of data: 1499
mean: 0.92 mg/l
relative standard deviation: 1.15
minimum: 0.02 mg/l May 9, 1994
maximum: 5.00 mg/l January 15, 1977

LOW PASS
minimum: 0.09 mg/l July 2016
maximum: 2.75 mg/l June 1985

ANNUAL CYCLE
minimum: 0.37 mg/l August, rel. stdev: 1.12
maximum: 1.11 mg/l February, rel. stdev: 1.11





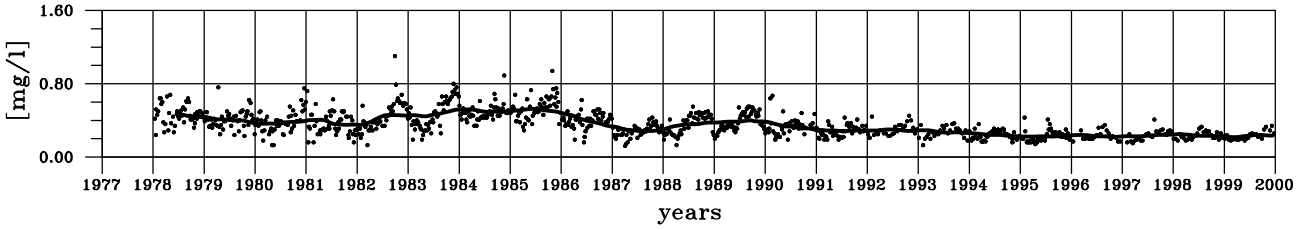


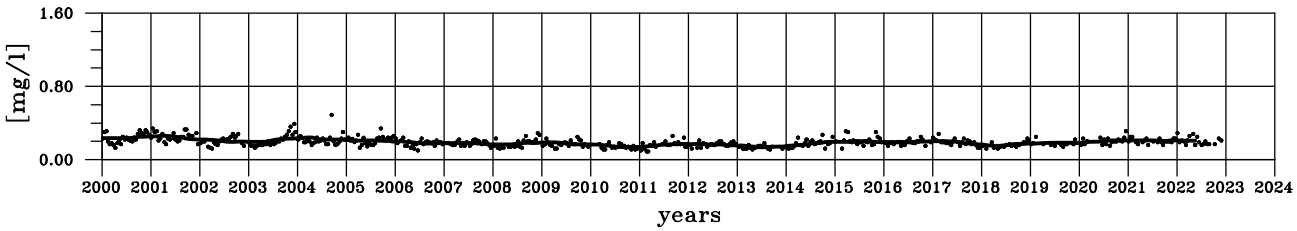
Total Phosphorus from River Elbe

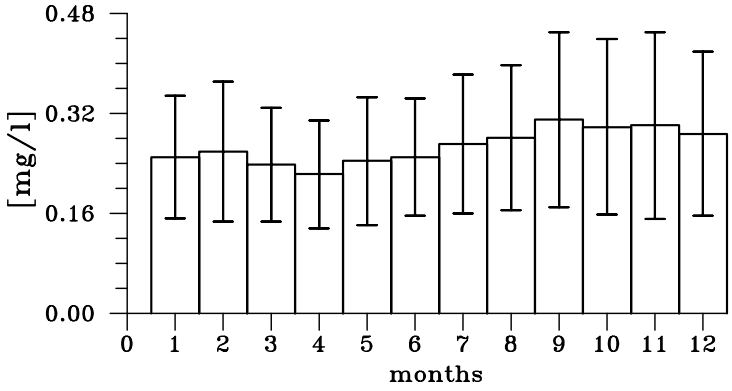
TIME SERIES
number of data: 1465
mean: 0.30 mg/l
relative standard deviation: 0.46
minimum: 0.09 mg/l February 23, 2011
maximum: 1.10 mg/l September 28, 1982

LOW PASS
minimum: 0.14 mg/l July 2013
maximum: 0.53 mg/l June 1985

ANNUAL CYCLE
minimum: 0.22 mg/l April, rel. stdev: 0.39
maximum: 0.31 mg/l September, rel. stdev: 0.45





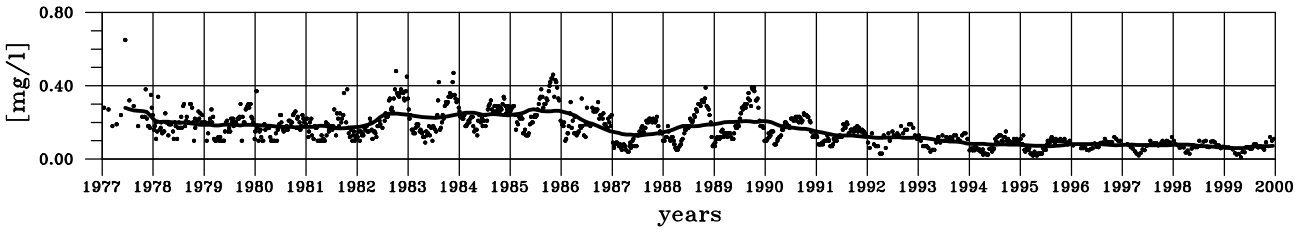


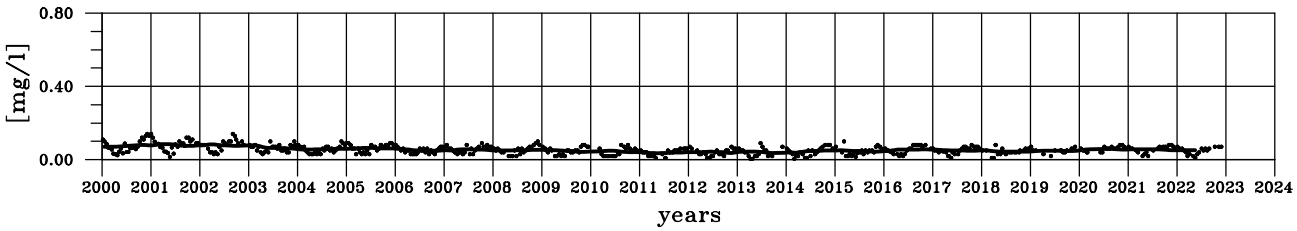
Phosphate from River Elbe

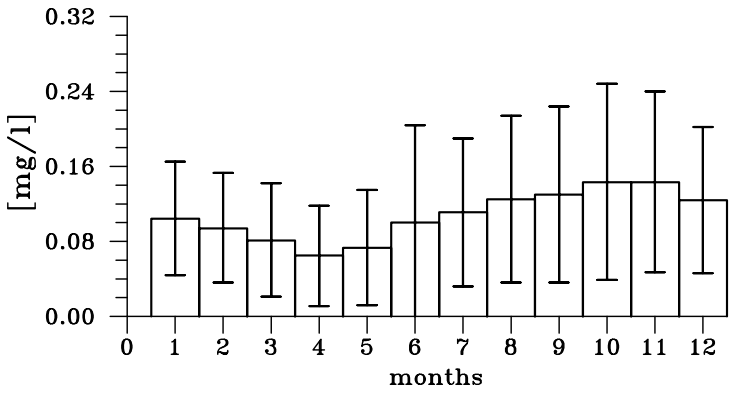
TIME SERIES
number of data: 1499
mean: 0.13 mg/l
relative standard deviation: 0.71
minimum: 0.00 mg/l April 10, 2013
maximum: 0.65 mg/l June 15, 1977

LOW PASS
minimum: 0.04 mg/l May 2011
maximum: 0.28 mg/l June 1977

ANNUAL CYCLE
minimum: 0.06 mg/l April, rel. stdev: 0.82
maximum: 0.14 mg/l October, rel. stdev: 0.73





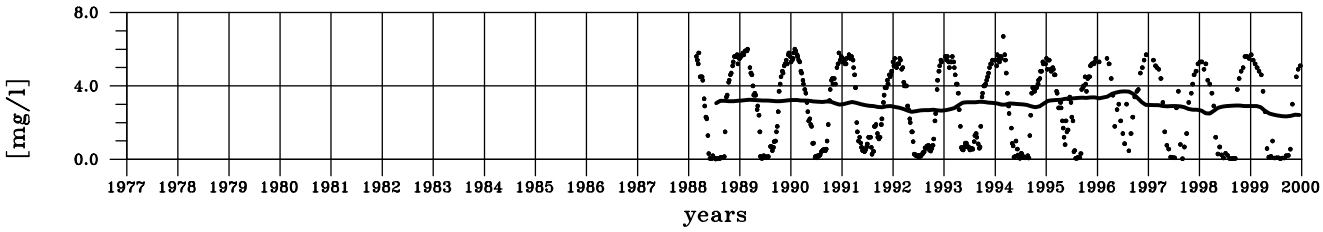


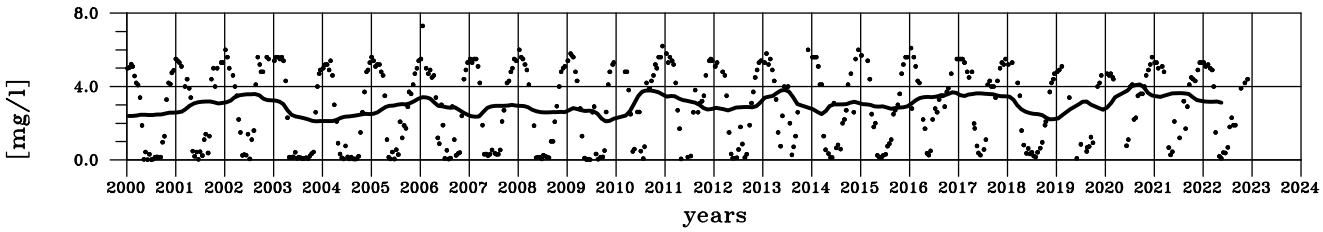
Silicate from River Elbe

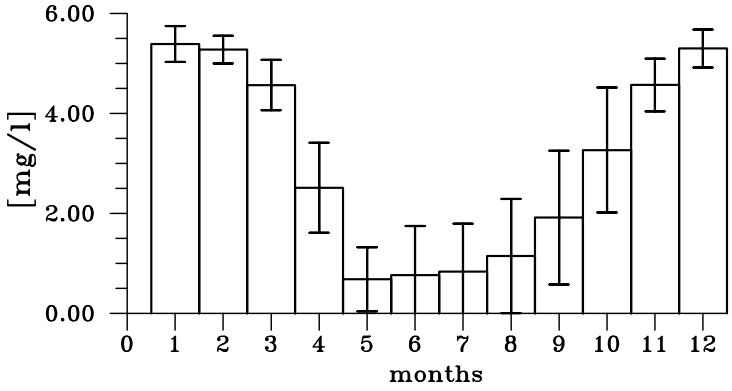
TIME SERIES
number of data: 1006
mean: 2.93 mg/l
relative standard deviation: 0.71
minimum: 0.02 mg/l July 13, 1988
maximum: 7.30 mg/l January 17, 2006

LOW PASS
minimum: 2.10 mg/l October 2009
maximum: 4.11 mg/l September 2020

ANNUAL CYCLE
minimum: 0.68 mg/l May, rel. stdev: 0.94
maximum: 5.39 mg/l January, rel. stdev: 0.07





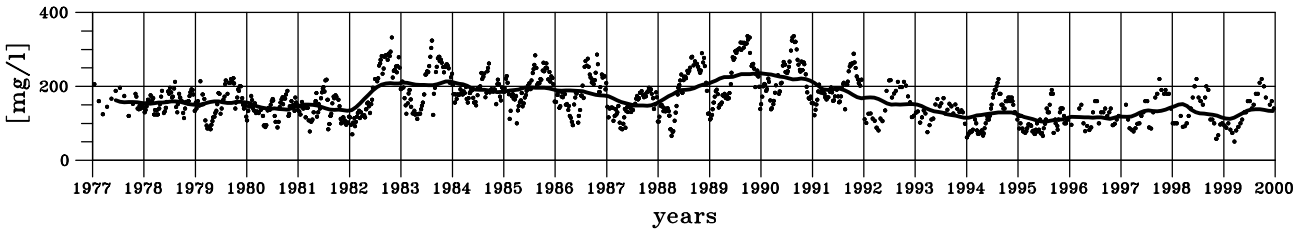


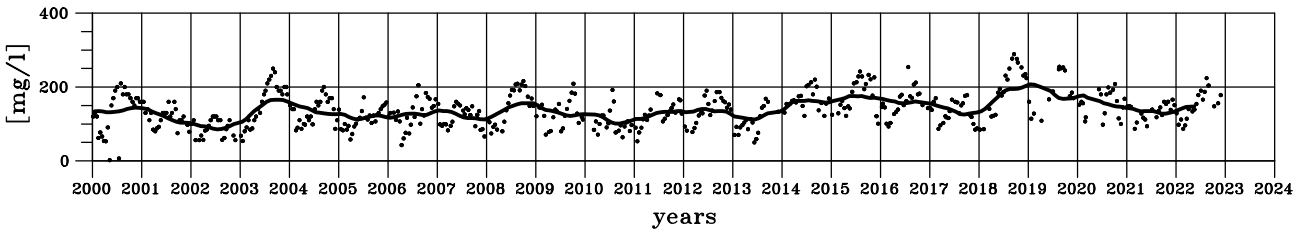
Chloride from River Elbe

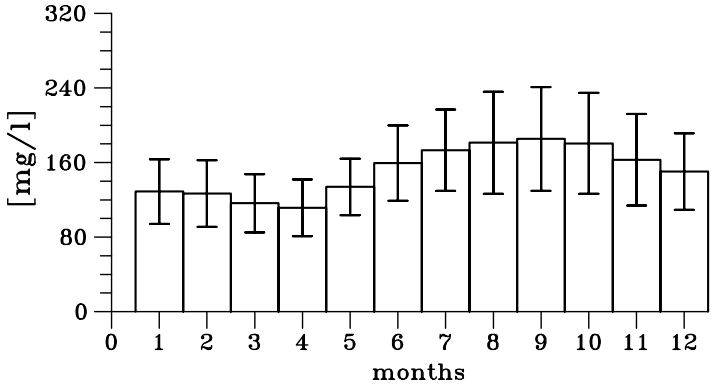
TIME SERIES
number of data: 1495
mean: 158 mg/l
relative standard deviation: 0.35
minimum: 2 mg/l May 9, 2000
maximum: 336 mg/l September 28, 1989

LOW PASS
minimum: 85 mg/l July 2002
maximum: 236 mg/l December 1989

ANNUAL CYCLE
minimum: 111 mg/l April, rel. stdev: 0.27
maximum: 185 mg/l September, rel. stdev: 0.30





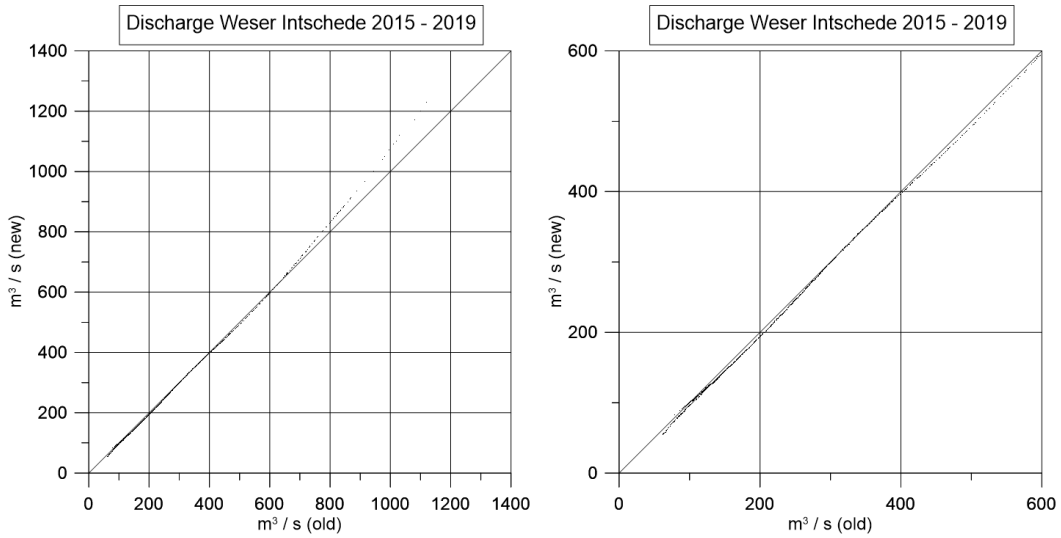


3.1.2 River Weser

The data source for the daily flow data at the last tide-free gauge station for the river Weser at Intschede was the Wasserstraßen- und Schifffahrtsverwaltung des Bundes (WSV). The data were provided by the Bundesanstalt für Gewässerkunde (BFG; Datenstelle-M1@bafg.de). The concentration data for the station Intschede for 1977 - 2006 and the station Uesen for 2007 - 2022 at the Weser were taken from the data portal (BFG; www.wasserdaten.niedersachsen.de). The portal is serviced by the Niedersäsischer Landesbetrieb für Wasserwirtschaft, Küsten- und Naturschutz (NLWKN).

The concentration data cover the whole range from 1977 up to the end of 2022 for nitrate, ammonium and total phosphorus. Data on total nitrogen were available from 1980 and for orthophosphate from 1981 on. For this updated report nitrite and chloride were only taken into account from 1990 onward. For all these time series of nutrient concentrations there is only one value available for the year 1993. In contrast, silicate data were available at the measuring site Brake for the years 1993 and 1994 only. An amount of 19 % of discharge has to be added to the actual discharge data at the station Intschede (pers. comm. Berger, former LfÖ) to get an improved estimate of the discharge entering the North Sea.

As reported above, the discharge data from the suppliers differ from the previous data. In the case of the Elbe, the deviation for the years 2015 - 2019 is on average 5.36 m^3/s (mean of the absolute differences).

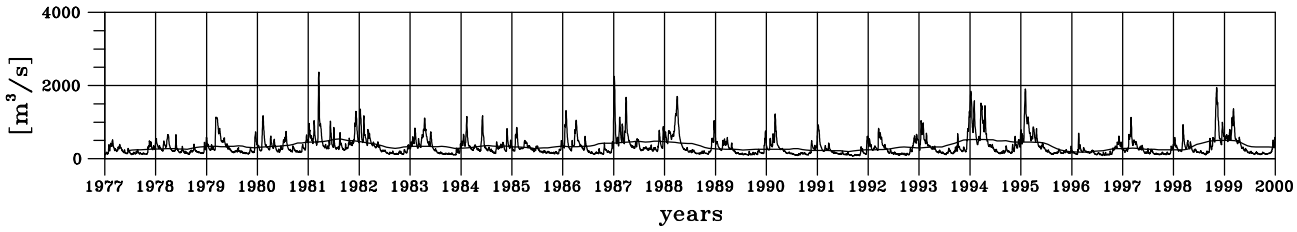


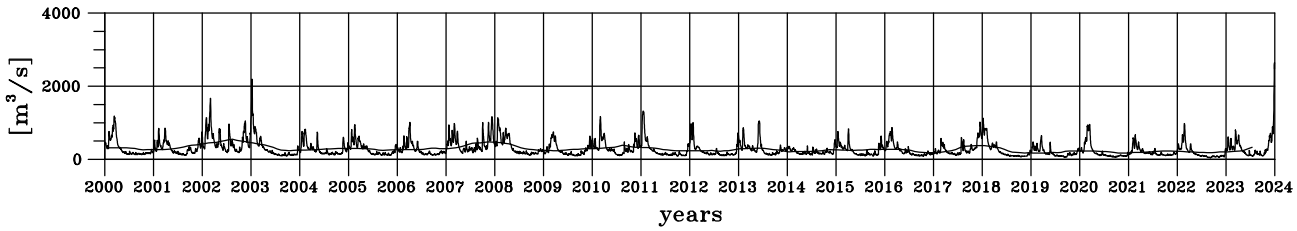
Discharge from River Weser

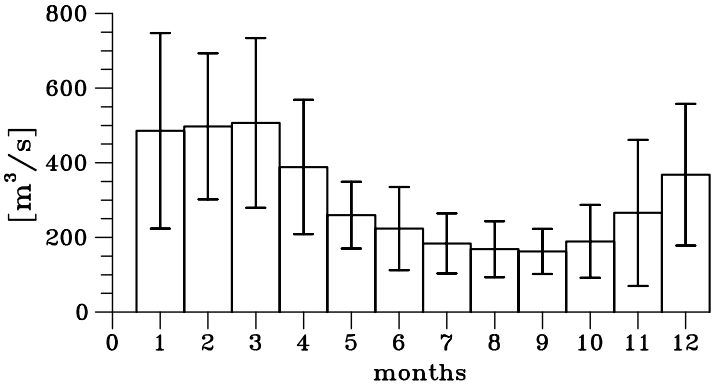
TIME SERIES
number of data: 17166
mean: 307 m^3/s
relative standard deviation: 0.78
minimum: 38 m^3/s September 6, 2022
maximum: 2640 m^3/s December 30, 2023

LOW PASS
minimum: 172 m^3/s October 2020
maximum: 552 m^3/s August 2002

ANNUAL CYCLE
minimum: 162 m^3/s September, rel. stdev: 0.37
maximum: 507 m^3/s March, rel. stdev: 0.45





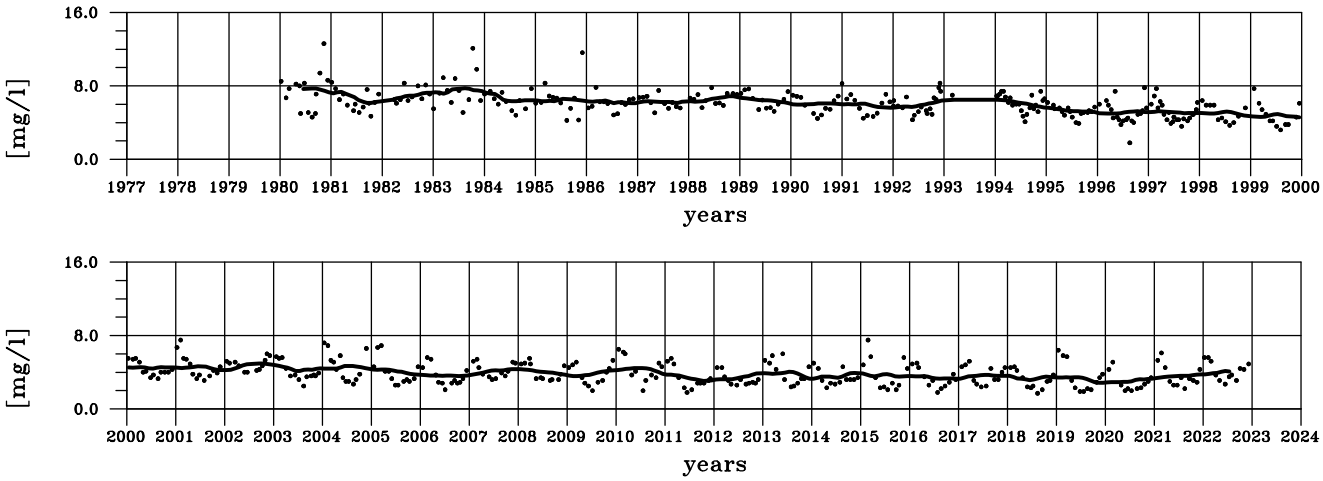


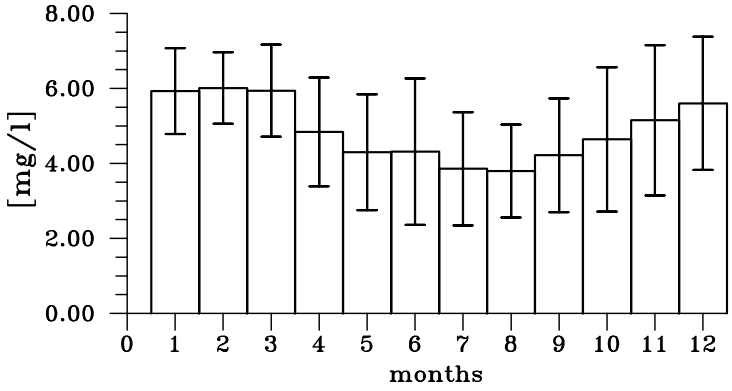
Total Nitrogen from River Weser

TIME SERIES
number of data: 547
mean: 4.92 mg/l
relative standard deviation: 0.35
minimum: 1.70 mg/l August 14, 2018
maximum: 12.60 mg/l November 10, 1980

LOW PASS
minimum: 2.87 mg/l December 2019
maximum: 7.77 mg/l August 1983

ANNUAL CYCLE
minimum: 3.79 mg/l August, rel. stdev: 0.33
maximum: 6.01 mg/l February, rel. stdev: 0.16



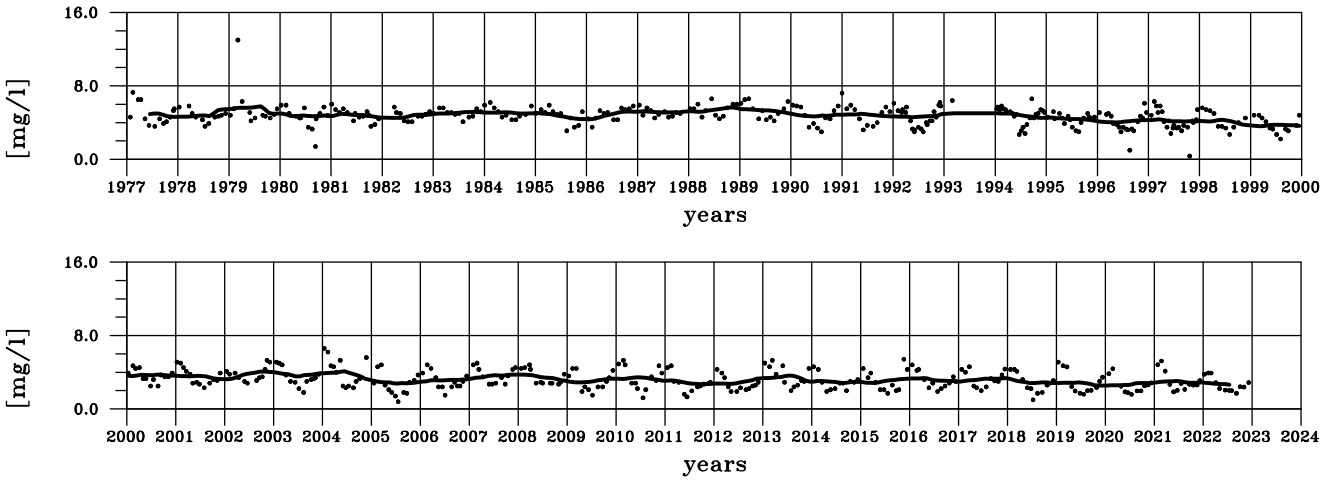


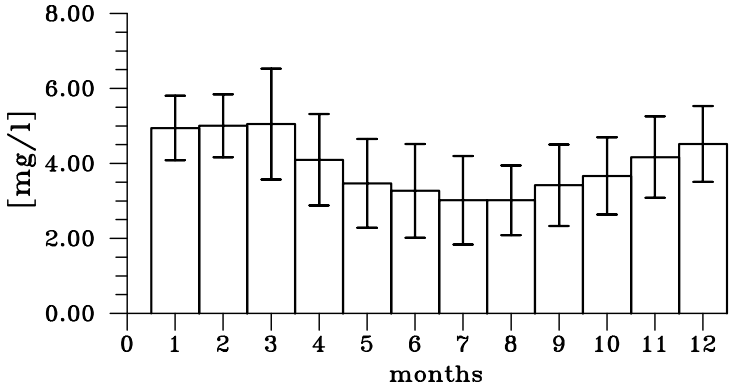
Nitrate from River Weser

TIME SERIES
number of data: 590
mean: 3.98 mg/l
relative standard deviation: 0.33
minimum: 0.35 mg/l October 23, 1997
maximum: 13.00 mg/l March 5, 1979

LOW PASS
minimum: 2.53 mg/l December 2019
maximum: 5.76 mg/l August 1979

ANNUAL CYCLE
minimum: 3.02 mg/l July, rel. stdev: 0.39
maximum: 5.05 mg/l March, rel. stdev: 0.29



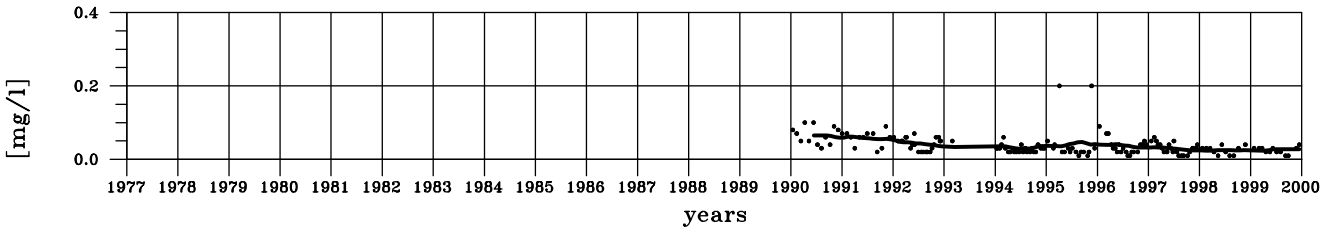


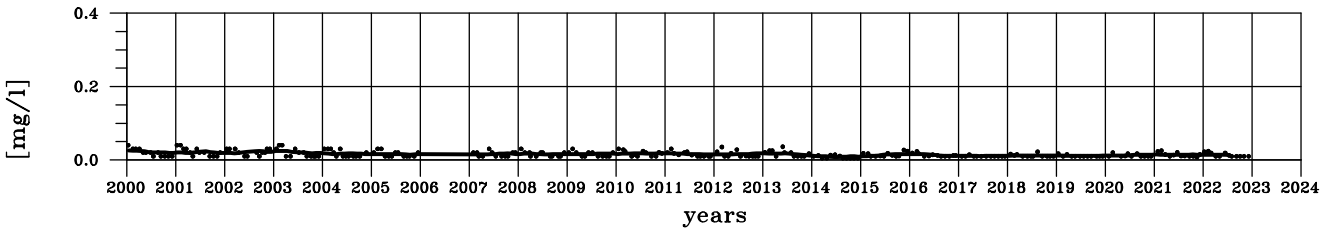
Nitrite from River Weser

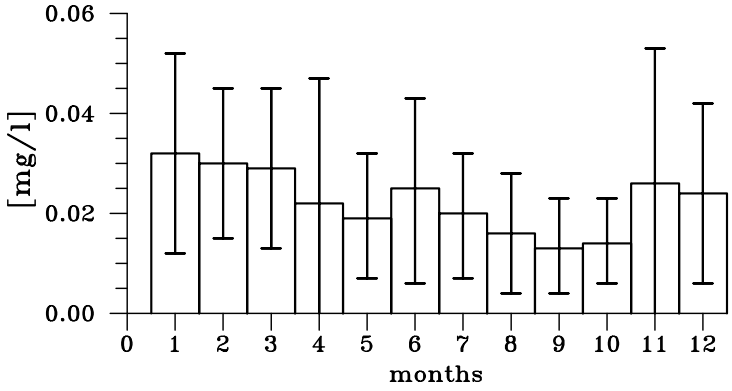
TIME SERIES
number of data: 421
mean: 0.02 mg/l
relative standard deviation: 0.87
minimum: 0.00 mg/l March 19, 2014
maximum: 0.20 mg/l April 5, 1995

LOW PASS
minimum: 0.01 mg/l July 2014
maximum: 0.07 mg/l September 1990

ANNUAL CYCLE
minimum: 0.01 mg/l September, rel. stdev: 0.73
maximum: 0.03 mg/l January, rel. stdev: 0.63





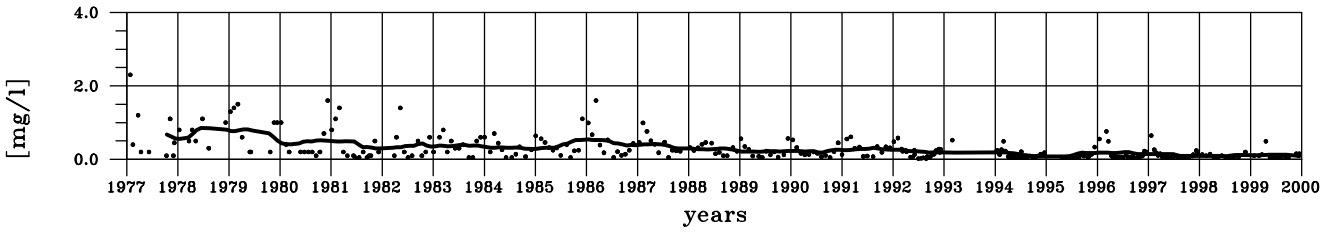


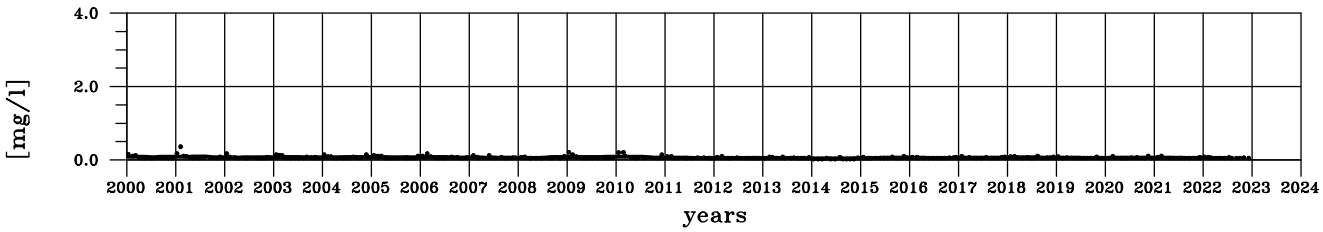
Ammonium from River Weser

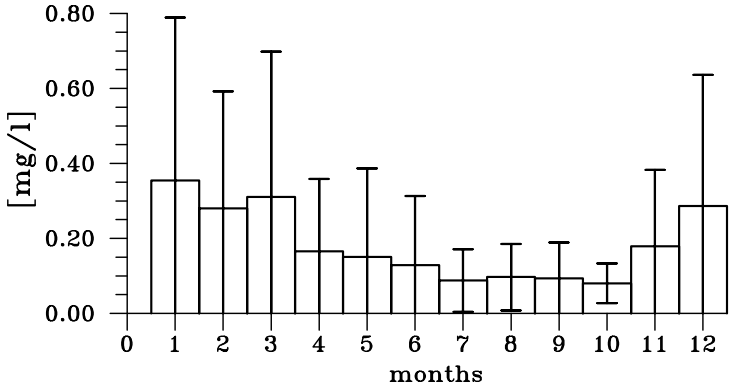
TIME SERIES
number of data: 572
mean: 0.18 mg/l
relative standard deviation: 1.46
minimum: 0.02 mg/l July 1, 1992
maximum: 2.30 mg/l January 26, 1977

LOW PASS
minimum: 0.03 mg/l June 2014
maximum: 0.85 mg/l June 1978

ANNUAL CYCLE
minimum: 0.08 mg/l October, rel. stdev: 0.66
maximum: 0.35 mg/l January, rel. stdev: 1.23





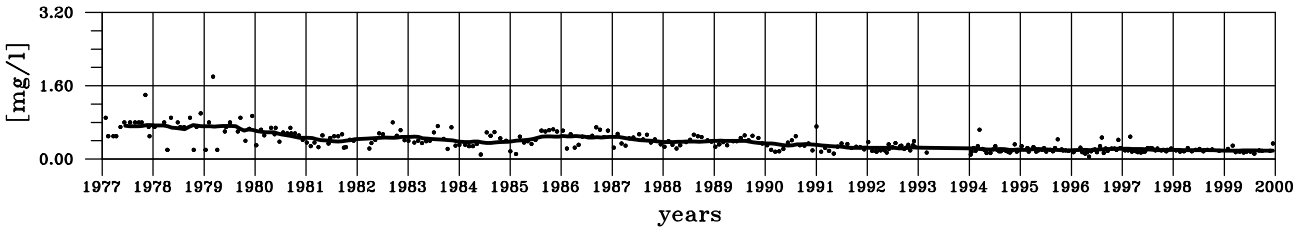


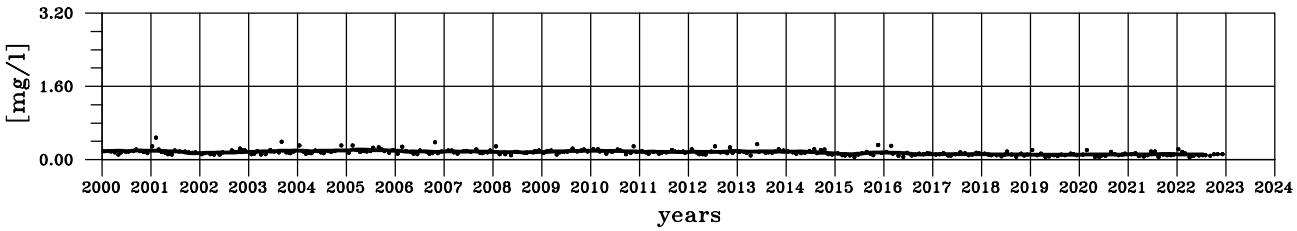
Total Phosphorus from River Weser

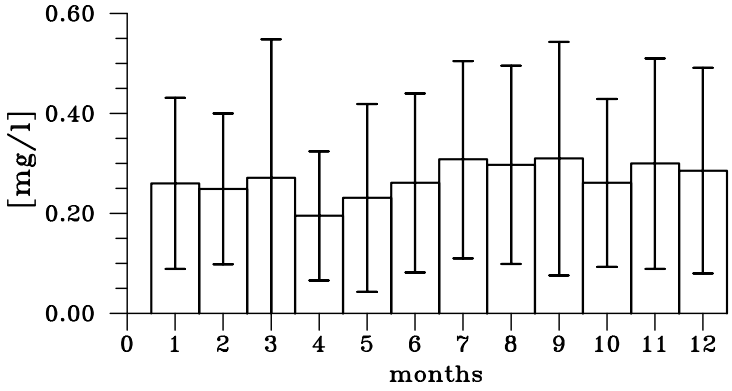
TIME SERIES
number of data: 588
mean: 0.27 mg/l
relative standard deviation: 0.73
minimum: 0.05 mg/l May 8, 1996
maximum: 1.80 mg/l March 5, 1979

LOW PASS
minimum: 0.10 mg/l October 2019
maximum: 0.74 mg/l October 1978

ANNUAL CYCLE
minimum: 0.20 mg/l April, rel. stdev: 0.66
maximum: 0.31 mg/l September, rel. stdev: 0.75





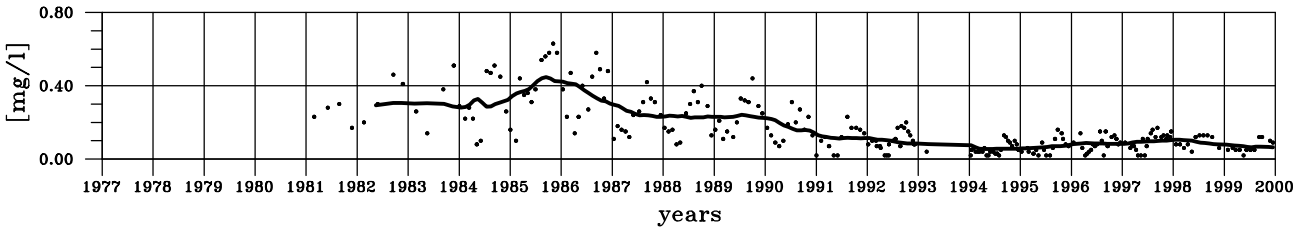


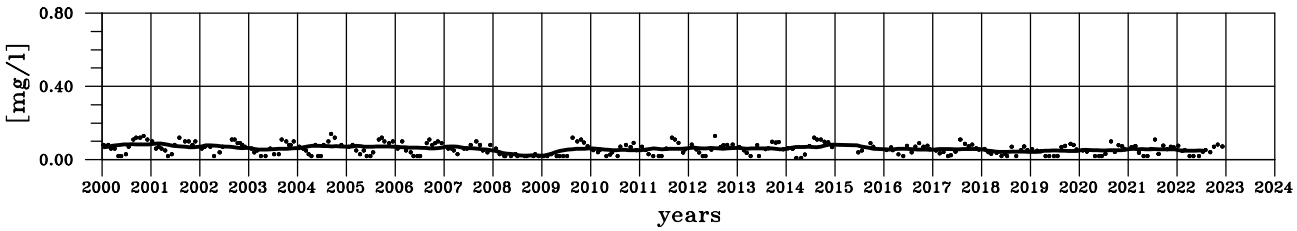
Phosphate from River Weser

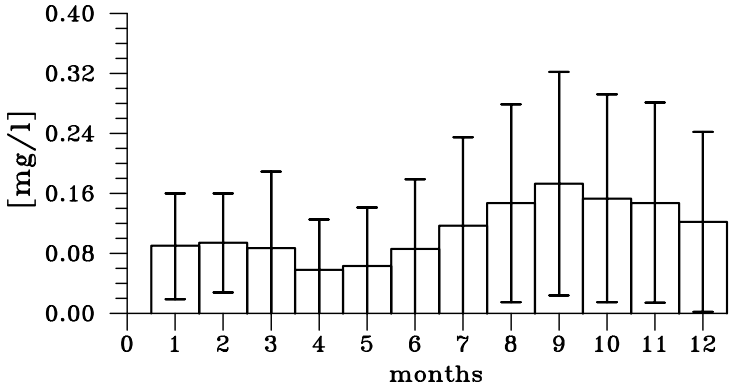
TIME SERIES
number of data: 508
mean: 0.11 mg/l
relative standard deviation: 1.01
minimum: 0.01 mg/l March 19, 2014
maximum: 0.63 mg/l November 5, 1985

LOW PASS
minimum: 0.02 mg/l January 2009
maximum: 0.45 mg/l September 1985

ANNUAL CYCLE
minimum: 0.06 mg/l April, rel. stdev: 1.17
maximum: 0.17 mg/l September, rel. stdev: 0.86





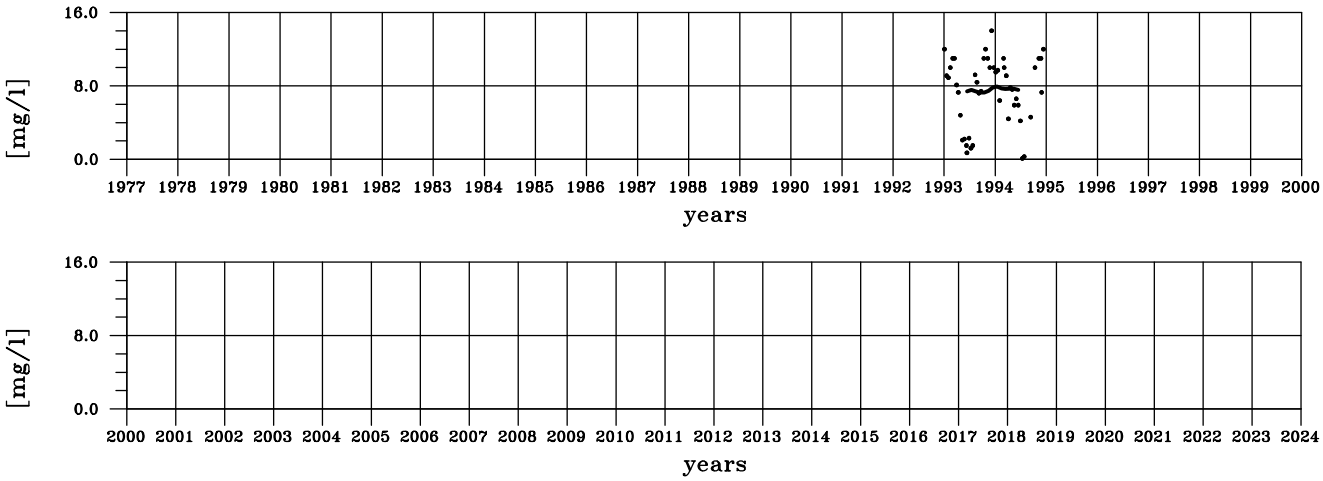


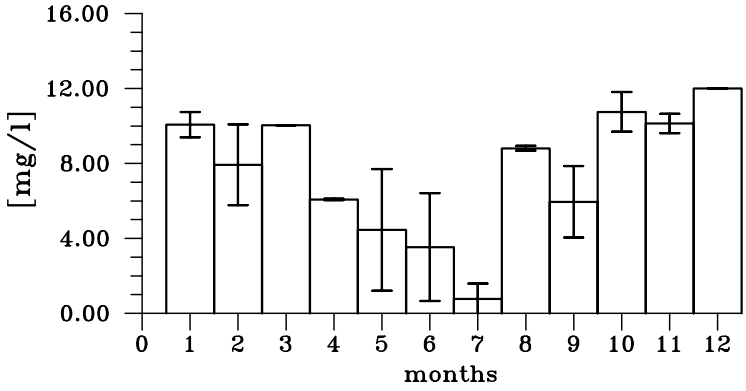
Silicate from River Weser

TIME SERIES
number of data: 47
mean: 7.41 mg/l
relative standard deviation: 0.50
minimum: 0.10 mg/l July 14, 1994
maximum: 14.00 mg/l December 7, 1993

LOW PASS
minimum: 7.27 mg/l September 1993
maximum: 7.94 mg/l January 1994

ANNUAL CYCLE
minimum: 0.78 mg/l July, rel. stdev: 1.05
maximum: 12.00 mg/l December, rel. stdev: 0.00



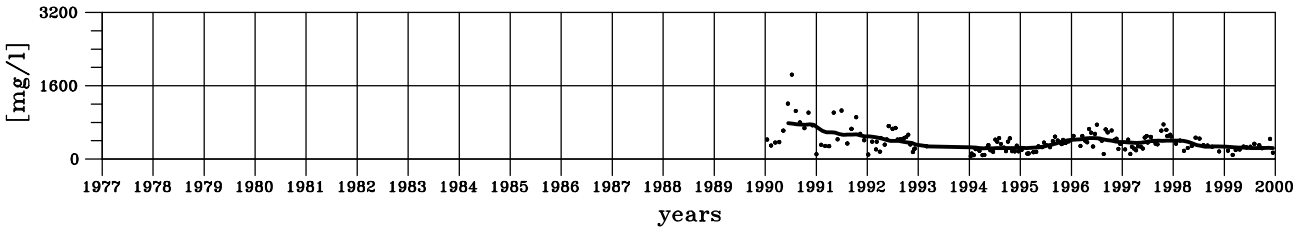


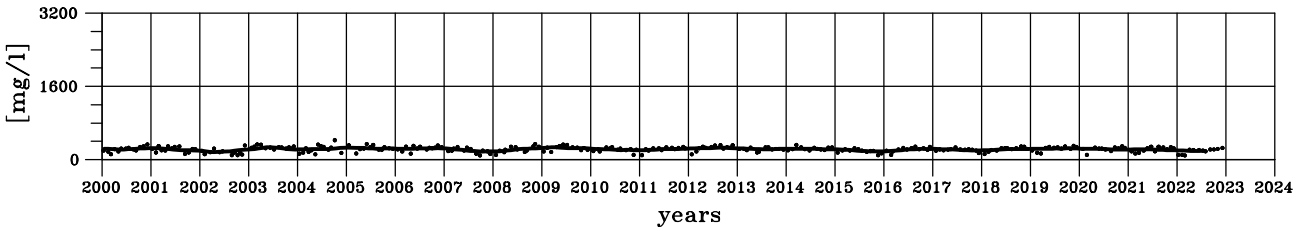
Chloride from River Weser

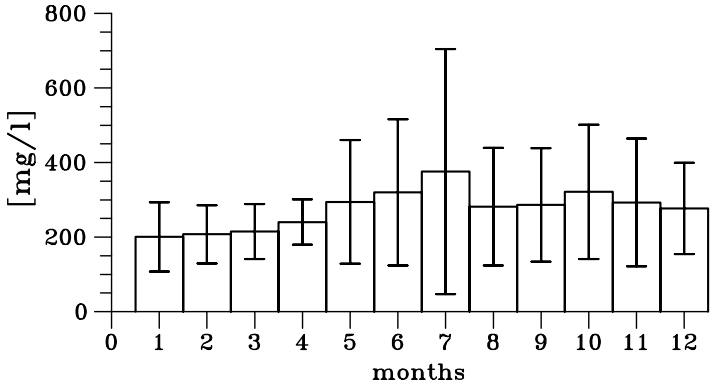
TIME SERIES
number of data: 433
mean: 284 mg/l
relative standard deviation: 0.60
minimum: 63 mg/l January 12, 1994
maximum: 1840 mg/l July 10, 1990

LOW PASS
minimum: 162 mg/l April 2002
maximum: 785 mg/l June 1990

ANNUAL CYCLE
minimum: 201 mg/l January, rel. stdev: 0.46
maximum: 376 mg/l July, rel. stdev: 0.87





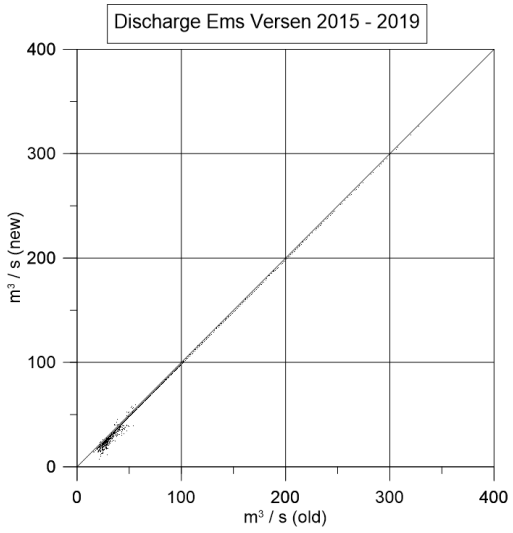


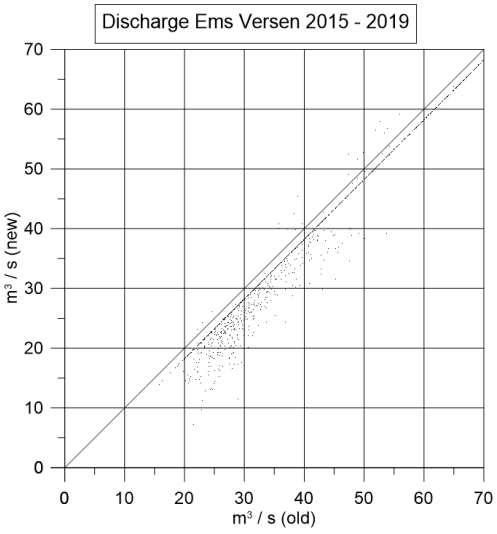
3.1.3 River Ems

The data source for the daily flow data for the river Ems at the station Versen-Wehrdurchstich (near the Herbrum habourdam) was the Wasserstraßen- und Schifffahrtsverwaltung des Bundes (WSV). The data were provided by the Bundesanstalt für Gewässerkunde (BFG; Datenstelle-M1@bafg.de). The concentration data for the station Herbrum for 1977 - 2023 at the Ems were taken from the dataportal (BFG; www.wasserdaten.niedersachsen.de). The portal is serviced by the Niedersäsischer Landesbetrieb für Wasserwirtschaft, Küsten- und Naturschutz (NLWKN).

The concentration data cover the whole range from 1977 up to the end of 2022 for nitrate, ammonium and total phosphorus. Data on total nitrogen were available from 1980 and for orthophosphate from 1981 on. For this updated report data on nitrite and chloride were only taken into account from 1990 onward. Silicate data were available for the years 1989 to 1994 at the measuring site Terborg and for the years 2020 to 2021 at Herbrum. These data stem from a different measuring program. An amount of 30 % of discharge has to be added to the actual discharge data at the station Herbrum (pers. comm. Berger, former LfÖ) to get an improved estimate of the discharge which also regards the contributions downstream of the gauge station.

As reported above, the discharge data from the suppliers differ from the previous data. In the case of the Elbe, the deviation for the years 2015 - 2019 is on average 2.55 m^3/s (mean of the absolute differences).



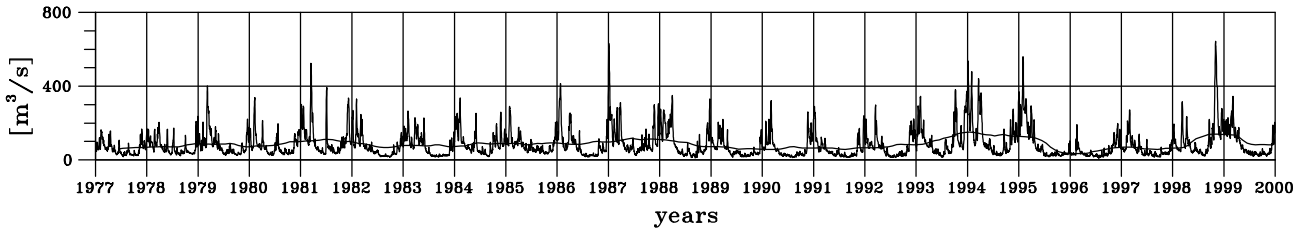


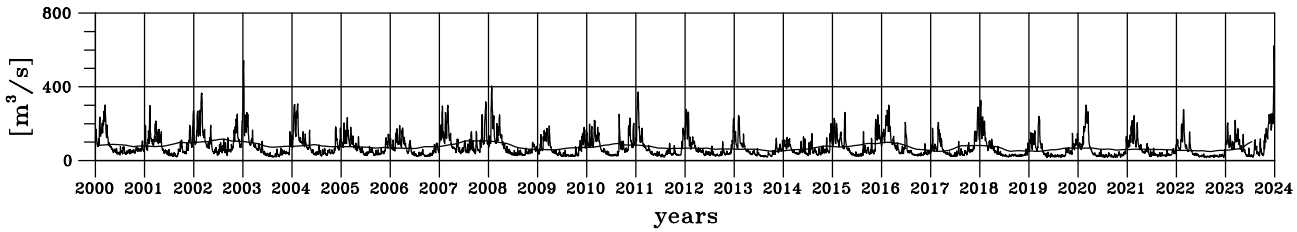
Discharge from River Ems

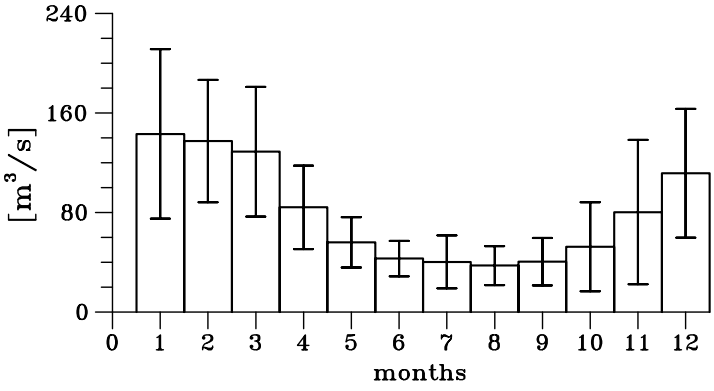
TIME SERIES
number of data: 17166
mean: 79 m^3/s
relative standard deviation: 0.86
minimum: 10 m^3/s September 11, 1988
maximum: 643 m^3/s November 3, 1998

LOW PASS
minimum: 34 m^3/s March 1996
maximum: 151 m^3/s January 1994

ANNUAL CYCLE
minimum: 37 m^3/s August, rel. stdev: 0.42
maximum: 143 m^3/s January, rel. stdev: 0.48





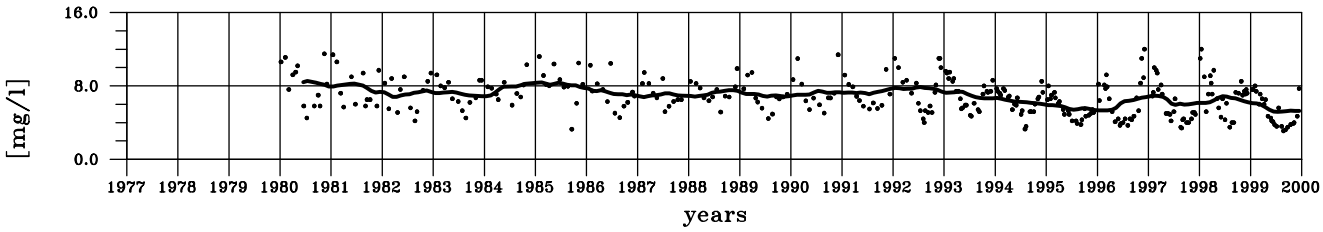


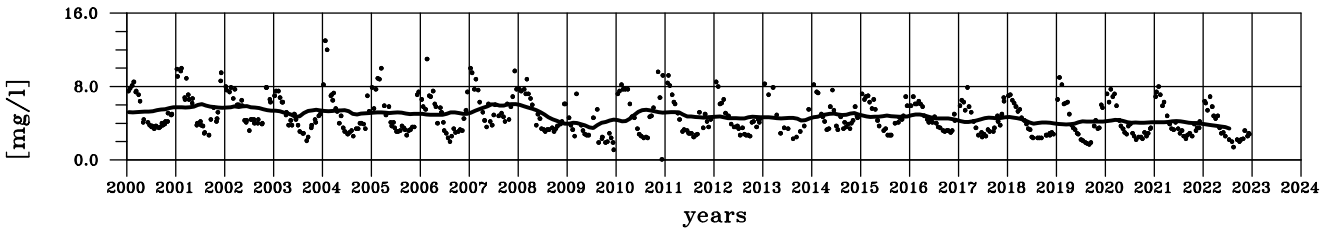
Total Nitrogen from River Ems

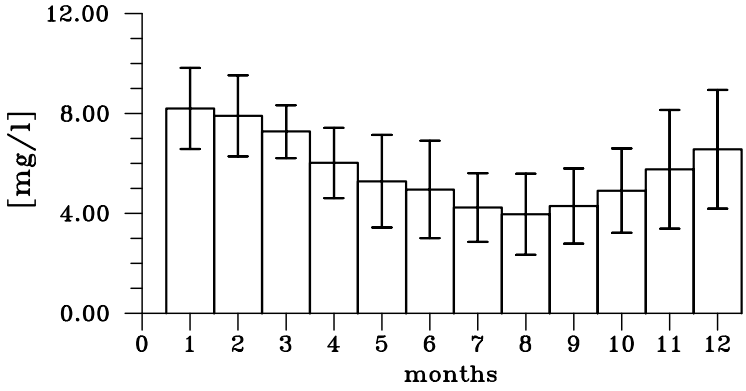
TIME SERIES
number of data: 874
mean: 5.54 mg/l
relative standard deviation: 0.40
minimum: 0.06 mg/l December 9, 2010
maximum: 13.00 mg/l January 22, 2004

LOW PASS
minimum: 3.41 mg/l July 2022
maximum: 8.54 mg/l July 1980

ANNUAL CYCLE
minimum: 3.97 mg/l August, rel. stdev: 0.41
maximum: 8.20 mg/l January, rel. stdev: 0.20





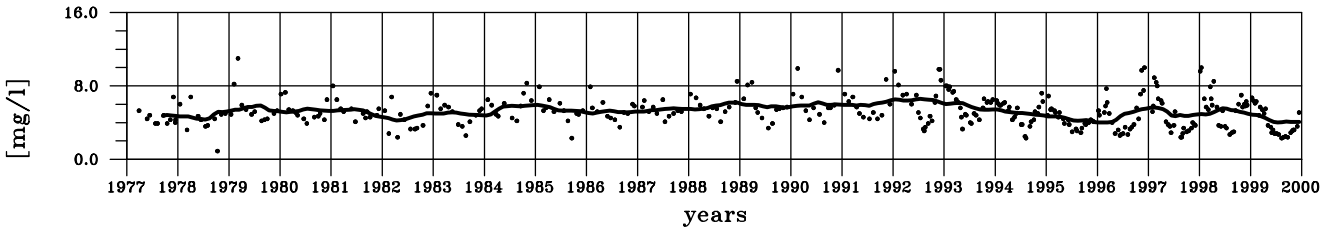


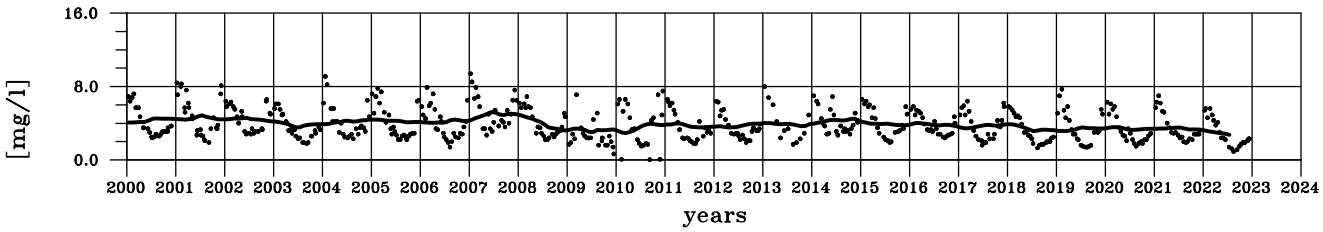
Nitrate from River Ems

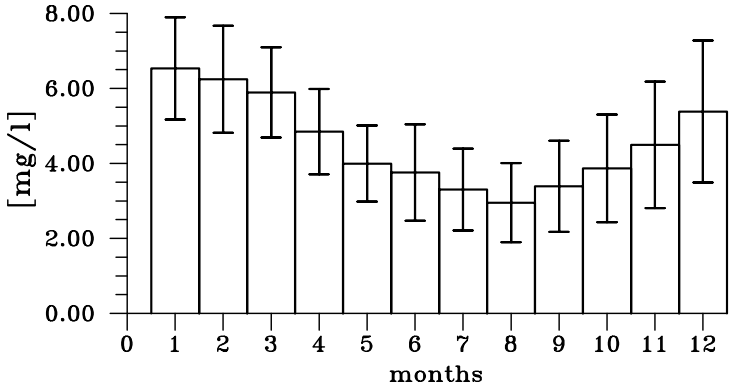
TIME SERIES
number of data: 911
mean: 4.38 mg/l
relative standard deviation: 0.41
minimum: 0.04 mg/l September 9, 2010
maximum: 11.00 mg/l March 6, 1979

LOW PASS
minimum: 2.72 mg/l July 2022
maximum: 6.60 mg/l July 1992

ANNUAL CYCLE
minimum: 2.95 mg/l August, rel. stdev: 0.36
maximum: 6.53 mg/l January, rel. stdev: 0.21





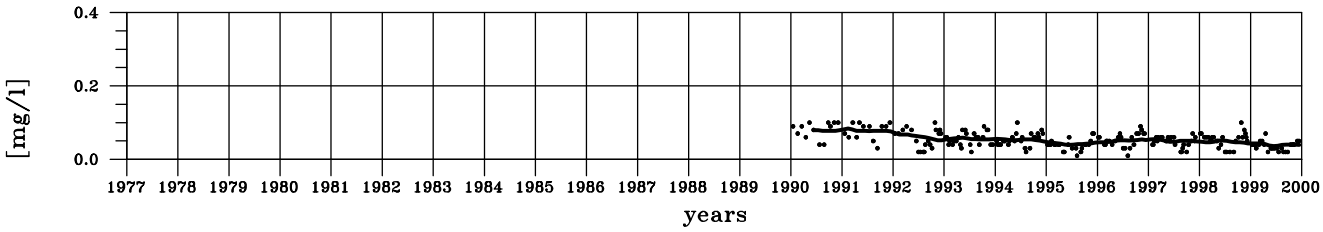


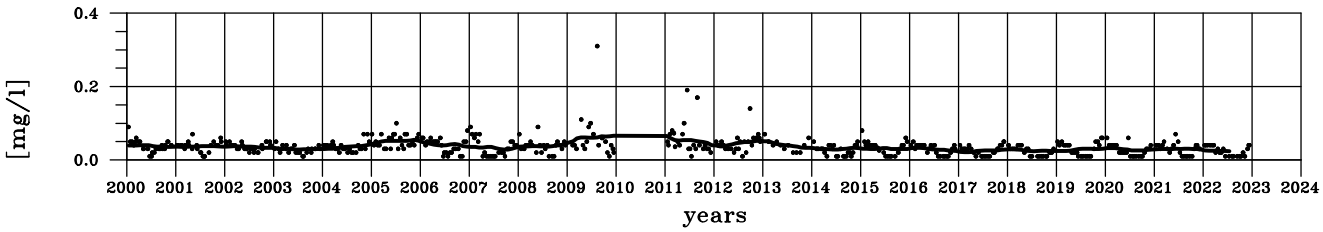
Nitrite from River Ems

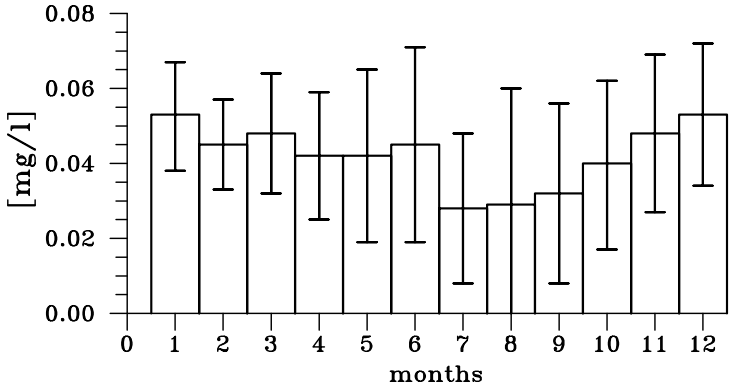
TIME SERIES
number of data: 732
mean: 0.04 mg/l
relative standard deviation: 0.60
minimum: 0.01 mg/l August 9, 1995
maximum: 0.31 mg/l August 13, 2009

LOW PASS
minimum: 0.02 mg/l February 2017
maximum: 0.08 mg/l February 1991

ANNUAL CYCLE
minimum: 0.03 mg/l July, rel. stdev: 0.70
maximum: 0.05 mg/l December, rel. stdev: 0.36





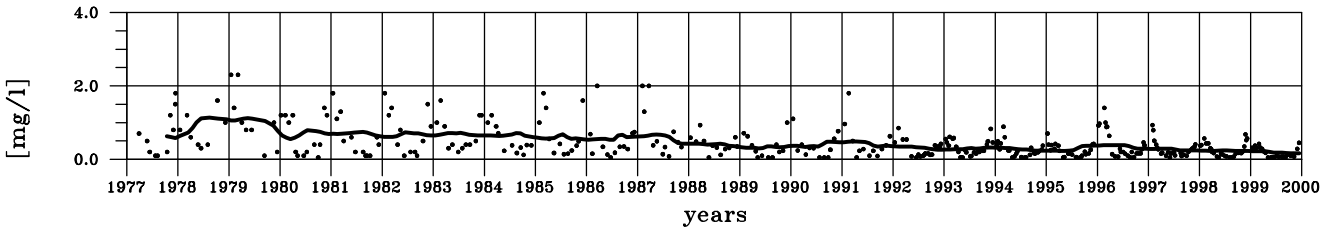


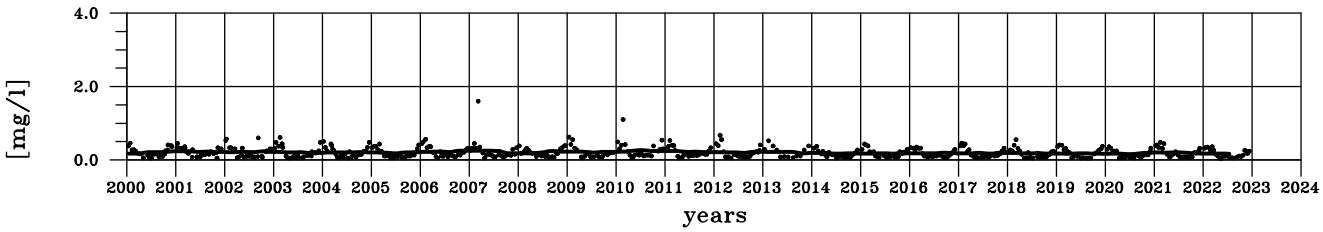
Ammonium from River Ems

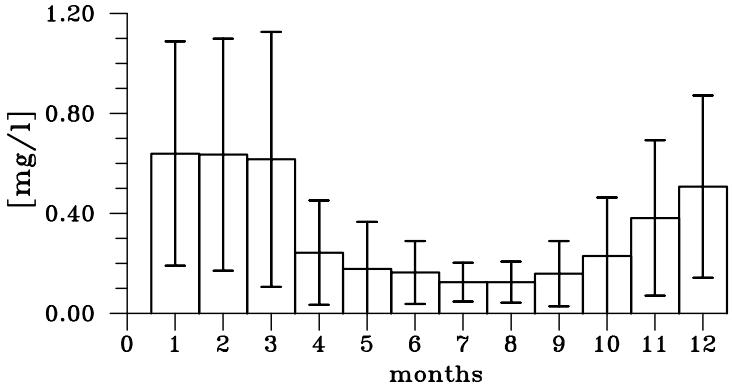
TIME SERIES
number of data: 906
mean: 0.29 mg/l
relative standard deviation: 1.08
minimum: 0.04 mg/l May 16, 2022
maximum: 2.30 mg/l January 16, 1979

LOW PASS
minimum: 0.16 mg/l June 2020
maximum: 1.14 mg/l August 1978

ANNUAL CYCLE
minimum: 0.12 mg/l August, rel. stdev: 0.67
maximum: 0.64 mg/l January, rel. stdev: 0.70





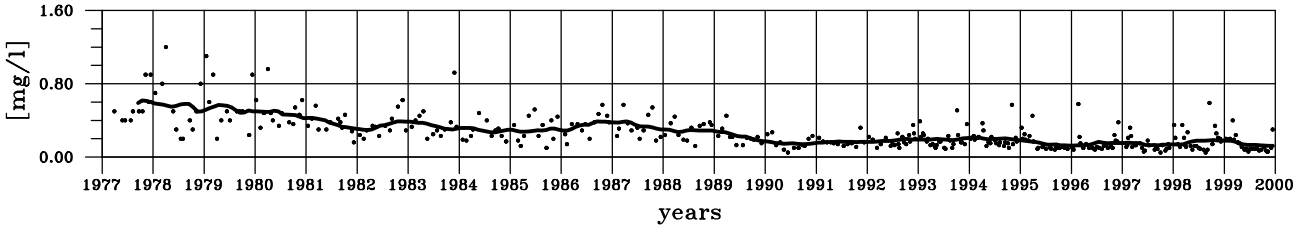


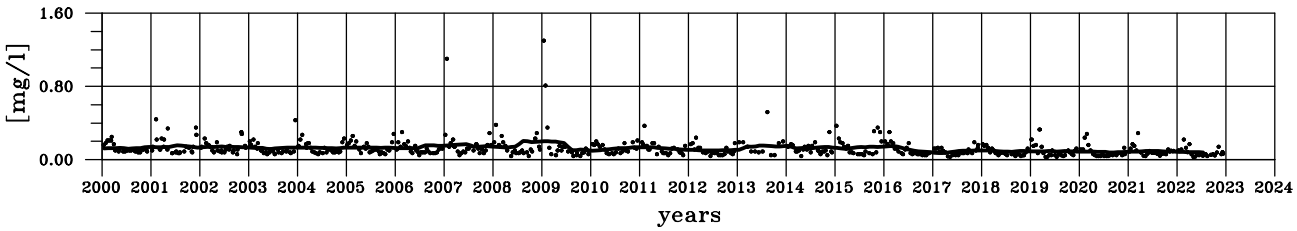
Total Phosphorus from River Ems

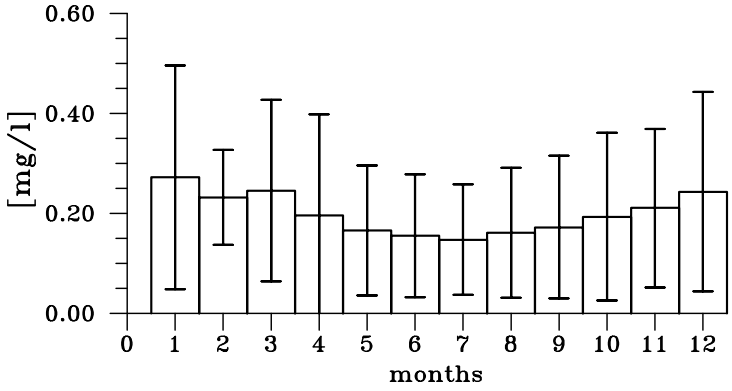
TIME SERIES
number of data: 914
mean: 0.18 mg/l
relative standard deviation: 0.87
minimum: 0.03 mg/l May 4, 2022
maximum: 1.30 mg/l January 15, 2009

LOW PASS
minimum: 0.07 mg/l February 2017
maximum: 0.62 mg/l October 1977

ANNUAL CYCLE
minimum: 0.15 mg/l July, rel. stdev: 0.75
maximum: 0.27 mg/l January, rel. stdev: 0.82





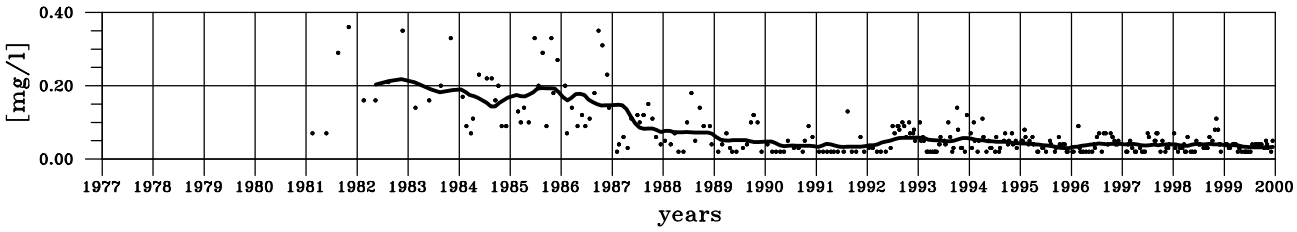


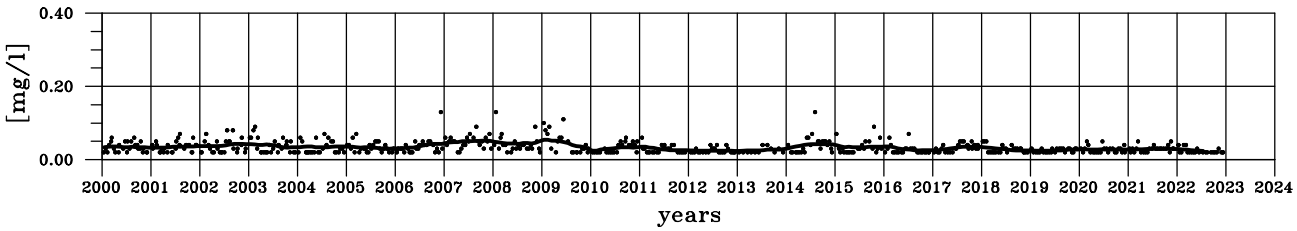
Phosphate from River Ems

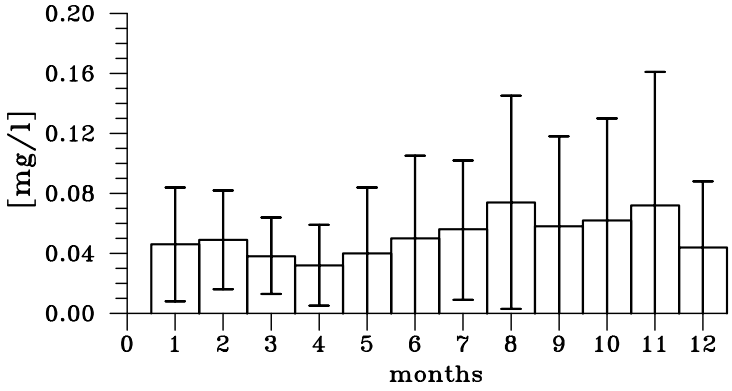
TIME SERIES
number of data: 841
mean: 0.05 mg/l
relative standard deviation: 0.98
minimum: 0.02 mg/l February 4, 1987
maximum: 0.36 mg/l November 2, 1981

LOW PASS
minimum: 0.02 mg/l July 2022
maximum: 0.22 mg/l November 1982

ANNUAL CYCLE
minimum: 0.03 mg/l April, rel. stdev: 0.86
maximum: 0.07 mg/l August, rel. stdev: 0.96





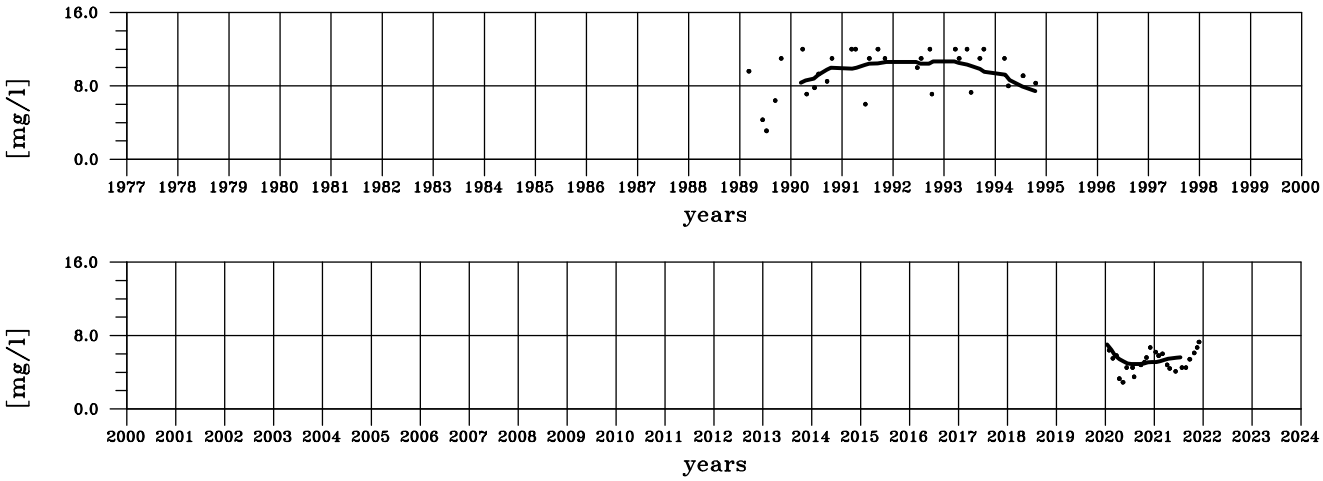


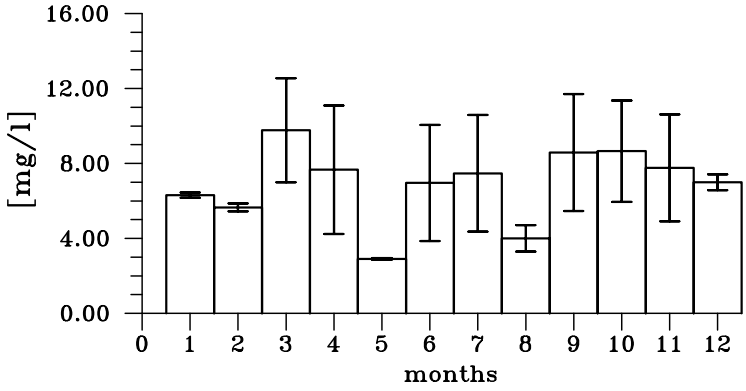
Silicate from River Ems

TIME SERIES
number of data: 55
mean: 7.64 mg/l
relative standard deviation: 0.39
minimum: 2.90 mg/l May 12, 2020
maximum: 12.00 mg/l March 26, 1990

LOW PASS
minimum: 4.88 mg/l July 2020
maximum: 10.66 mg/l March 1993

ANNUAL CYCLE
minimum: 2.90 mg/l May, rel. stdev: 0.02
maximum: 9.77 mg/l March, rel. stdev: 0.28



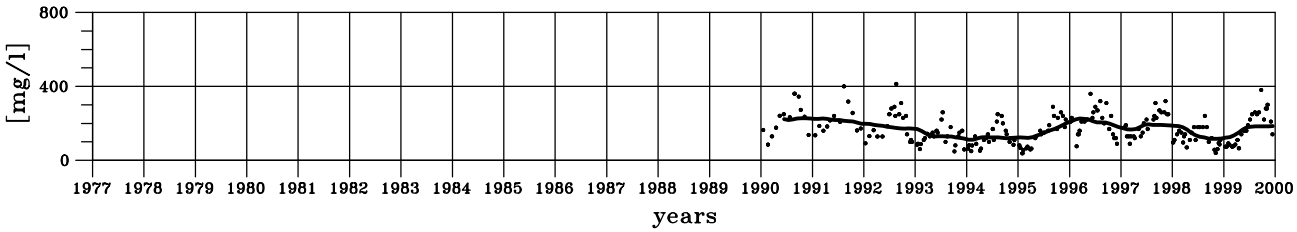


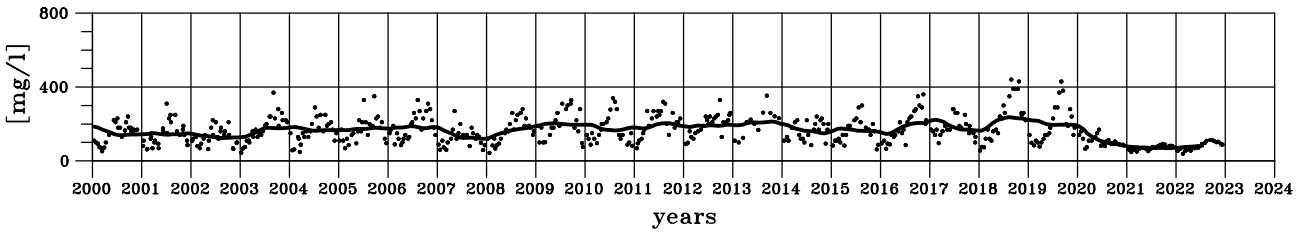
Chloride from River Ems

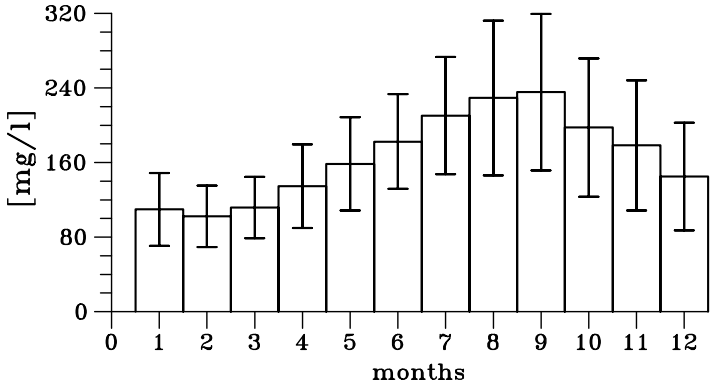
TIME SERIES
number of data: 758
mean: 164 mg/l
relative standard deviation: 0.47
minimum: 38 mg/l February 1, 1995
maximum: 440 mg/l August 28, 2018

LOW PASS
minimum: 70 mg/l November 2021
maximum: 237 mg/l August 2018

ANNUAL CYCLE
minimum: 102 mg/l February, rel. stdev: 0.32
maximum: 236 mg/l September, rel. stdev: 0.36







3.2 River inputs from the Dutch coast

All data of the Netherlands riverine inlets into the North Sea including the Scheldt were supplied by Rijkswaterstaat, the Netherlands. From 2003 - 2022 the data were extracted from the data base www.waterbase.nl (and from the successor https://waterinfo.rws.nl/#!/nav/expert/) which is serviced by Rijkswaterstaat. Additional data for discharge at the stations Kornwederzand buiten and Den Oever buiten, which were not accessible via waterdase at that time, were kindly provided Henry van den Heuvel from the waterbase Servicedesk.

From 2007 on the combined concentration of nitrate and nitrite are calculated using the corresponding two different timeseries. Information on the older data is provided by the series "Jaarboek Monitoring Rijkswateren", especially edition 1998, "part 2 Kengetallen" contains statistics of discharge, concentrations and loads over the years 1989 to 1998 (pers. comm. Doekes, former RIKZ).

Since the Netherlands have established a dense net of channels for regulating the waterflow and especially the waterlevel throughout the country it is usually not possible to trace back the input of a certain river, e.g. the Rhine. So in view on calculating the overall input into the North Sea we loose the information on the contribution of a single river. However, within the short description on each inlet some comments on the sources of the river will be made. Furthermore it should be mentioned that the data of the Netherlands inlets contain concentration and discharge data right at the inlet. Therefore the additional multiplication factors to get the contribution for the area downstream the gauge station are not necessary.

A certain way of handling the Netherland‘s sluice system allows to stop the flow of several inlets. This results in zero discharge values for short intervals. For these intervals the corresponding load of all substances is also zero, independent of the concentration measured during such a period. However, at the inlet Nieuwe Waterweg (Maassluis), the largest branch of the river Rhine, even single events of negative discharge values occur, indicating an inflow of North Sea water into the channel system. Very seldom this also happened at Haringvlietsluis. Together with the date of occurrance these values are listed in Tab. 2. For our load calculation these discharge values are set to zero.

The Kjeldahl nitrogen data was only provided by the authorities up to and including 2021. This meant that we were able to calculate total nitrogen. From 2022, the authorities provided total nitrogen directly. We have taken this data directly from them.

Tab. 2:
Overview on negative discharge events at the inlet Nieuwe Waterweg (M) and Haringvlietsluis (H)

River	Date	$[m^3/s]$	River	Date	$[m^3/s]$	River	Date	$[m^3/s]$
M	1999.11.06	-1371	M	2008.10.05	-35	M	2016.12.26	-680
M	1999.11.27	-98	M	2009.01.18	-174	M	2017.01.04	-412
M	1999.12.01	-194	M	2009.01.23	-637	M	2017.01.11	-728
M	2000.01.29	-391	M	2009.09.09	-240	M	2017.01.13	-713
M	2000.03.03	-7	M	2009.10.16	-198	M	2017.10.22	-116
M	2003.04.01	-170	M	2009.11.23	-219	M	2017.11.10	-113
M	2003.04.02	-490	M	2010.01.17	-28	M	2017.12.08	-127
M	2003.10.07	-480	M	2010.11.12	-469	M	2018.08.27	-132
M	2003.11.03	-2	M	2011.05.24	-449	M	2018.09.21	-216
M	2003.11.15	-116	M	2011.07.14	-50	M	2018.10.13	-197
M	2003.11.30	-202	M	2011.10.04	-78	M	2018.10.23	-401
M	2003.12.13	-439	M	2011.10.06	-170	M	2018.10.30	-930
M	2003.12.14	-144	M	2011.11.25	-605	M	2018.11.29	-486
M	2003.12.21	-1128	M	2011.11.27	-760	M	2019.01.08	-148
M	2004.01.09	-126	M	2011.12.03	-453	M	2019.01.27	-266
M	2004.02.08	-99	M	2011.12.09	-595	H	2019.09.10	-87
M	2004.09.21	-408	M	2012.09.14	-14	M	2019.09.15	-459
M	2004.12.17	-795	M	2012.09.24	-213	M	2019.10.08	-2648
M	2005.01.02	-473	M	2012.12.09	-40	M	2020.08.26	-628
M	2005.11.15	-296	M	2013.09.10	-802	M	2020.09.25	-538
M	2005.11.24	-515	M	2013.12.05	-1047	M	2020.11.19	-665
M	2005.12.16	-159	M	2014.12.10	-504	M	2020.11.21	-248
M	2006.01.17	-28	M	2015.03.29	-70	M	2021.03.11	-432
M	2006.02.08	-387	M	2015.07.25	-425	M	2021.04.05	-902
M	2006.10.31	-834	M	2015.11.09	-200	M	2021.05.04	-944
M	2006.11.11	-1259	M	2015.11.13	-910	M	2021.09.29	-305
M	2007.01.04	-49	M	2015.12.31	-459	M	2021.10.21	-964
M	2007.01.18	-955	M	2016.09.28	-17	M	2021.11.07	-673
M	2007.03.18	-152	M	2016.10.18	-173			
M	2007.11.25	-595	M	2016.11.05	-153			
M	2008.03.01	-1004	M	2016.12.24	-715			

3.2.1 Lake IJssel

In comparison to the first report (Lenhart *et al.*, 1996), the data basis for the calculation of nutrient loads for the Lake IJssel has changed completely. While sampling at Kornwederzand and Den Oever, the two locations at the outlets of the Lake IJssel, was terminated in 1995, concentration data could be supplemented from the location Vrouwenzand. However, at this location no discharge data were available. Therefore, the outflows data from the locations Kornwederzand and Den Oever were used and combined with the concentration data at Vrouwenzand.

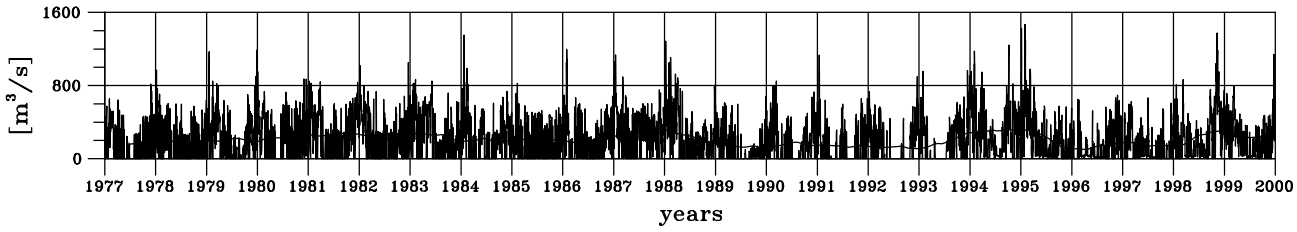
The authorities provided data from 2019 to 2022. The new phosphate values were different from the old ones in 2020. We have used the new phosphate data from 2019.

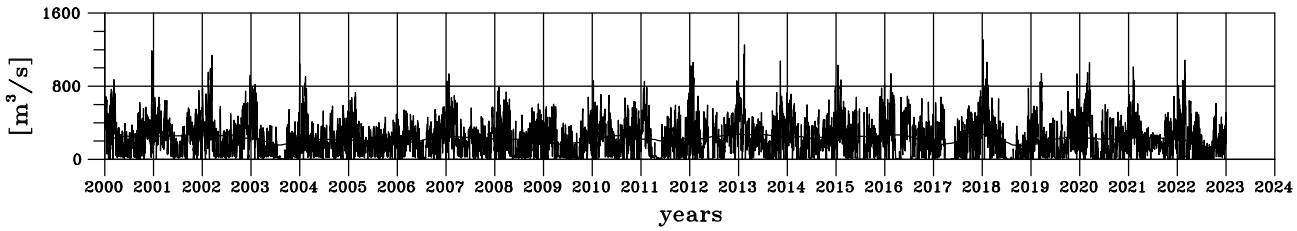
Discharge from Kornwerderzand

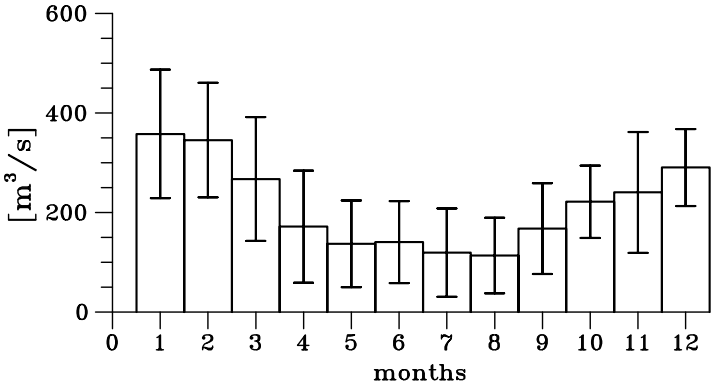
TIME SERIES
number of data: 16798
mean: 214 m^3/s
relative standard deviation: 0.97
minimum: 0 m^3/s January 1, 1977
maximum: 1468 m^3/s January 31, 1995

LOW PASS
minimum: 100 m^3/s April 1996
maximum: 336 m^3/s November 1987

ANNUAL CYCLE
minimum: 114 m^3/s August, rel. stdev: 0.67
maximum: 358 m^3/s January, rel. stdev: 0.36





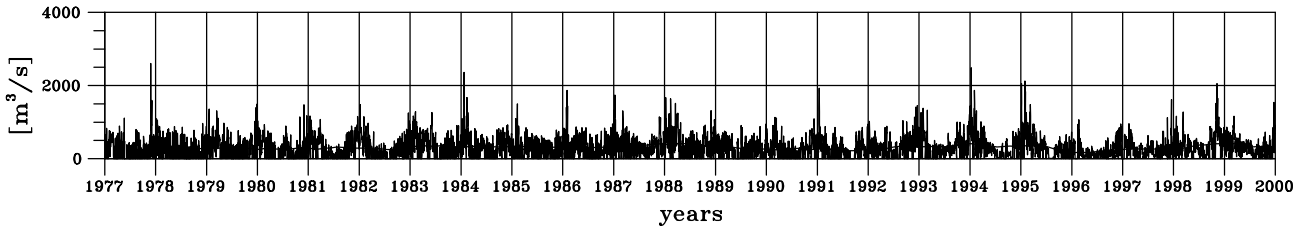


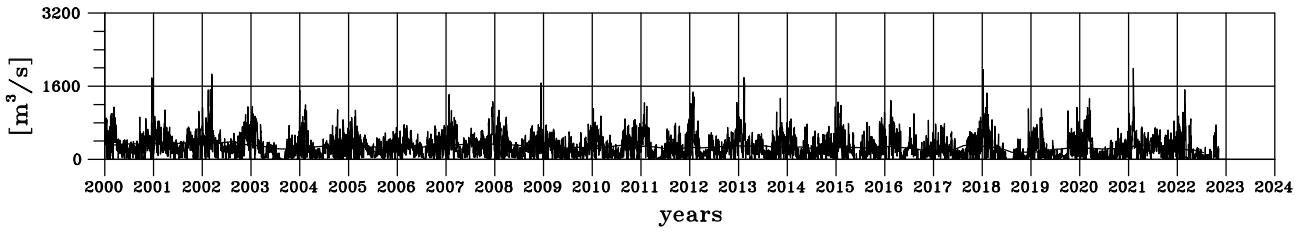
Discharge from Den Oever

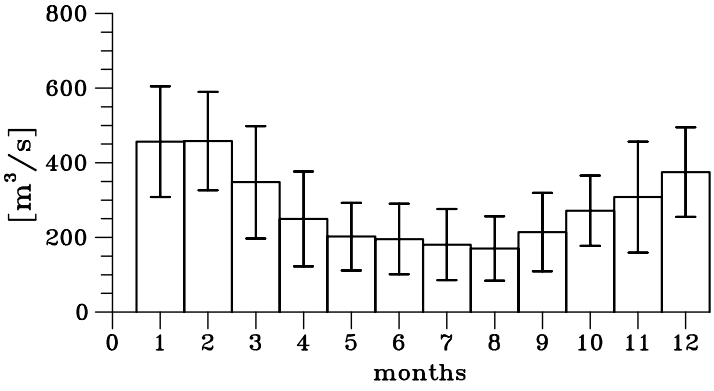
TIME SERIES
number of data: 16801
mean: 285 m^3/s
relative standard deviation: 0.92
minimum: 0 m^3/s January 1, 1977
maximum: 2602 m^3/s November 26, 1977

LOW PASS
minimum: 147 m^3/s July 2022
maximum: 414 m^3/s February 1999

ANNUAL CYCLE
minimum: 170 m^3/s August, rel. stdev: 0.51
maximum: 458 m^3/s February, rel. stdev: 0.29





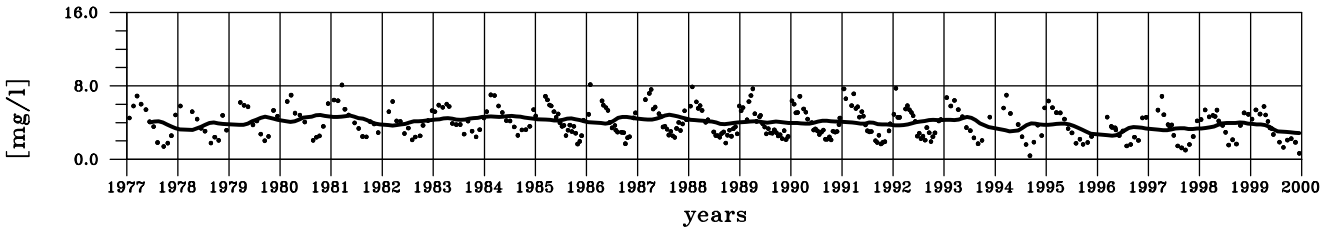


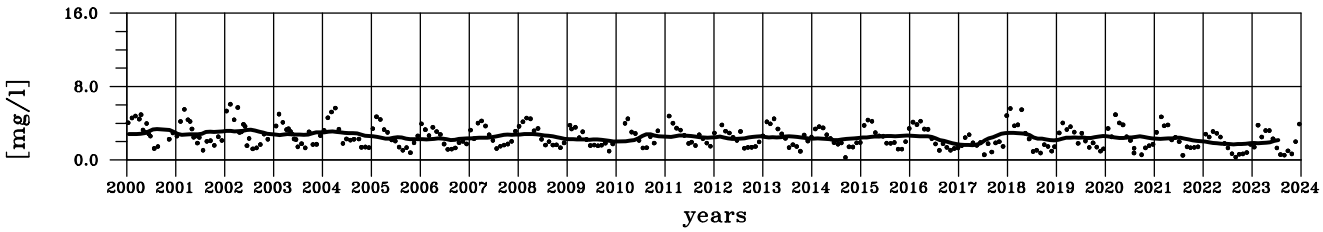
Total Nitrogen from Vrouwenzand

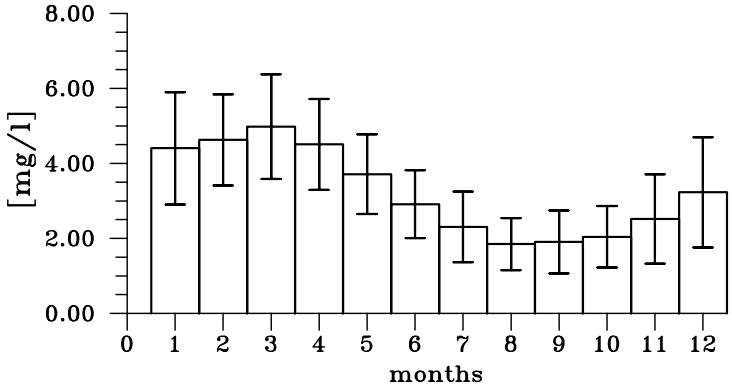
TIME SERIES
number of data: 672
mean: 3.28 mg/l
relative standard deviation: 0.48
minimum: 0.27 mg/l September 9, 2014
maximum: 8.14 mg/l January 28, 1986

LOW PASS
minimum: 1.60 mg/l April 2017
maximum: 4.85 mg/l August 1987

ANNUAL CYCLE
minimum: 1.85 mg/l August, rel. stdev: 0.37
maximum: 4.98 mg/l March, rel. stdev: 0.28





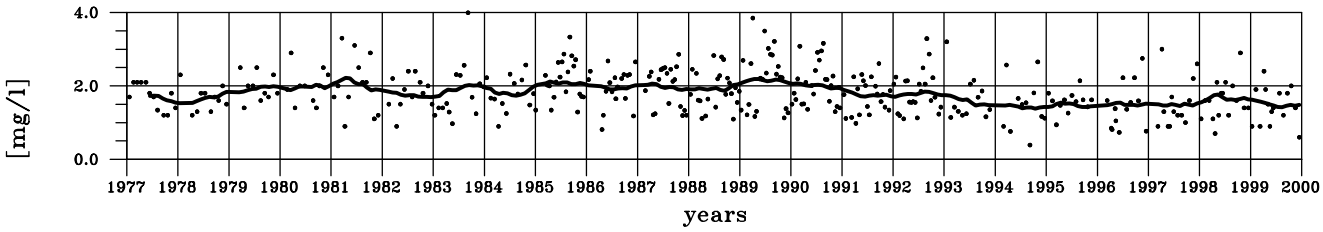


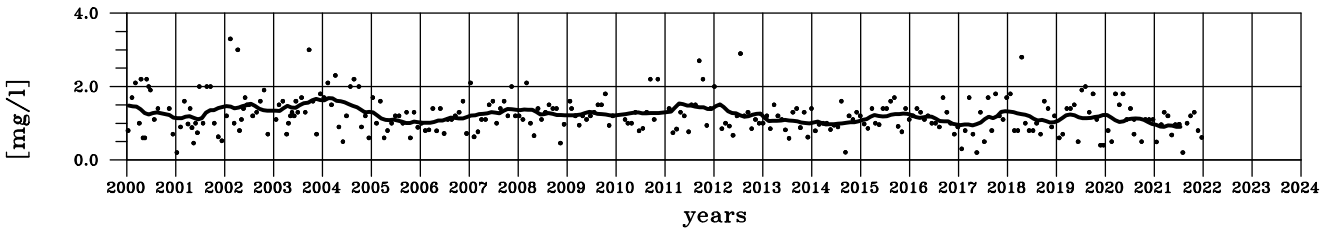
Kjeldahl Nitrogen from Vrouwenzand

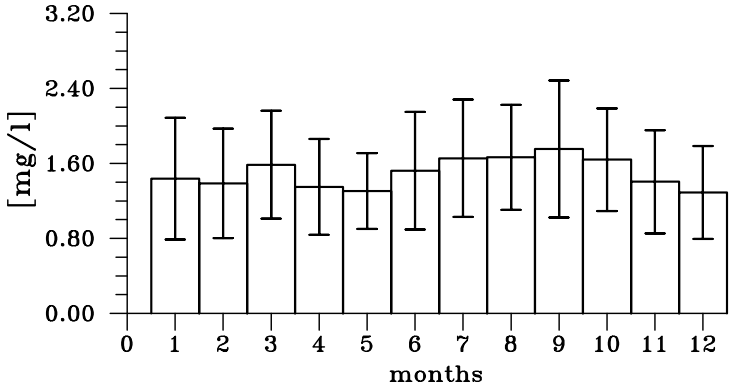
TIME SERIES
number of data: 650
mean: 1.56 mg/l
relative standard deviation: 0.41
minimum: 0.20 mg/l January 9, 2001
maximum: 3.99 mg/l September 7, 1983

LOW PASS
minimum: 0.90 mg/l July 2021
maximum: 2.22 mg/l April 1981

ANNUAL CYCLE
minimum: 1.29 mg/l December, rel. stdev: 0.38
maximum: 1.75 mg/l September, rel. stdev: 0.42





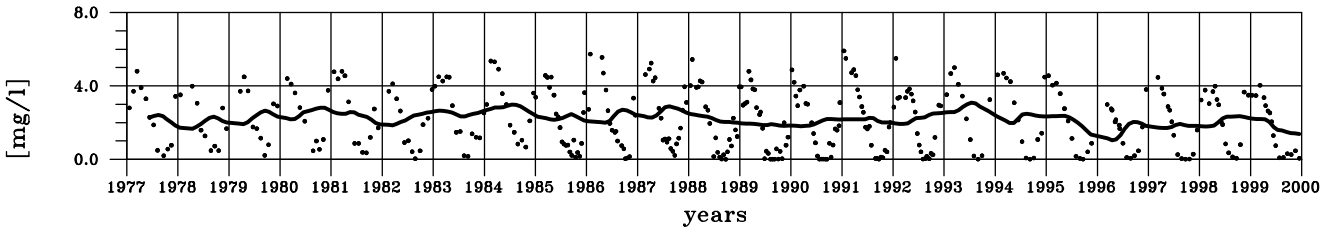


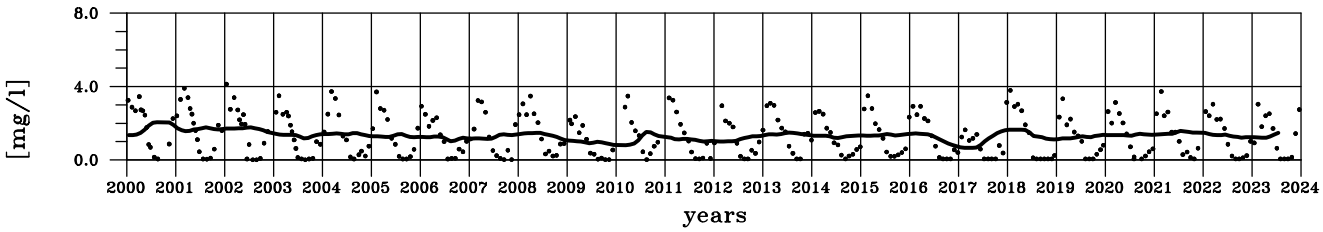
Nitrate + Nitrite from Vrouwenzand

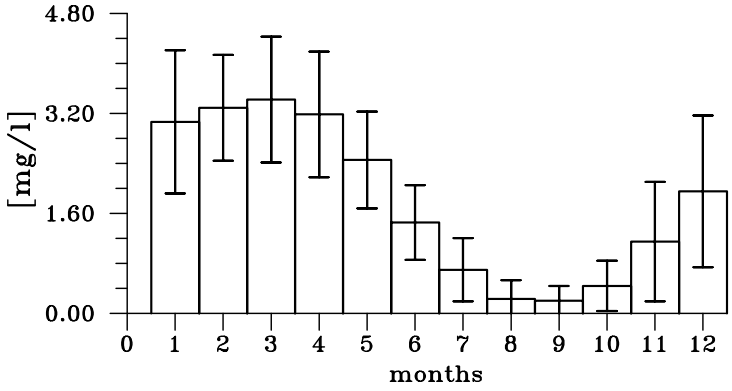
TIME SERIES
number of data: 680
mean: 1.76 mg/l
relative standard deviation: 0.83
minimum: 0.00 mg/l September 22, 1988
maximum: 5.90 mg/l January 15, 1991

LOW PASS
minimum: 0.66 mg/l April 2017
maximum: 3.09 mg/l July 1993

ANNUAL CYCLE
minimum: 0.20 mg/l September, rel. stdev: 1.18
maximum: 3.42 mg/l March, rel. stdev: 0.29





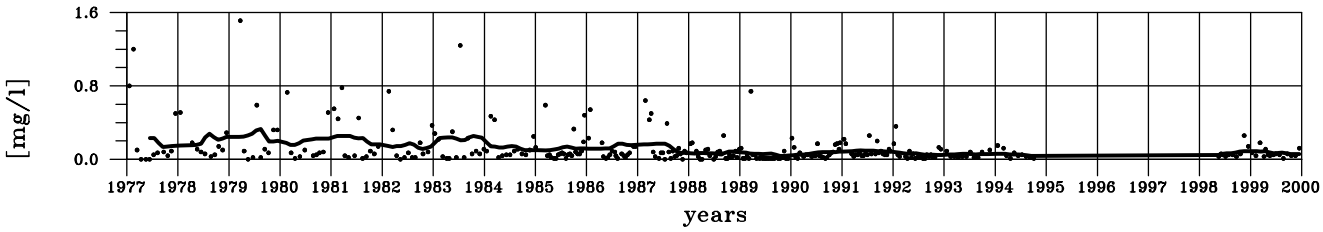


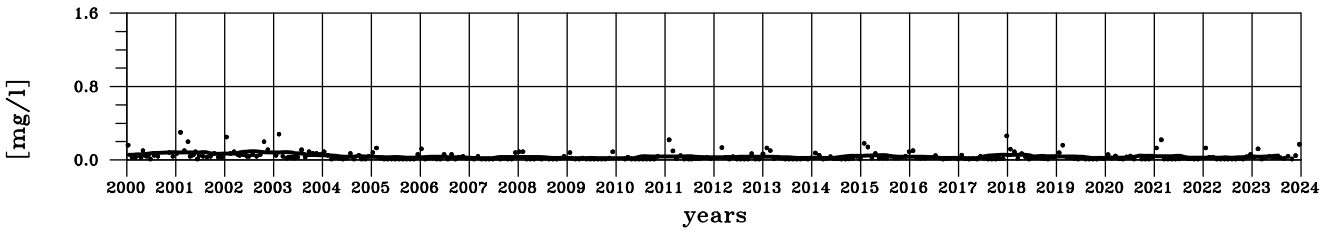
Ammonium from Vrouwenzand

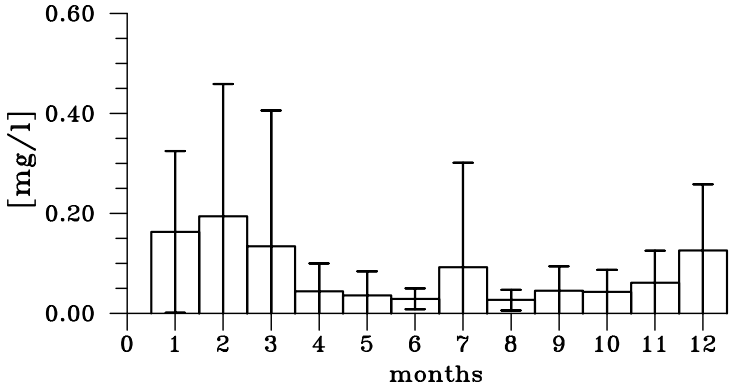
TIME SERIES
number of data: 632
mean: 0.08 mg/l
relative standard deviation: 1.83
minimum: 0.00 mg/l April 13, 1977
maximum: 1.51 mg/l March 22, 1979

LOW PASS
minimum: 0.02 mg/l May 2007
maximum: 0.33 mg/l August 1979

ANNUAL CYCLE
minimum: 0.03 mg/l August, rel. stdev: 0.78
maximum: 0.19 mg/l February, rel. stdev: 1.36





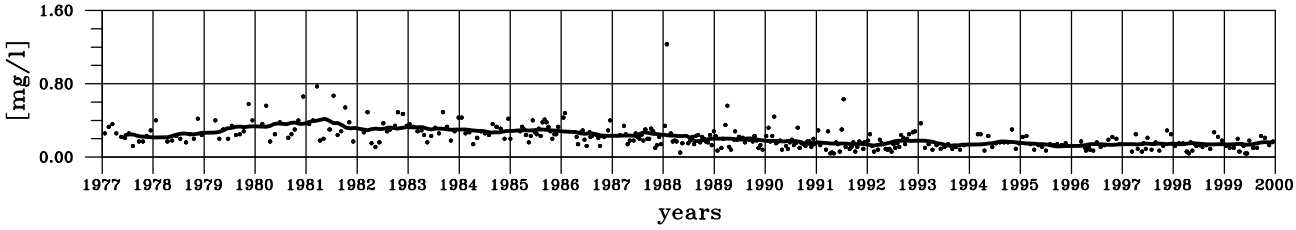


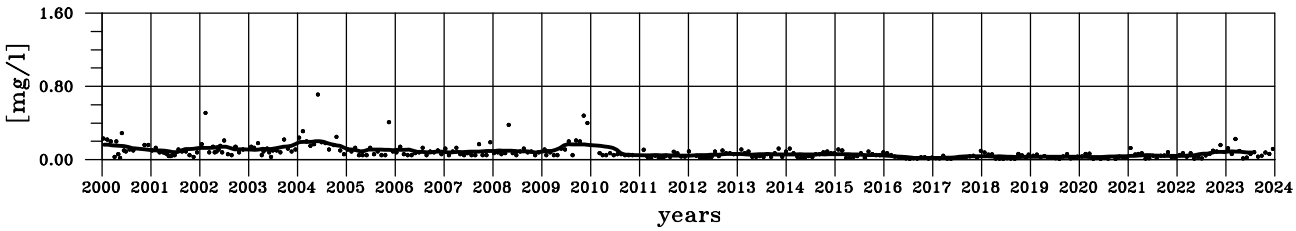
Total Phosphorus from Vrouwenzand

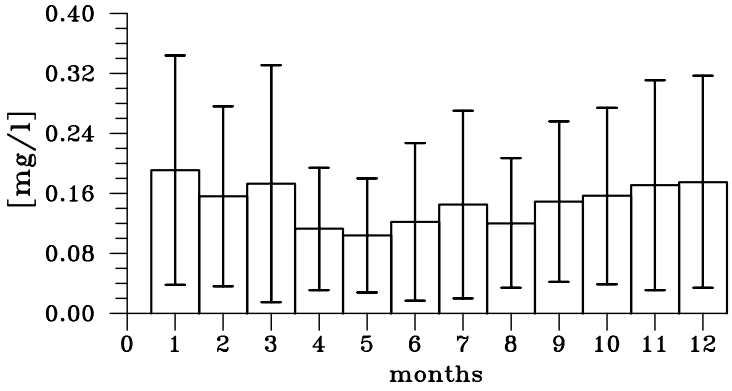
TIME SERIES
number of data: 678
mean: 0.15 mg/l
relative standard deviation: 0.83
minimum: 0.01 mg/l July 13, 2016
maximum: 1.23 mg/l January 27, 1988

LOW PASS
minimum: 0.02 mg/l December 2016
maximum: 0.42 mg/l May 1981

ANNUAL CYCLE
minimum: 0.10 mg/l May, rel. stdev: 0.73
maximum: 0.19 mg/l January, rel. stdev: 0.80





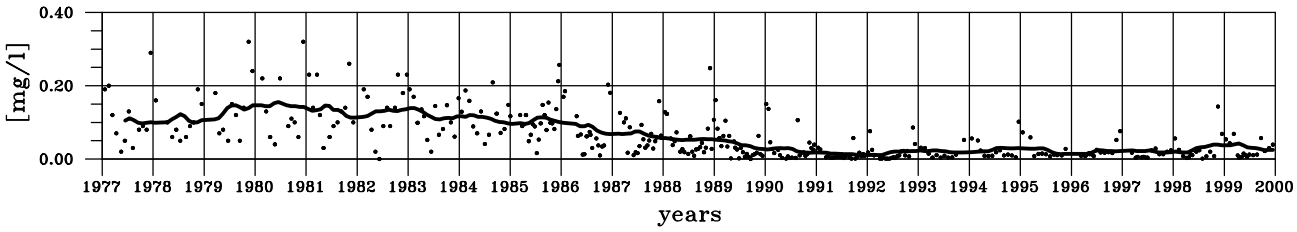


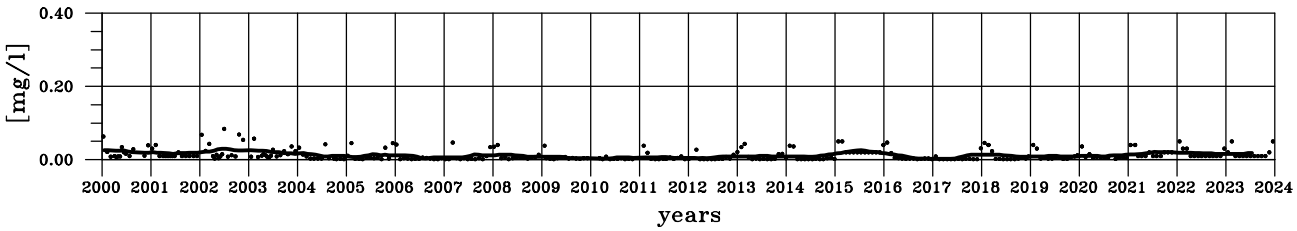
Phosphate from Vrouwenzand

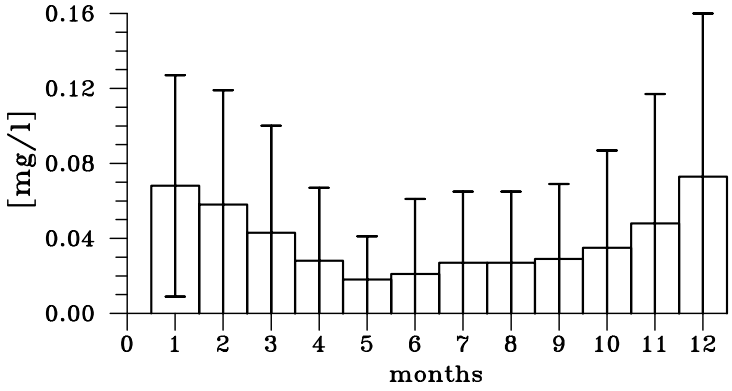
TIME SERIES
number of data: 678
mean: 0.04 mg/l
relative standard deviation: 1.40
minimum: 0.00 mg/l June 8, 1982
maximum: 0.32 mg/l November 15, 1979

LOW PASS
minimum: 0.00 mg/l May 2017
maximum: 0.16 mg/l June 1980

ANNUAL CYCLE
minimum: 0.02 mg/l May, rel. stdev: 1.26
maximum: 0.07 mg/l December, rel. stdev: 1.19





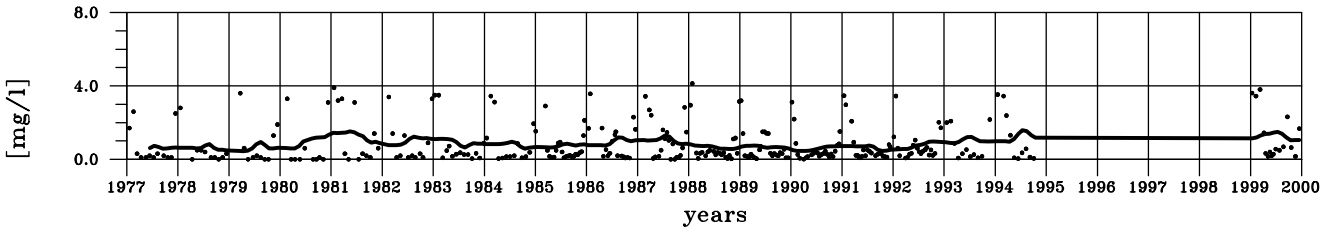


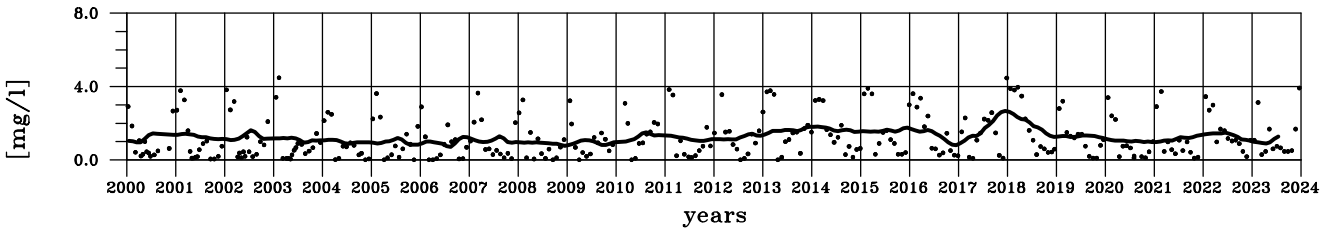
Silicate from Vrouwenzand

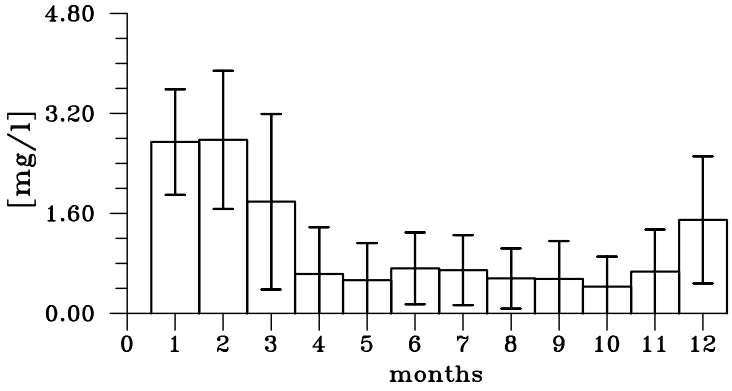
TIME SERIES
number of data: 622
mean: 1.01 mg/l
relative standard deviation: 1.09
minimum: 0.00 mg/l April 13, 1978
maximum: 4.48 mg/l February 10, 2003

LOW PASS
minimum: 0.43 mg/l April 1979
maximum: 2.66 mg/l December 2017

ANNUAL CYCLE
minimum: 0.43 mg/l October, rel. stdev: 1.12
maximum: 2.78 mg/l February, rel. stdev: 0.40





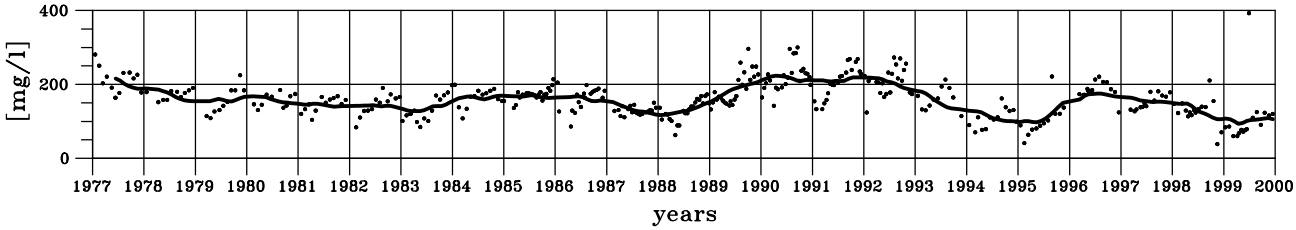


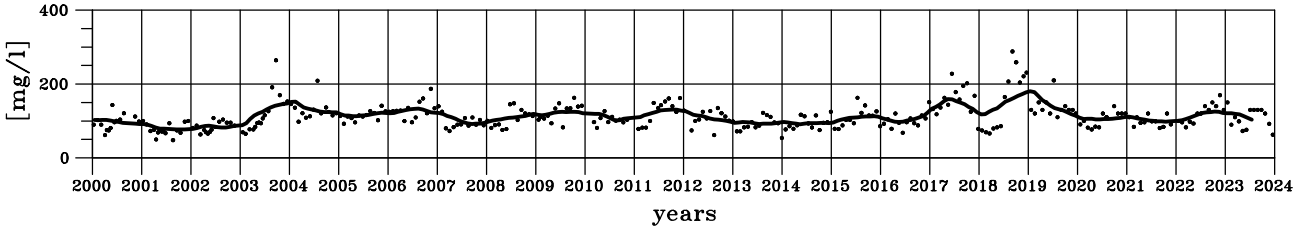
Chloride from Vrouwenzand

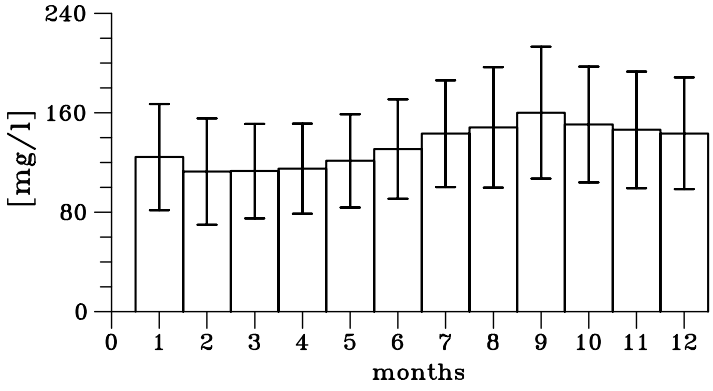
TIME SERIES
number of data: 679
mean: 139 mg/l
relative standard deviation: 0.36
minimum: 39 mg/l November 17, 1998
maximum: 393 mg/l June 29, 1999

LOW PASS
minimum: 77 mg/l October 2001
maximum: 223 mg/l April 1990

ANNUAL CYCLE
minimum: 113 mg/l February, rel. stdev: 0.38
maximum: 160 mg/l September, rel. stdev: 0.33







3.2.2 Nordzeekanaal

This channel represents the direct connection from Amsterdam to the North Sea. Additional water masses enter from the Markermeer which is separated from the Lake IJssel by a damm. Daily discharge data and biweekly samples for all the concentration values were available. The sampling took place about 2 km before the sluice system (Ijmuiden). The elevated chloride content of about 2000 mg/l was caused by opening the locks for in- and outgoing ships, thereby permitting seawater to enter the sluice system. Discharge values are available until 2021 only. This is due to construction work there.

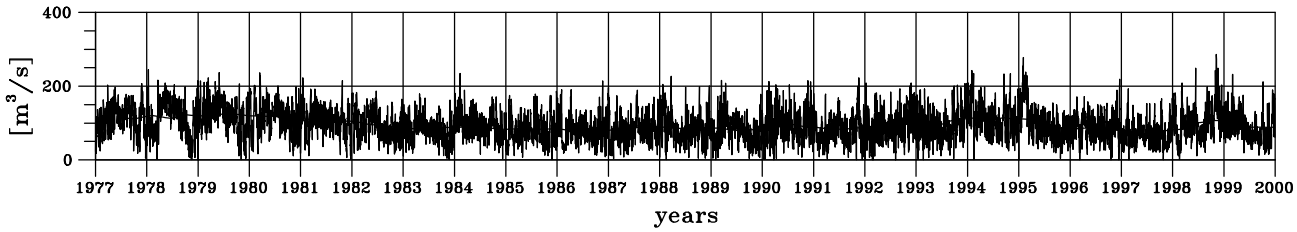
The Kjeldahl nitrogen data from the authorities seems to have been revised for 2020. We have adopted the new data. For the calculation of total nitrogen we have also used the new Kjeldahl nitrogen data. Also for N23, NH4, NO2, NO3, PO4, Si, TP the new data for 2020 differs from the old data set. In these cases we have used the new 2020 data.

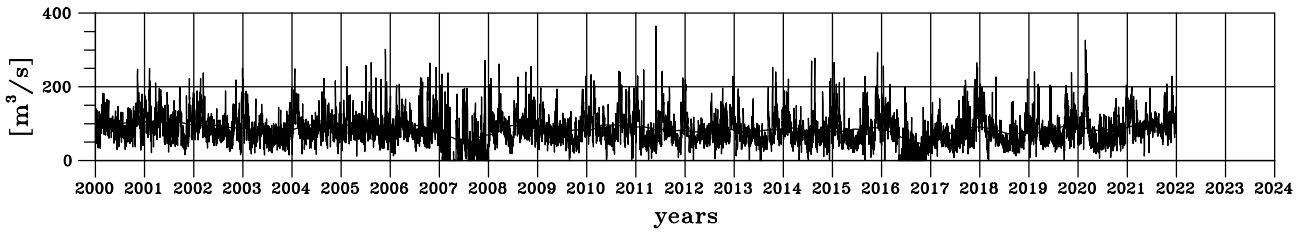
Discharge from Nordzeekanaal

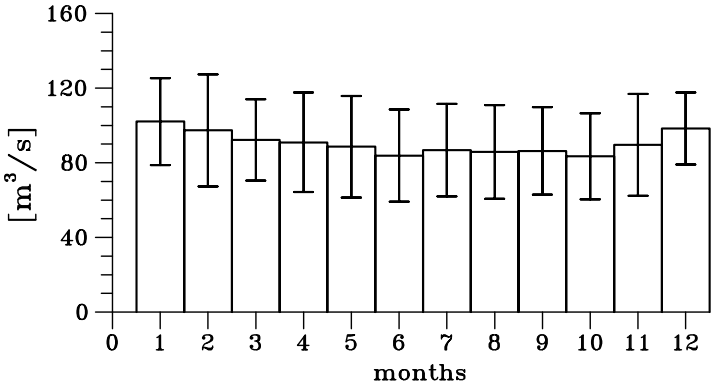
TIME SERIES
number of data: 16413
mean: 90 m^3/s
relative standard deviation: 0.48
minimum: 0 m^3/s March 24, 1990
maximum: 365 m^3/s May 29, 2011

LOW PASS
minimum: 47 m^3/s November 2016
maximum: 124 m^3/s August 1979

ANNUAL CYCLE
minimum: 83 m^3/s October, rel. stdev: 0.28
maximum: 102 m^3/s January, rel. stdev: 0.23





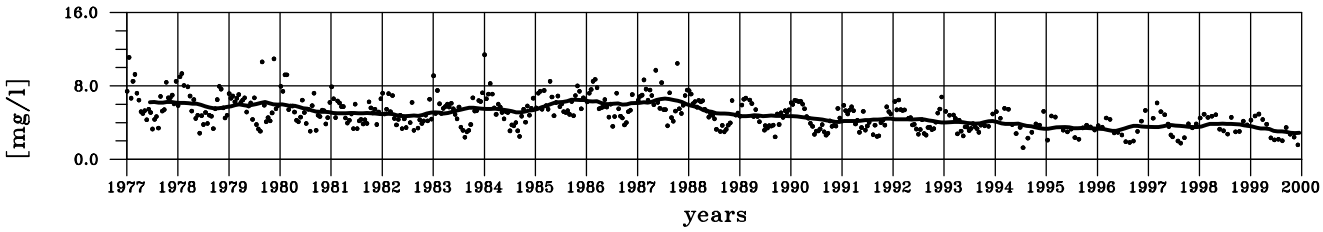


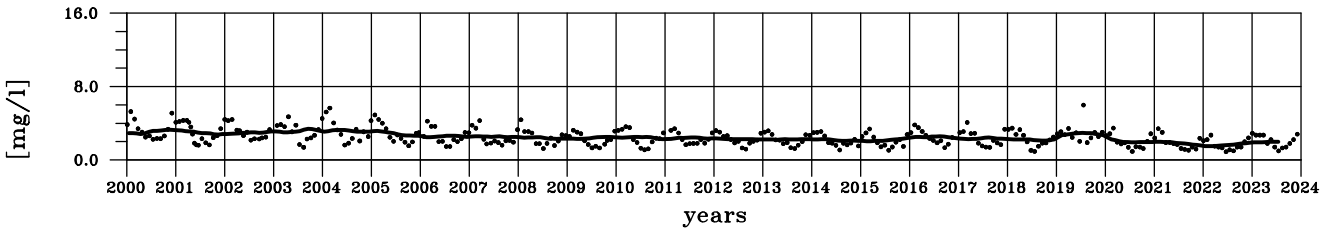
Total Nitrogen from Nordzeekanaal

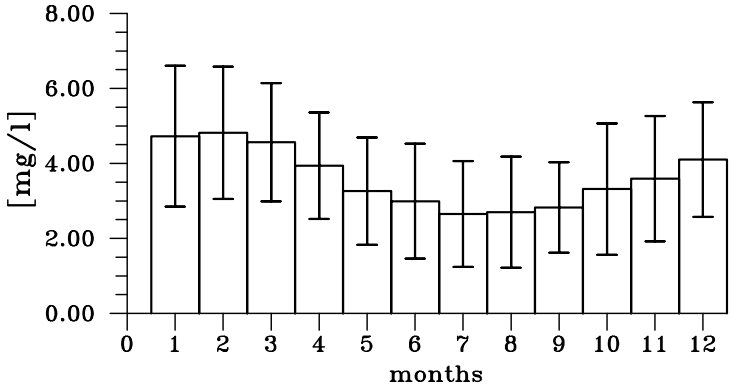
TIME SERIES
number of data: 813
mean: 4.03 mg/l
relative standard deviation: 0.47
minimum: 0.89 mg/l June 20, 2022
maximum: 11.40 mg/l January 2, 1984

LOW PASS
minimum: 1.51 mg/l February 2022
maximum: 6.61 mg/l July 1987

ANNUAL CYCLE
minimum: 2.65 mg/l July, rel. stdev: 0.53
maximum: 4.82 mg/l February, rel. stdev: 0.37





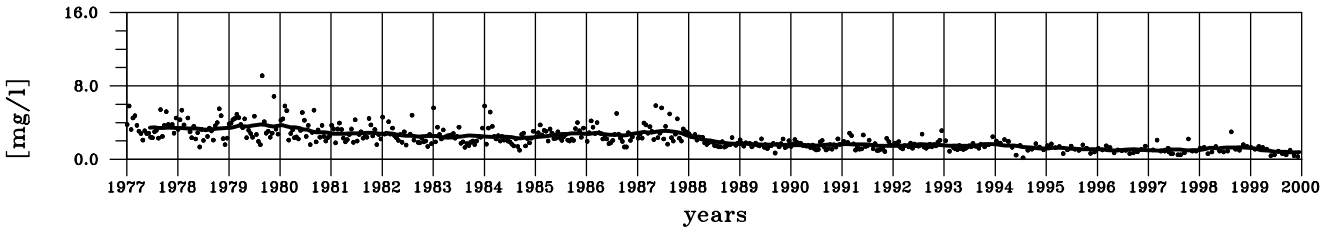


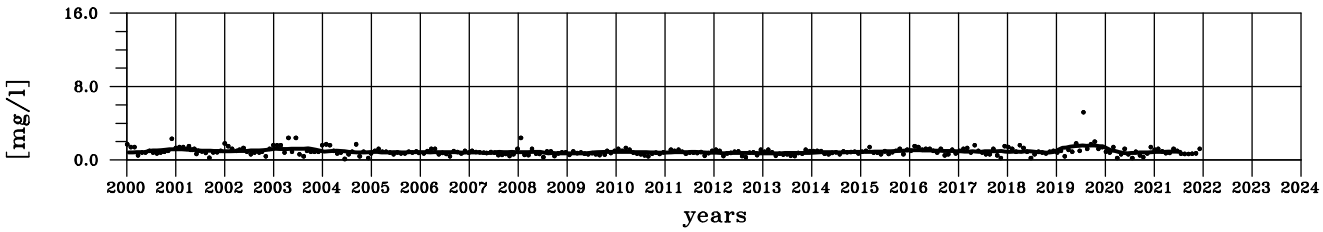
Kjeldahl Nitrogen from Nordzeekanaal

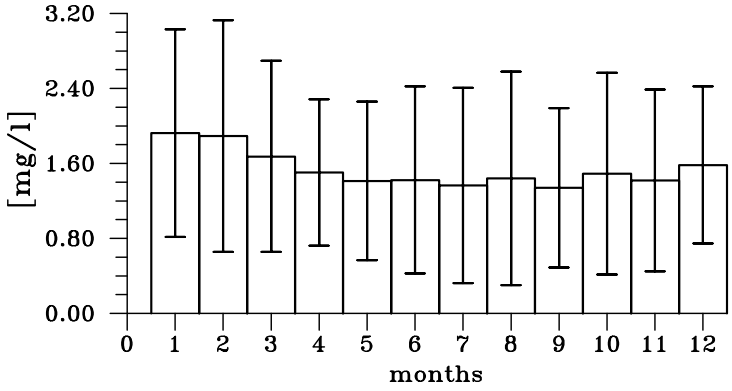
TIME SERIES
number of data: 792
mean: 1.78 mg/l
relative standard deviation: 0.66
minimum: 0.10 mg/l June 16, 2004
maximum: 9.10 mg/l August 27, 1979

LOW PASS
minimum: 0.72 mg/l April 2013
maximum: 3.79 mg/l August 1979

ANNUAL CYCLE
minimum: 1.34 mg/l September, rel. stdev: 0.64
maximum: 1.92 mg/l January, rel. stdev: 0.58





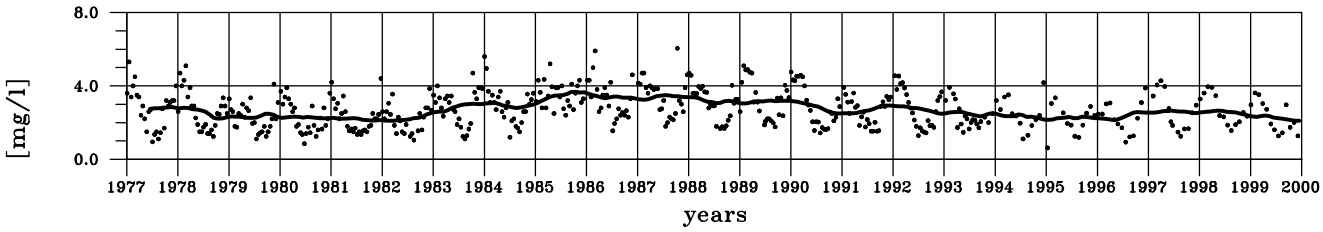


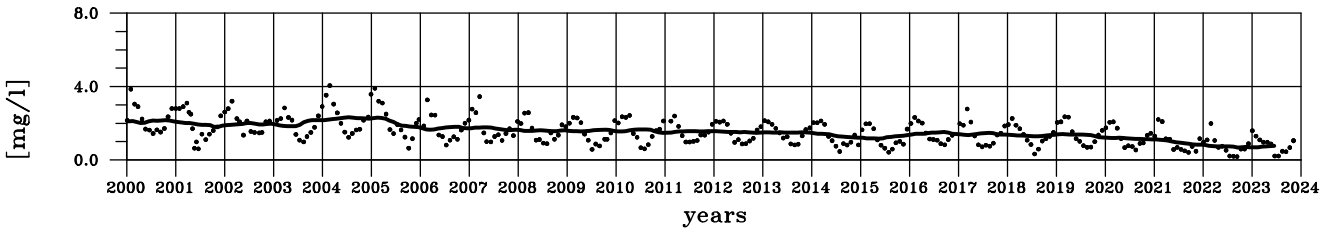
Nitrate + Nitrite from Nordzeekanaal

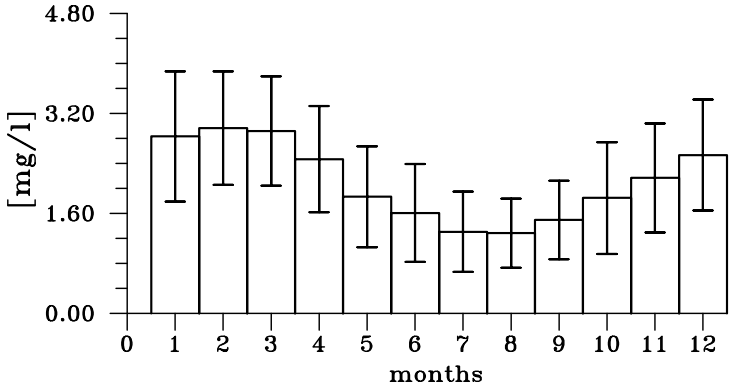
TIME SERIES
number of data: 818
mean: 2.28 mg/l
relative standard deviation: 0.47
minimum: 0.18 mg/l September 12, 2022
maximum: 6.05 mg/l October 12, 1987

LOW PASS
minimum: 0.68 mg/l September 2022
maximum: 3.67 mg/l October 1985

ANNUAL CYCLE
minimum: 1.28 mg/l August, rel. stdev: 0.43
maximum: 2.96 mg/l February, rel. stdev: 0.31





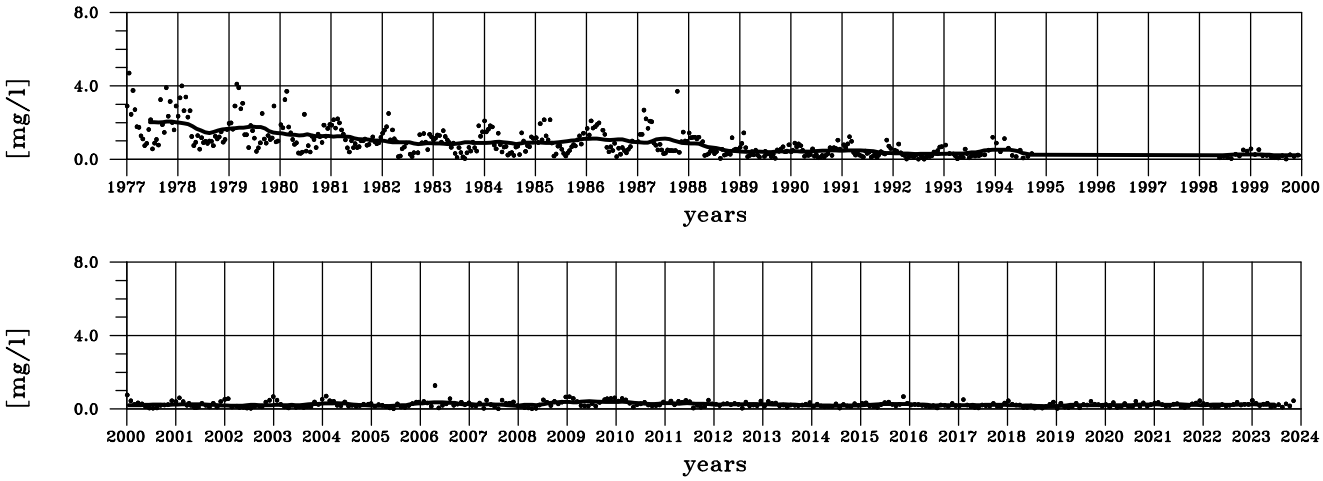


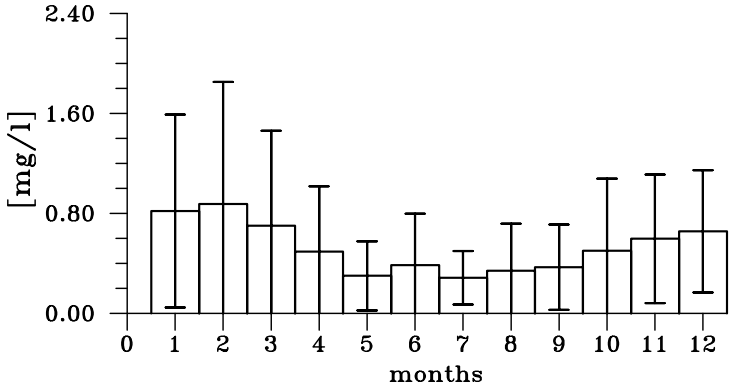
Ammonium from Nordzeekanaal

TIME SERIES
number of data: 771
mean: 0.65 mg/l
relative standard deviation: 1.09
minimum: 0.01 mg/l June 30, 1992
maximum: 4.70 mg/l January 17, 1977

LOW PASS
minimum: 0.15 mg/l October 2018
maximum: 2.05 mg/l November 1977

ANNUAL CYCLE
minimum: 0.29 mg/l July, rel. stdev: 0.75
maximum: 0.88 mg/l February, rel. stdev: 1.12



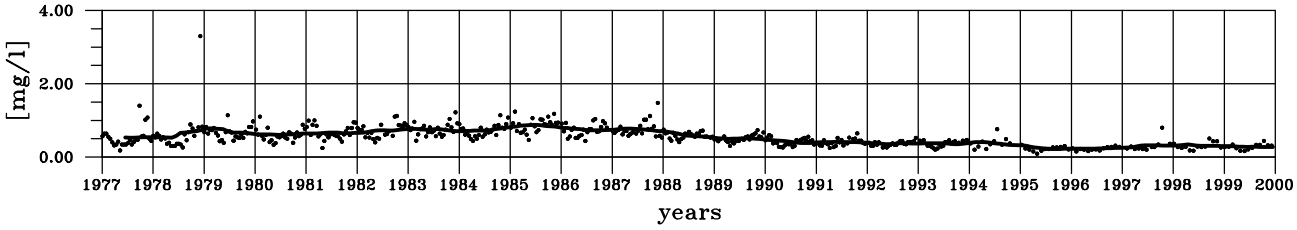


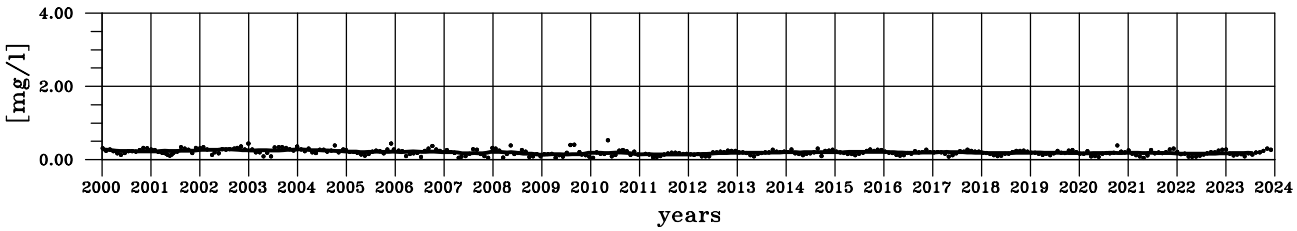
Total Phosphorus from Nordzeekanaal

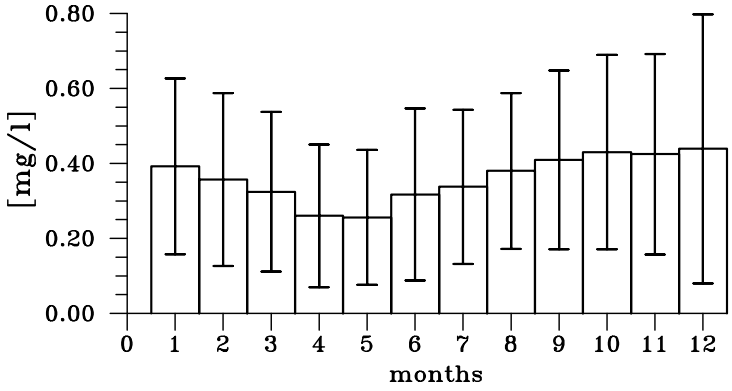
TIME SERIES
number of data: 815
mean: 0.42 mg/l
relative standard deviation: 0.66
minimum: 0.05 mg/l April 26, 2021
maximum: 3.30 mg/l December 4, 1978

LOW PASS
minimum: 0.14 mg/l January 2009
maximum: 0.88 mg/l June 1985

ANNUAL CYCLE
minimum: 0.26 mg/l May, rel. stdev: 0.70
maximum: 0.44 mg/l December, rel. stdev: 0.82





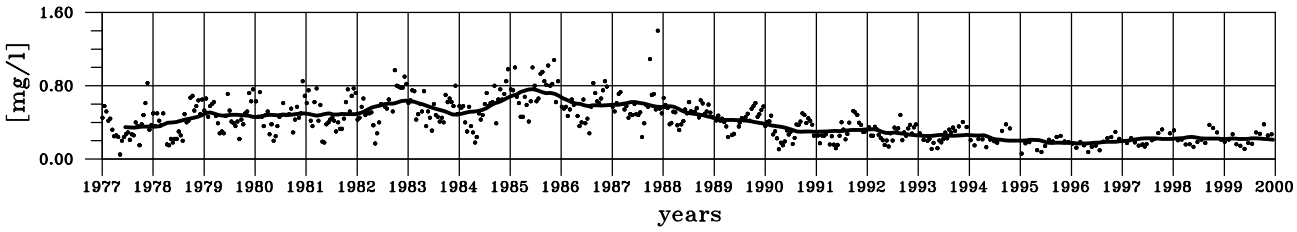


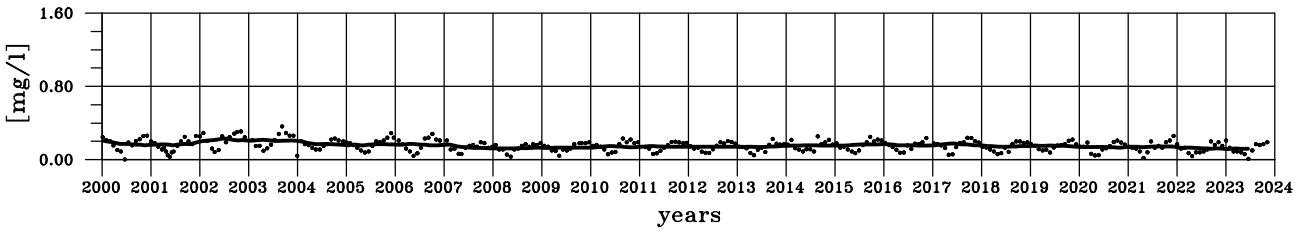
Phosphate from Nordzeekanaal

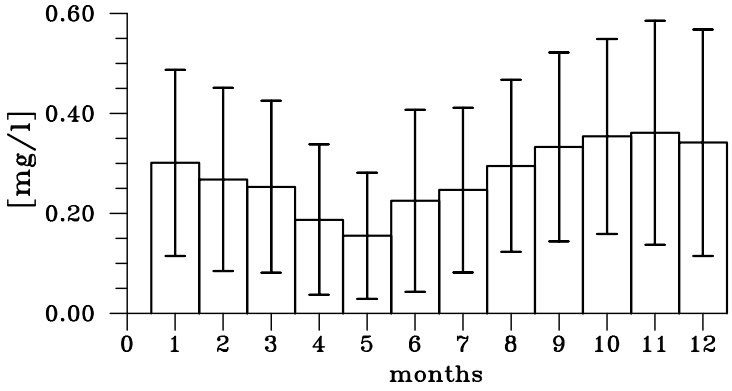
TIME SERIES
number of data: 807
mean: 0.32 mg/l
relative standard deviation: 0.66
minimum: 0.00 mg/l June 19, 2000
maximum: 1.40 mg/l November 23, 1987

LOW PASS
minimum: 0.12 mg/l January 2023
maximum: 0.76 mg/l June 1985

ANNUAL CYCLE
minimum: 0.16 mg/l May, rel. stdev: 0.81
maximum: 0.36 mg/l November, rel. stdev: 0.62





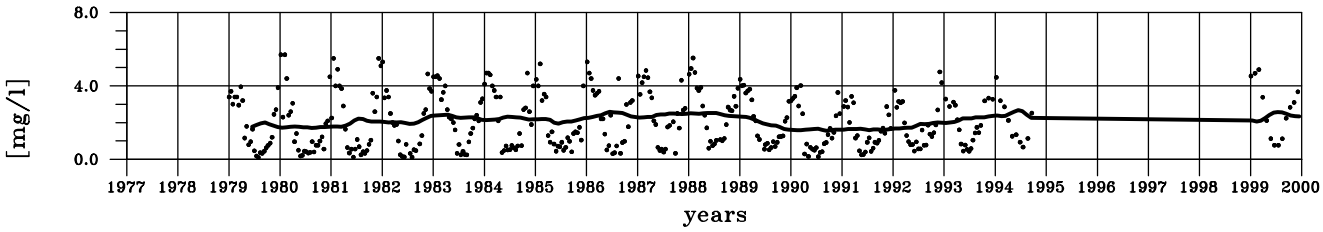


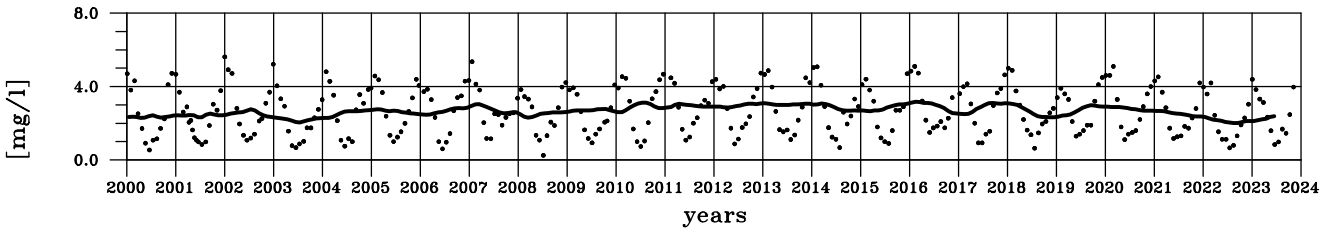
Silicate from Nordzeekanaal

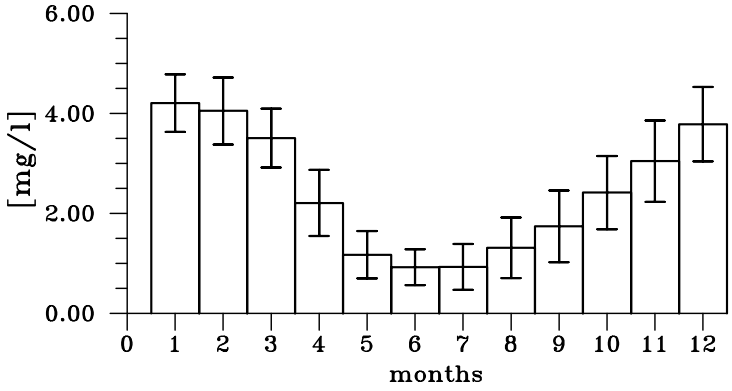
TIME SERIES
number of data: 709
mean: 2.33 mg/l
relative standard deviation: 0.61
minimum: 0.10 mg/l July 30, 1979
maximum: 5.70 mg/l January 7, 1980

LOW PASS
minimum: 1.56 mg/l September 1990
maximum: 3.18 mg/l February 2016

ANNUAL CYCLE
minimum: 0.92 mg/l June, rel. stdev: 0.39
maximum: 4.21 mg/l January, rel. stdev: 0.14





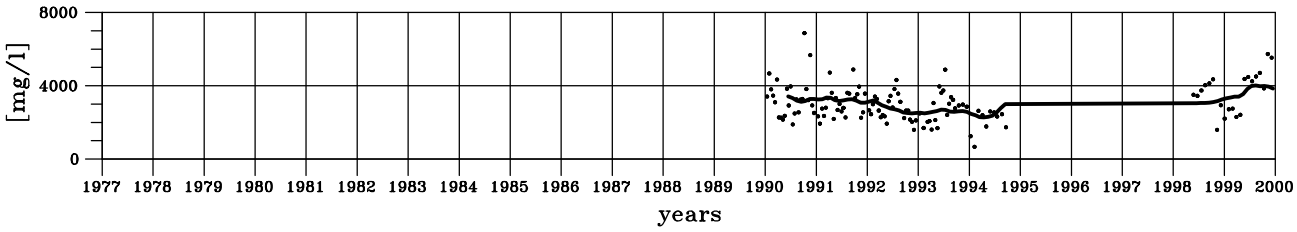


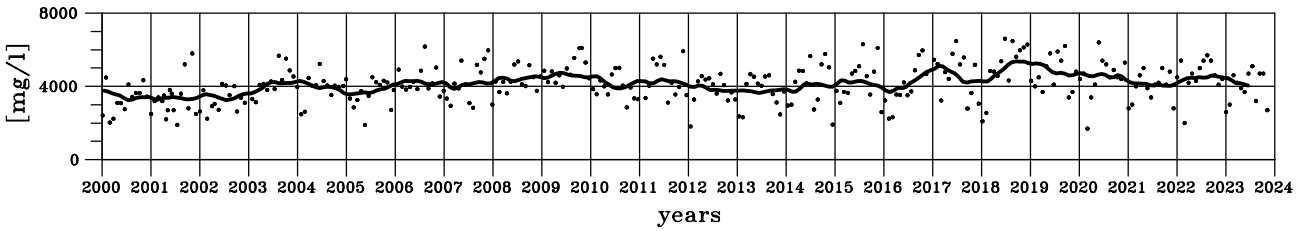
Chloride from Nordzeekanaal

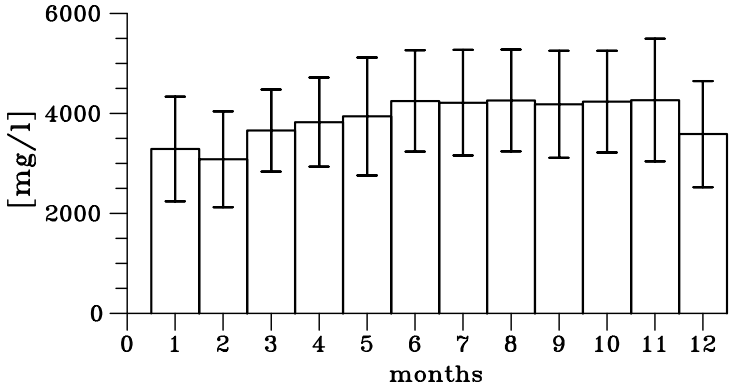
TIME SERIES
number of data: 436
mean: 3818 mg/l
relative standard deviation: 0.29
minimum: 663 mg/l February 8, 1994
maximum: 6870 mg/l October 8, 1990

LOW PASS
minimum: 2269 mg/l April 1994
maximum: 5368 mg/l September 2018

ANNUAL CYCLE
minimum: 3083 mg/l February, rel. stdev: 0.31
maximum: 4267 mg/l November, rel. stdev: 0.29







3.2.3 Nieuwe Waterweg

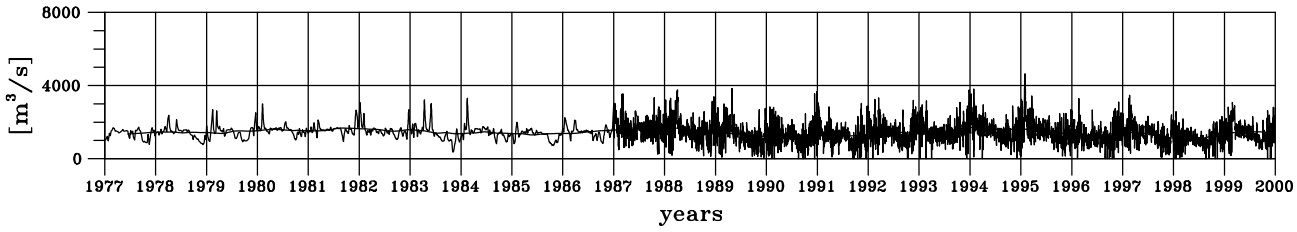
The sampling station lies just beyond the combined outflow from Nieuwe Maas and Oude Maas (Maassluise). Both waterways have different connections to the Waal, the largest branch of the river Rhine. For the calculation of discharge weekly measured data until 1980 and daily data since 1980 are available. Since 1987 these data were modelled instead of measured. The model simulates the discharge using the information of the phase of the tide, water surface elevation as well as the movement of the sluices. The change from measured discharge towards modelled discharge can clearly be seen in the figure of the time series. All concentrations were measured every two weeks. The sampling location was situated in the mixing zone, near the city of Maassluis which results, on a tidal average basis, in 10 to 15 % seawater. The 24-hour, and therefore tidal-averaged, mean chloride content is about 1200 mg/l.

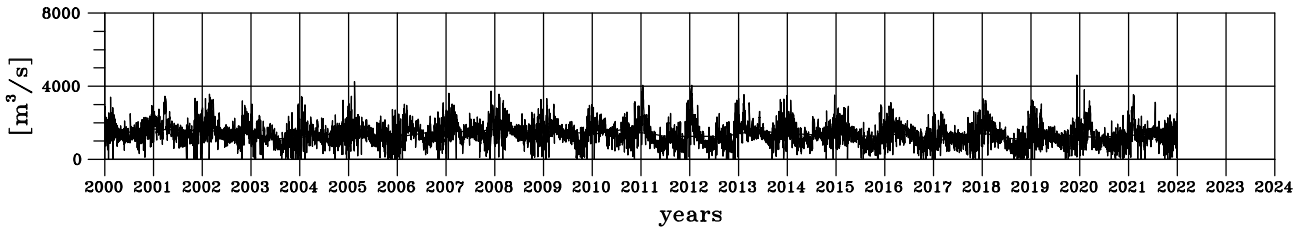
Discharge from Nieuwe Waterweg

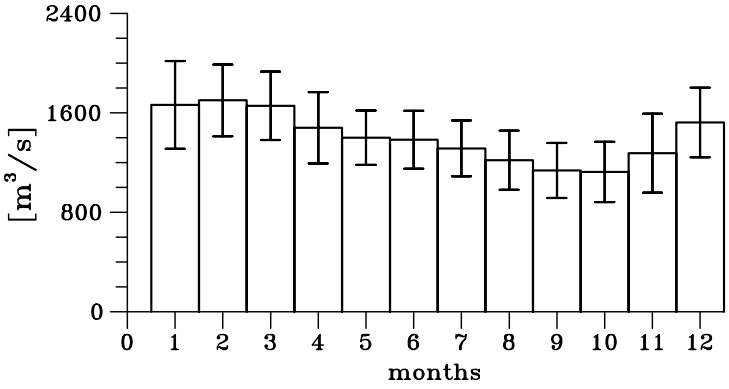
TIME SERIES
number of data: 15485
mean: 1404 m^3/s
relative standard deviation: 0.40
minimum: 0 m^3/s February 8, 1990
maximum: 4649 m^3/s January 31, 1995

LOW PASS
minimum: 1037 m^3/s April 1998
maximum: 1740 m^3/s November 1987

ANNUAL CYCLE
minimum: 1125 m^3/s October, rel. stdev: 0.22
maximum: 1700 m^3/s February, rel. stdev: 0.17





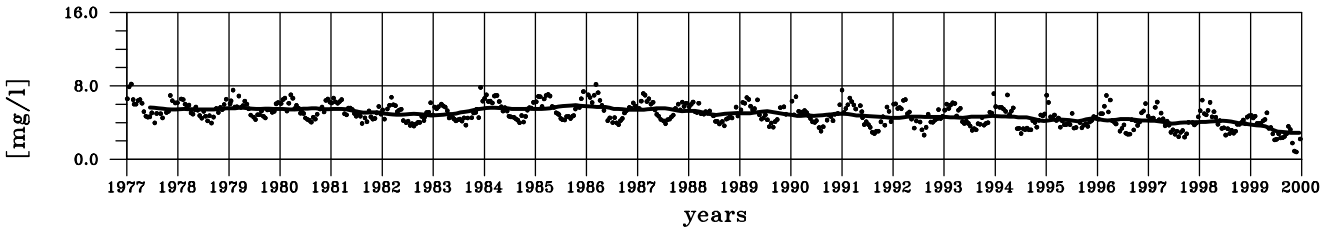


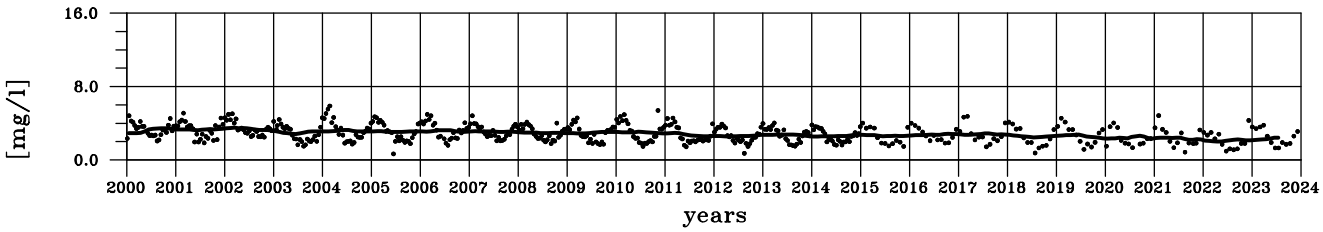
Total Nitrogen from Nieuwe Waterweg

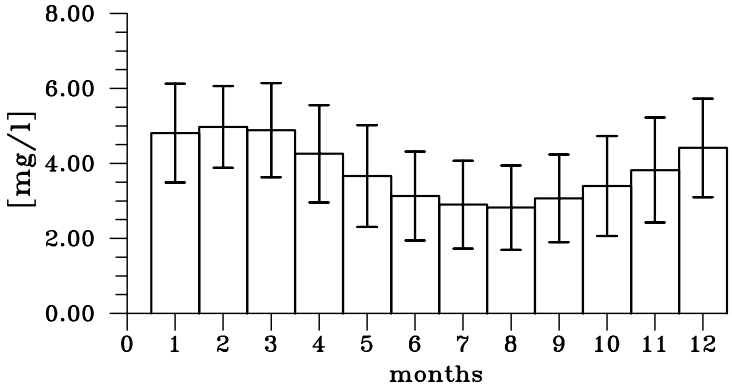
TIME SERIES
number of data: 1073
mean: 3.95 mg/l
relative standard deviation: 0.37
minimum: 0.65 mg/l June 15, 2005
maximum: 8.20 mg/l February 1, 1977

LOW PASS
minimum: 2.02 mg/l May 2022
maximum: 5.88 mg/l October 1985

ANNUAL CYCLE
minimum: 2.82 mg/l August, rel. stdev: 0.40
maximum: 4.97 mg/l February, rel. stdev: 0.22





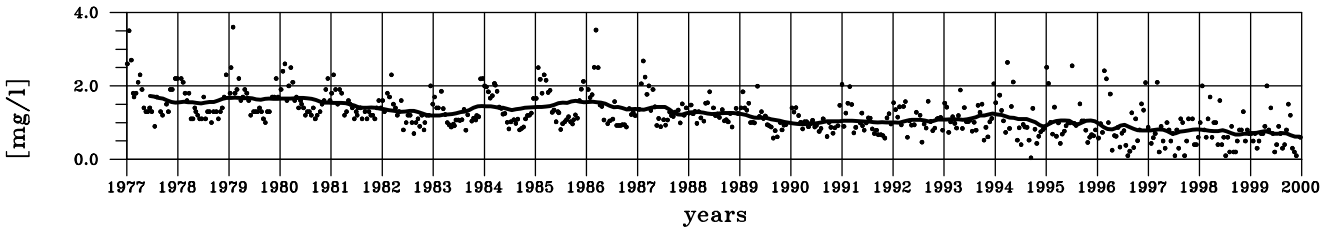


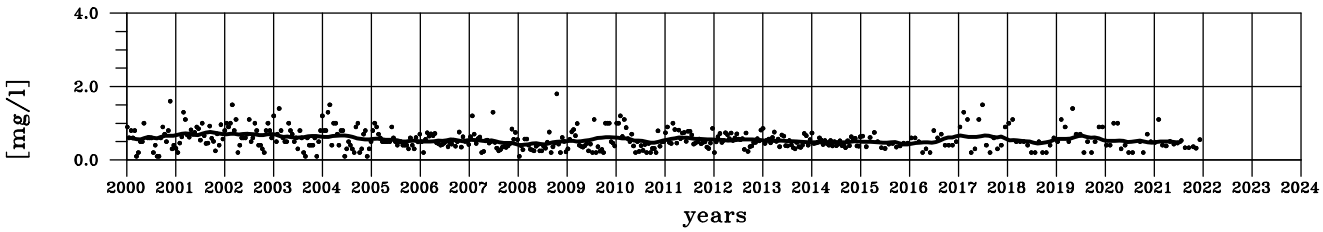
Kjeldahl Nitrogen from Nieuwe Waterweg

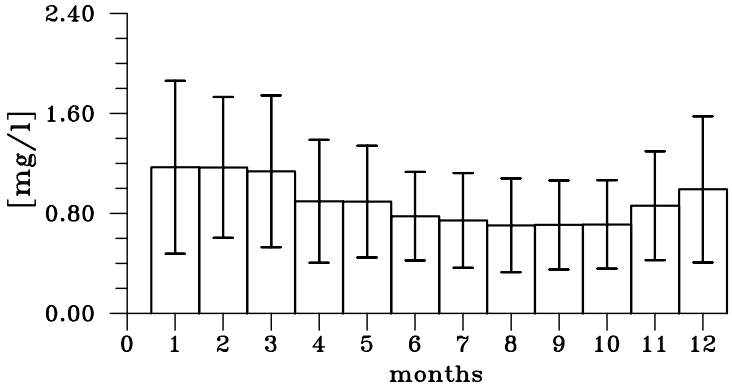
TIME SERIES
number of data: 1050
mean: 0.92 mg/l
relative standard deviation: 0.59
minimum: 0.04 mg/l September 14, 1994
maximum: 3.60 mg/l January 30, 1979

LOW PASS
minimum: 0.40 mg/l January 2008
maximum: 1.73 mg/l June 1977

ANNUAL CYCLE
minimum: 0.70 mg/l August, rel. stdev: 0.53
maximum: 1.17 mg/l January, rel. stdev: 0.59





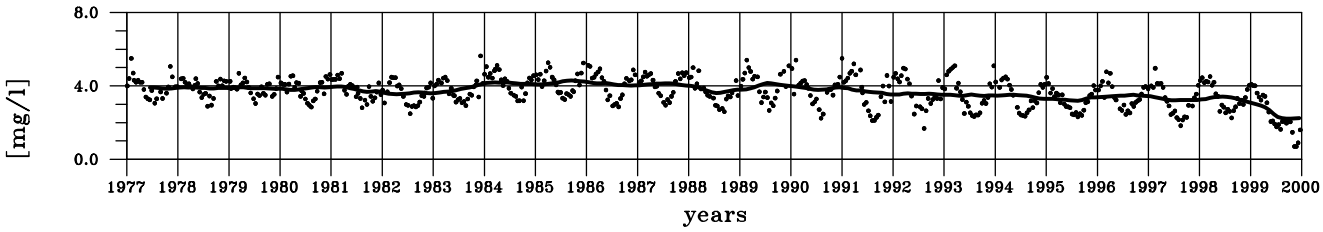


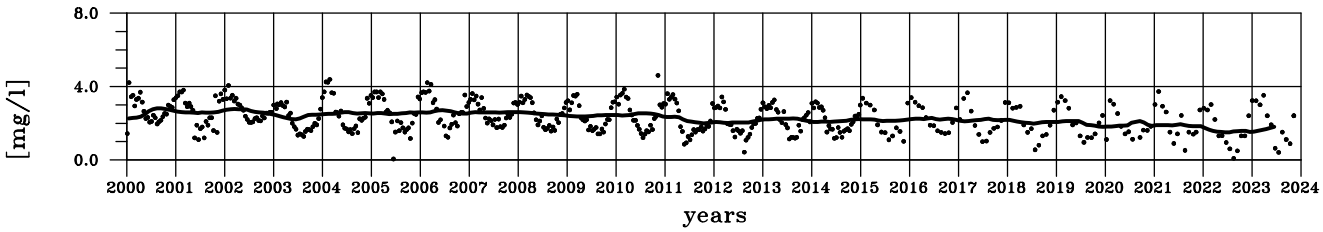
Nitrate + Nitrite from Nieuwe Waterweg

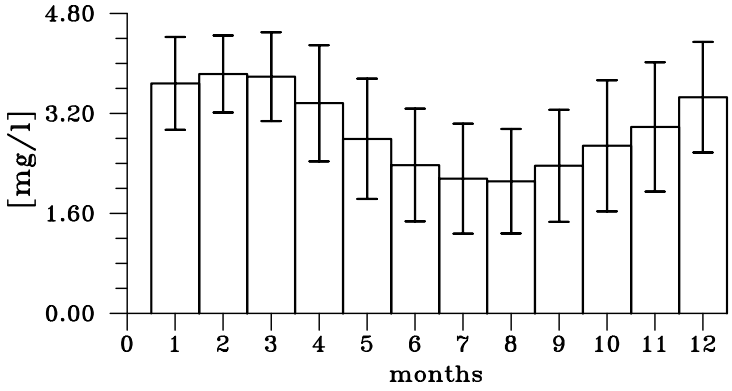
TIME SERIES
number of data: 1079
mean: 3.04 mg/l
relative standard deviation: 0.34
minimum: 0.05 mg/l June 15, 2005
maximum: 5.63 mg/l December 5, 1983

LOW PASS
minimum: 1.51 mg/l June 2022
maximum: 4.30 mg/l September 1985

ANNUAL CYCLE
minimum: 2.12 mg/l August, rel. stdev: 0.40
maximum: 3.83 mg/l February, rel. stdev: 0.16





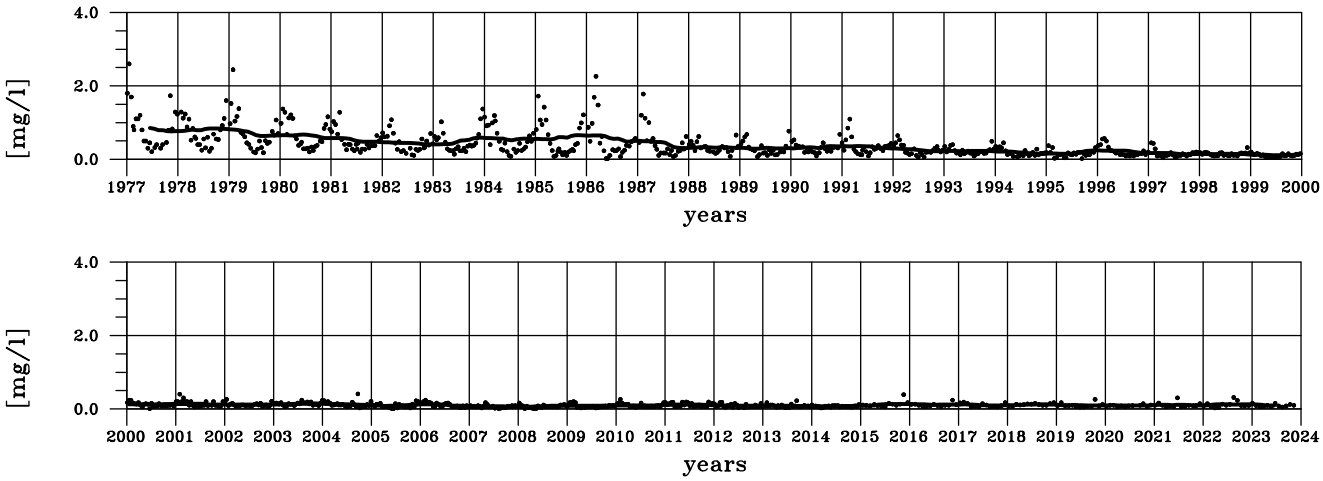


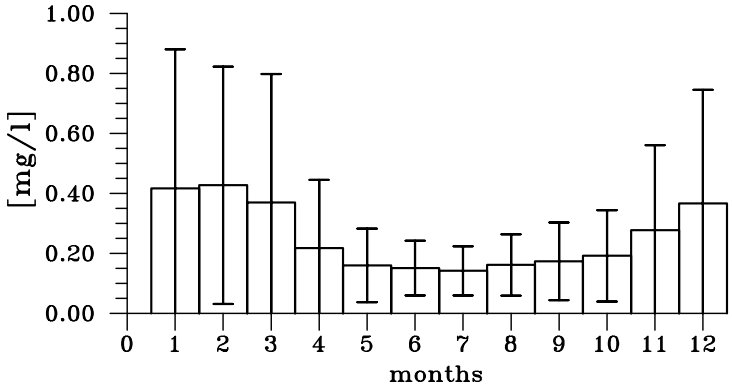
Ammonium from Nieuwe Waterweg

TIME SERIES
number of data: 1083
mean: 0.26 mg/l
relative standard deviation: 1.17
minimum: 0.01 mg/l June 21, 2000
maximum: 2.60 mg/l January 18, 1977

LOW PASS
minimum: 0.06 mg/l December 2007
maximum: 0.85 mg/l June 1977

ANNUAL CYCLE
minimum: 0.14 mg/l July, rel. stdev: 0.58
maximum: 0.43 mg/l February, rel. stdev: 0.93



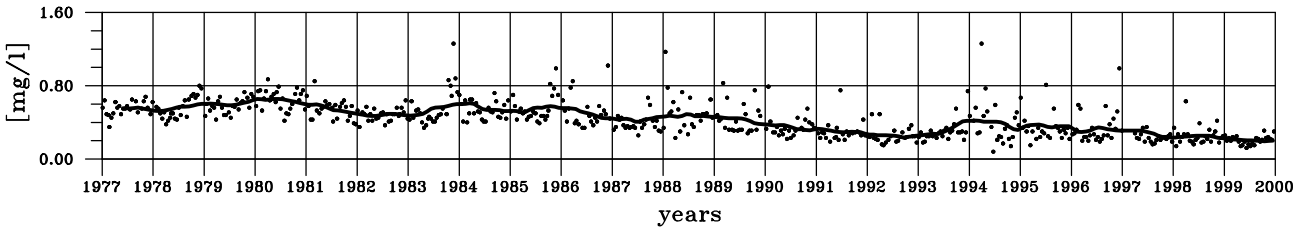


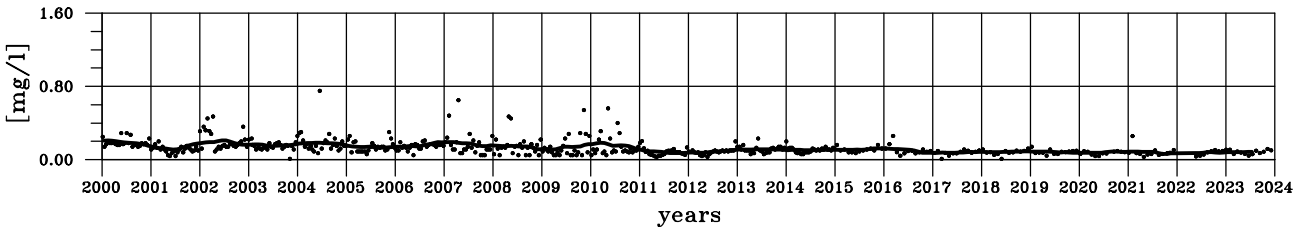
Total Phosphorus from Nieuwe Waterweg

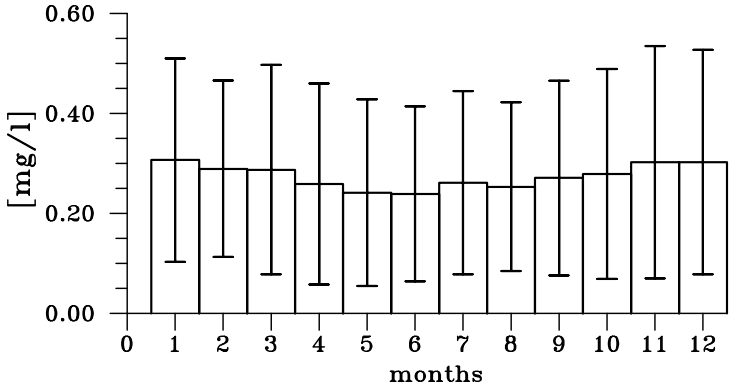
TIME SERIES
number of data: 1067
mean: 0.29 mg/l
relative standard deviation: 0.72
minimum: 0.01 mg/l November 5, 2003
maximum: 1.26 mg/l November 21, 1983

LOW PASS
minimum: 0.06 mg/l September 2021
maximum: 0.65 mg/l January 1980

ANNUAL CYCLE
minimum: 0.24 mg/l June, rel. stdev: 0.73
maximum: 0.31 mg/l January, rel. stdev: 0.66





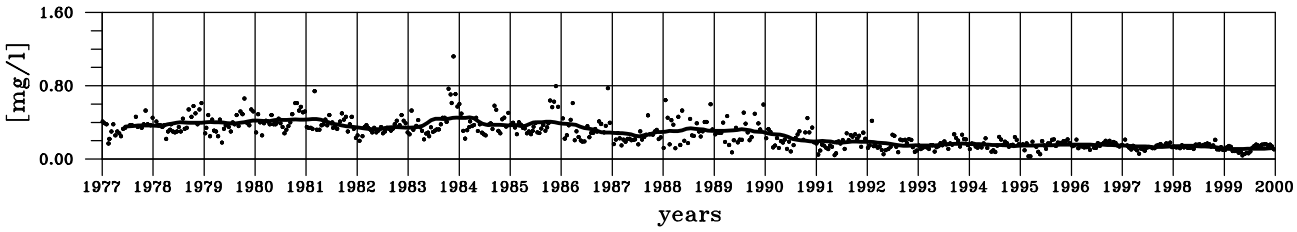


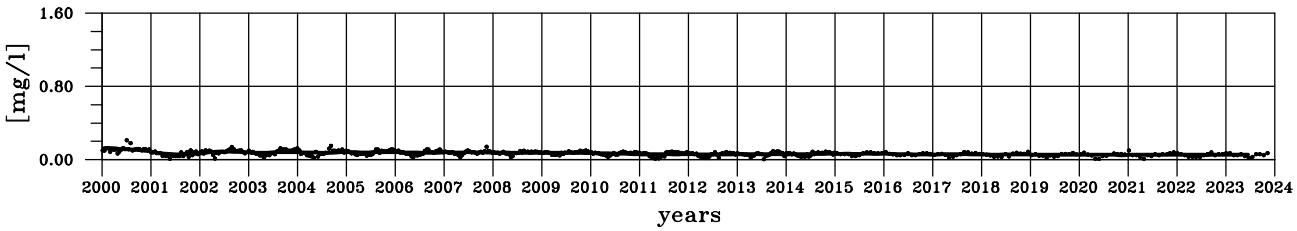
Phosphate from Nieuwe Waterweg

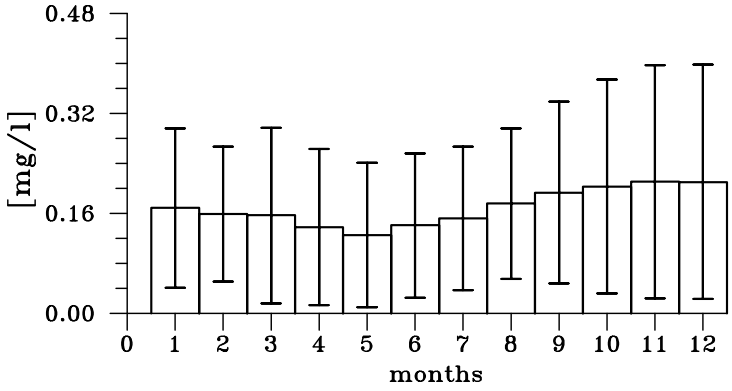
TIME SERIES
number of data: 1079
mean: 0.18 mg/l
relative standard deviation: 0.83
minimum: 0.00 mg/l July 18, 2013
maximum: 1.12 mg/l November 21, 1983

LOW PASS
minimum: 0.05 mg/l November 2020
maximum: 0.45 mg/l March 1984

ANNUAL CYCLE
minimum: 0.13 mg/l May, rel. stdev: 0.92
maximum: 0.21 mg/l November, rel. stdev: 0.88





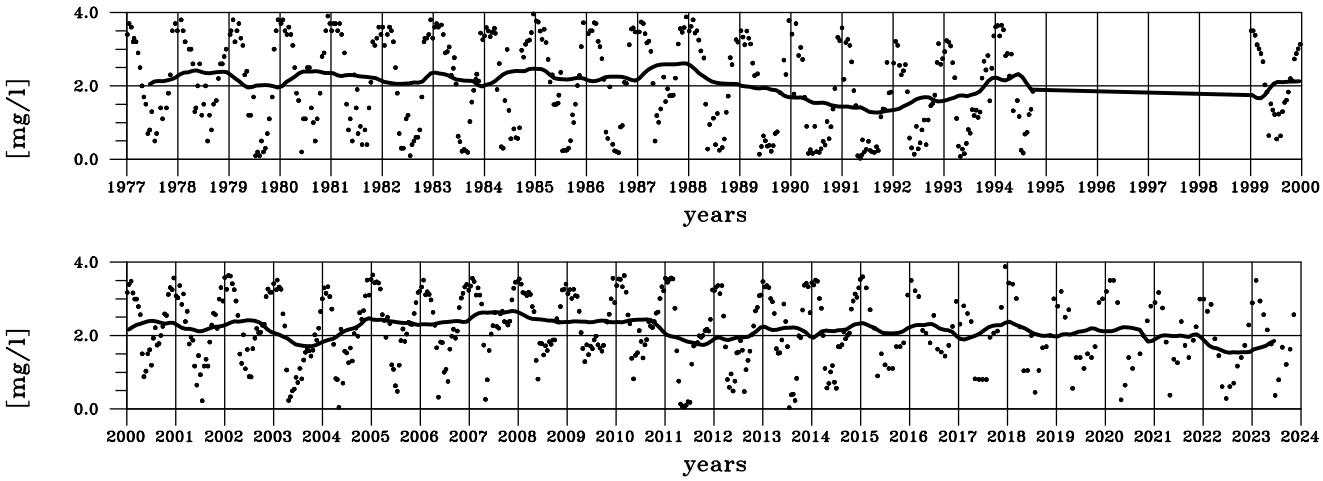


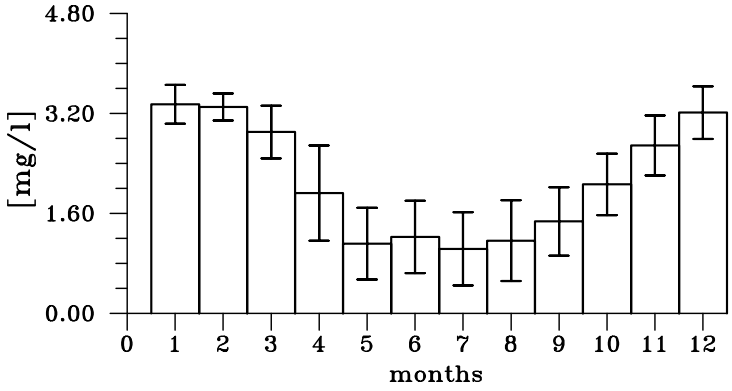
Silicate from Nieuwe Waterweg

TIME SERIES
number of data: 974
mean: 2.11 mg/l
relative standard deviation: 0.51
minimum: 0.03 mg/l May 13, 1991
maximum: 3.96 mg/l December 18, 1984

LOW PASS
minimum: 1.27 mg/l September 1991
maximum: 2.67 mg/l November 2007

ANNUAL CYCLE
minimum: 1.03 mg/l July, rel. stdev: 0.57
maximum: 3.35 mg/l January, rel. stdev: 0.09



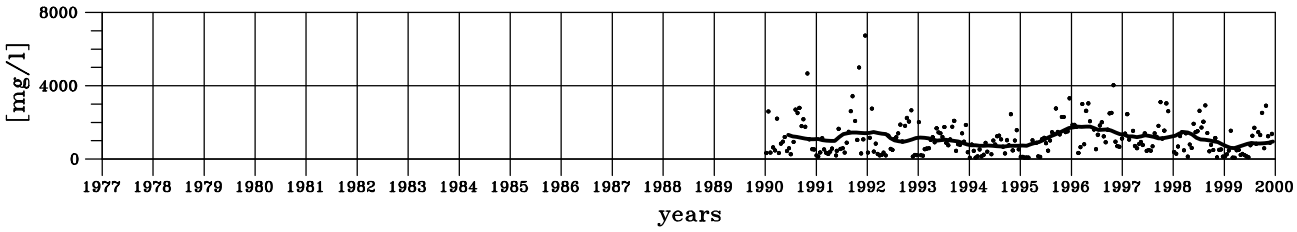


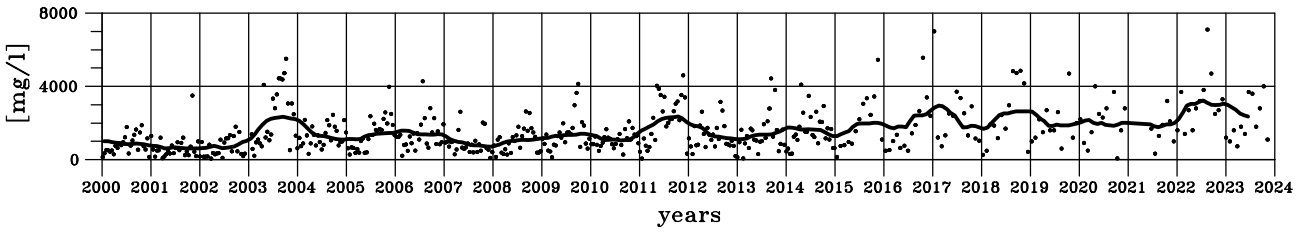
Chloride from Nieuwe Waterweg

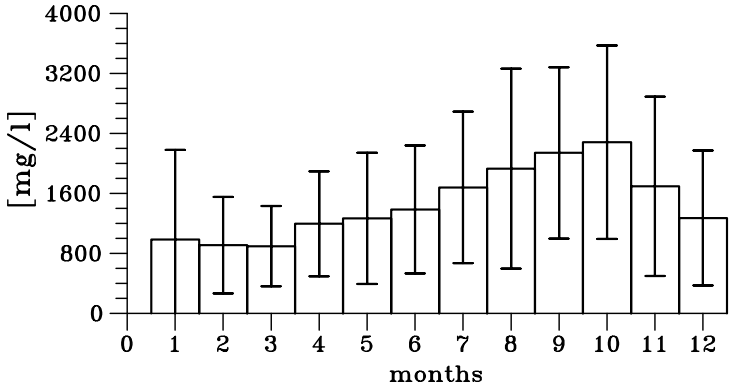
TIME SERIES
number of data: 745
mean: 1375 mg/l
relative standard deviation: 0.80
minimum: 63 mg/l January 19, 2011
maximum: 7100 mg/l August 16, 2022

LOW PASS
minimum: 601 mg/l March 1999
maximum: 3233 mg/l July 2022

ANNUAL CYCLE
minimum: 895 mg/l March, rel. stdev: 0.60
maximum: 2282 mg/l October, rel. stdev: 0.57







3.2.4 Haringvliet

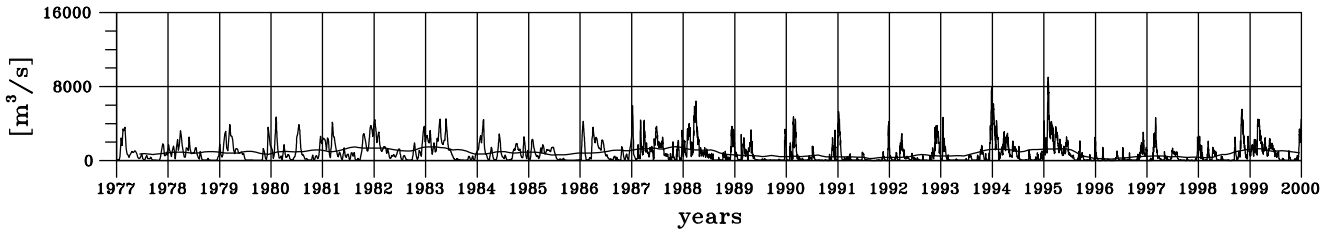
Sampling took place close to the big weir (Haringvlietsluis), before the water masses combined from Rhine and Maas enter the North Sea. From 1980 on there were daily data available for the discharge and samples for all the concentrations every two weeks. Even though the samples are taken very near to the North Sea the mean chloride content of about 100 mg/l indicates that there is no mixing of outgoing freshwater with seawater. This results from the fact that the big weir is regulated only for outlet of freshwater which therefore yields no elevated chloride contents.

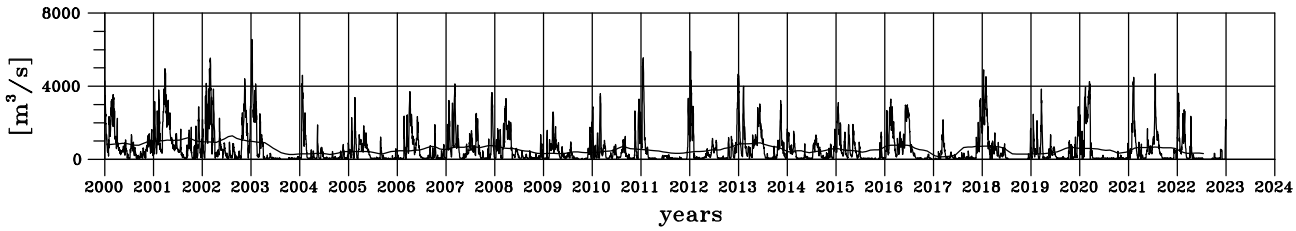
Discharge from Haringvliet

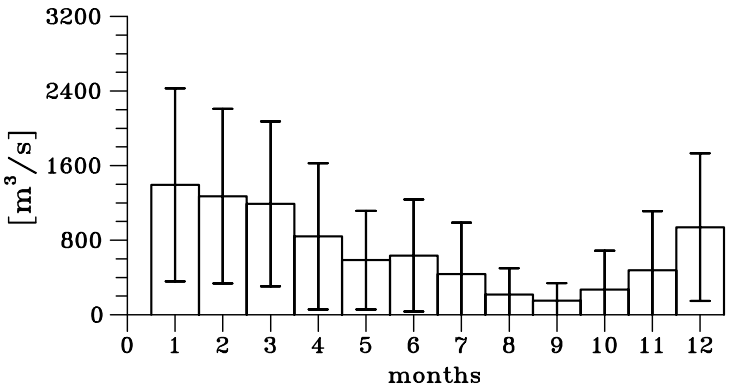
TIME SERIES
number of data: 15831
mean: 687 m^3/s
relative standard deviation: 1.42
minimum: 0 m^3/s August 28, 1990
maximum: 9015 m^3/s February 2, 1995

LOW PASS
minimum: 147 m^3/s February 2017
maximum: 1520 m^3/s November 1987

ANNUAL CYCLE
minimum: 152 m^3/s September, rel. stdev: 1.22
maximum: 1392 m^3/s January, rel. stdev: 0.74





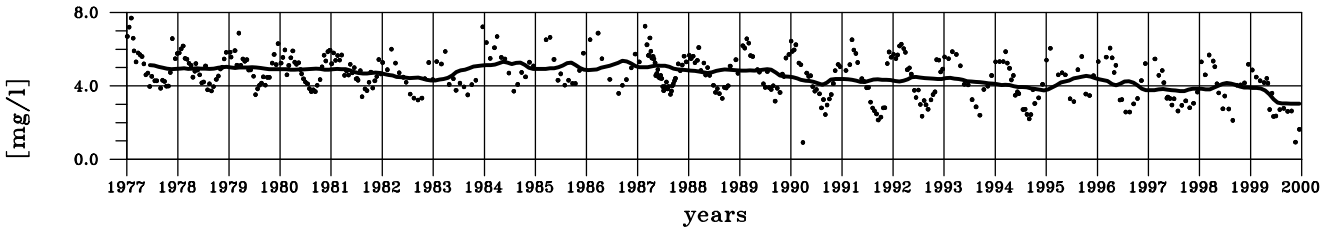


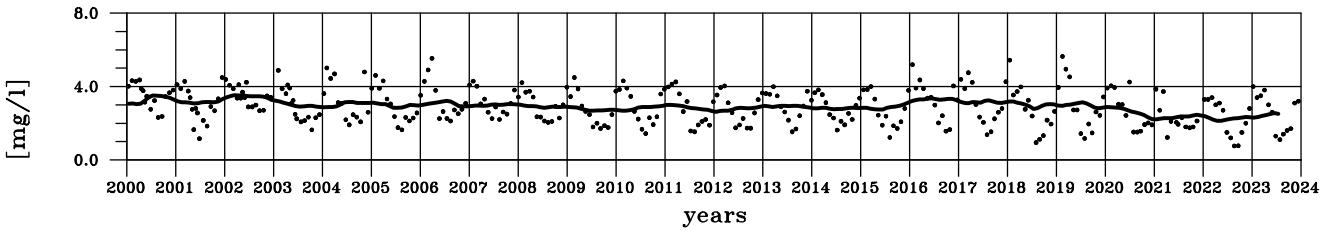
Total Nitrogen from Haringvliet

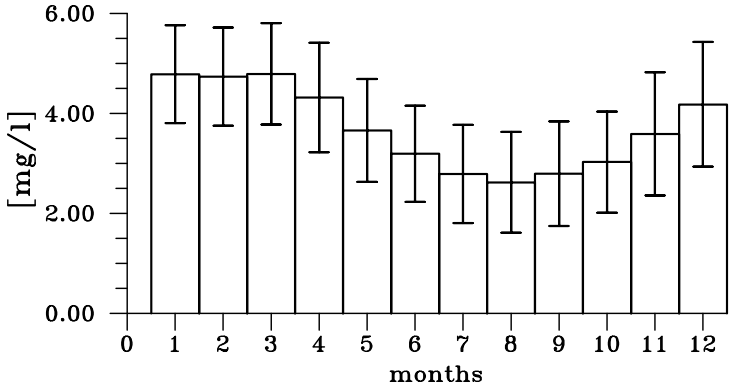
TIME SERIES
number of data: 762
mean: 3.87 mg/l
relative standard deviation: 0.34
minimum: 0.76 mg/l August 22, 2022
maximum: 7.70 mg/l February 1, 1977

LOW PASS
minimum: 2.14 mg/l May 2022
maximum: 5.36 mg/l September 1986

ANNUAL CYCLE
minimum: 2.62 mg/l August, rel. stdev: 0.38
maximum: 4.79 mg/l March, rel. stdev: 0.21





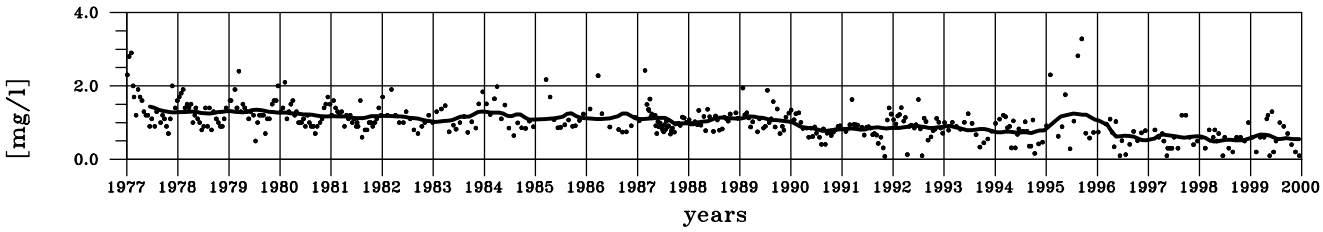


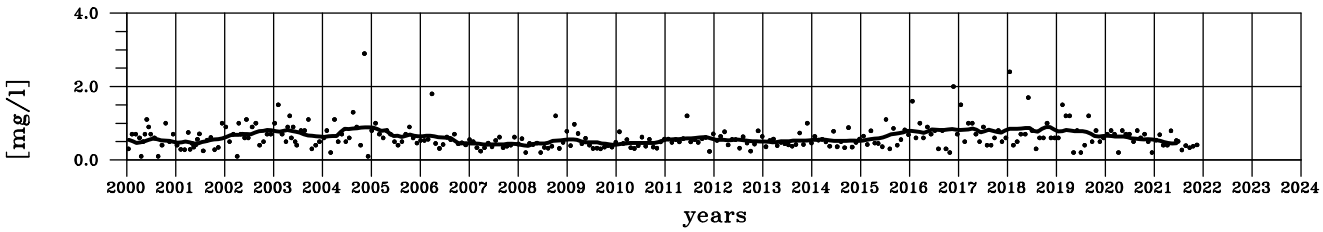
Kjeldahl Nitrogen from Haringvliet

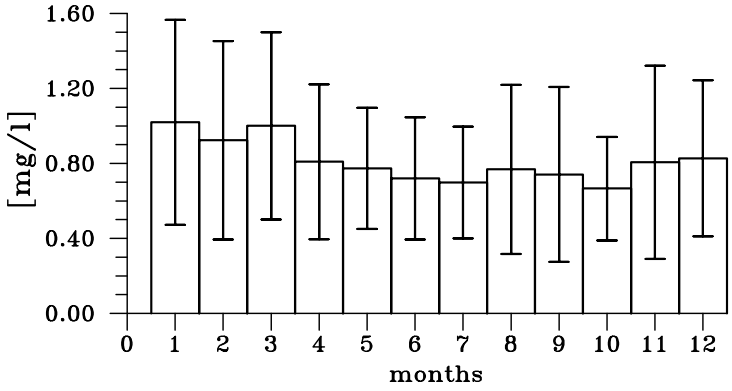
TIME SERIES
number of data: 738
mean: 0.86 mg/l
relative standard deviation: 0.53
minimum: 0.08 mg/l November 4, 1991
maximum: 3.28 mg/l September 12, 1995

LOW PASS
minimum: 0.39 mg/l March 2008
maximum: 1.43 mg/l June 1977

ANNUAL CYCLE
minimum: 0.67 mg/l October, rel. stdev: 0.41
maximum: 1.02 mg/l January, rel. stdev: 0.54





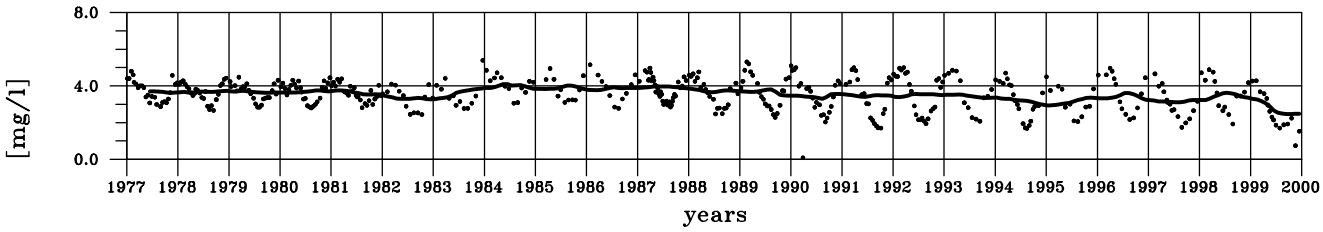


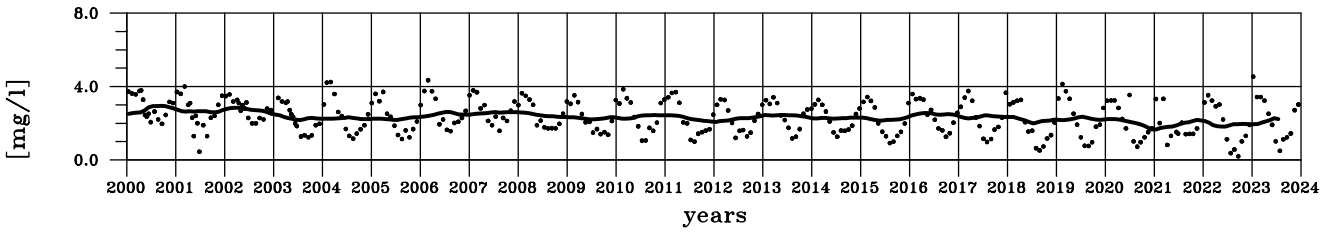
Nitrate + Nitrite from Haringvliet

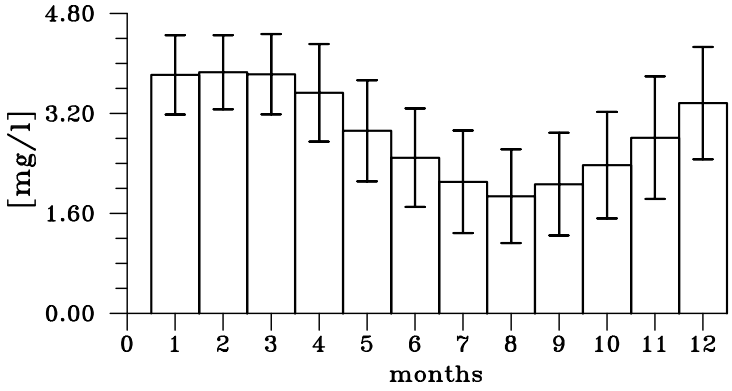
TIME SERIES
number of data: 769
mean: 3.03 mg/l
relative standard deviation: 0.35
minimum: 0.08 mg/l March 28, 1990
maximum: 5.38 mg/l December 20, 1983

LOW PASS
minimum: 1.66 mg/l January 2021
maximum: 4.10 mg/l May 1984

ANNUAL CYCLE
minimum: 1.88 mg/l August, rel. stdev: 0.40
maximum: 3.86 mg/l February, rel. stdev: 0.15





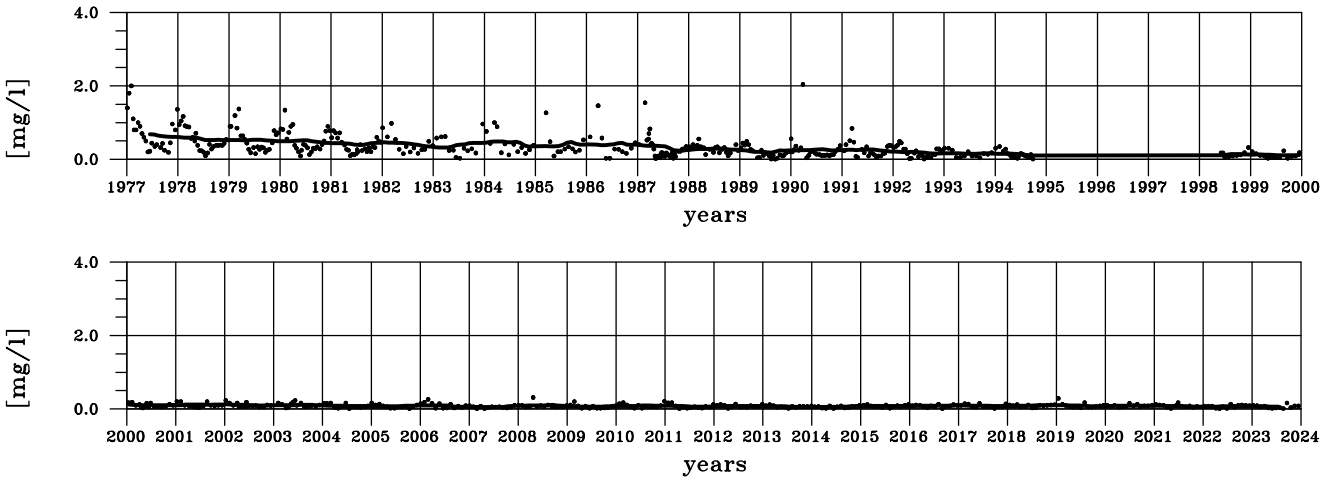


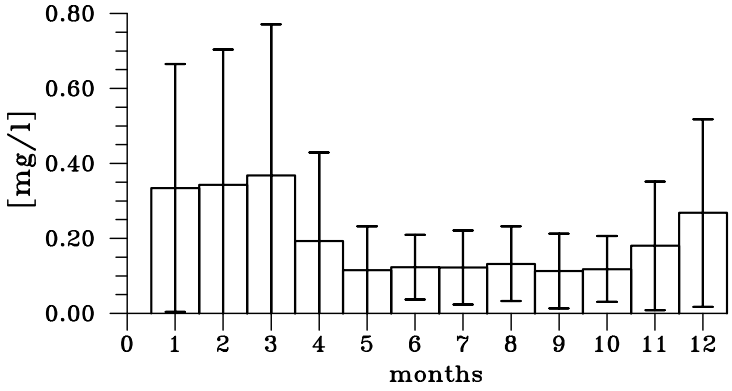
Ammonium from Haringvliet

TIME SERIES
number of data: 715
mean: 0.23 mg/l
relative standard deviation: 1.19
minimum: 0.00 mg/l September 11, 1989
maximum: 2.04 mg/l March 28, 1990

LOW PASS
minimum: 0.05 mg/l May 2007
maximum: 0.68 mg/l June 1977

ANNUAL CYCLE
minimum: 0.11 mg/l September, rel. stdev: 0.89
maximum: 0.37 mg/l March, rel. stdev: 1.10



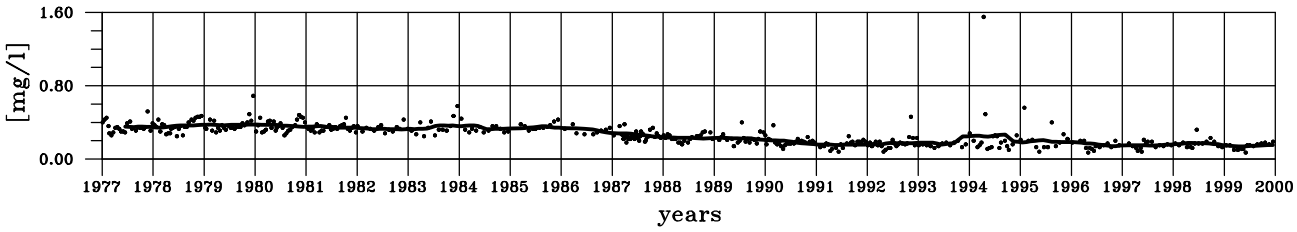


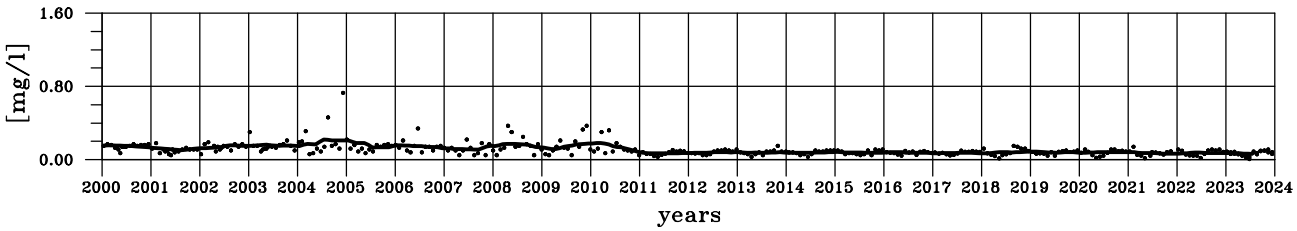
Total Phosphorus from Haringvliet

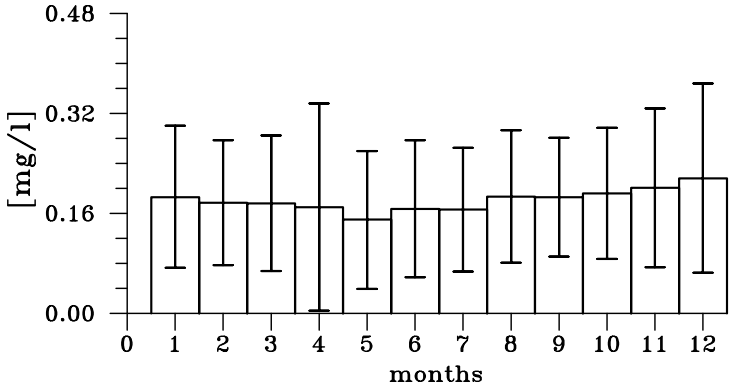
TIME SERIES
number of data: 777
mean: 0.20 mg/l
relative standard deviation: 0.65
minimum: 0.01 mg/l June 26, 2023
maximum: 1.55 mg/l April 14, 1994

LOW PASS
minimum: 0.06 mg/l July 2023
maximum: 0.38 mg/l January 1980

ANNUAL CYCLE
minimum: 0.15 mg/l May, rel. stdev: 0.74
maximum: 0.22 mg/l December, rel. stdev: 0.70





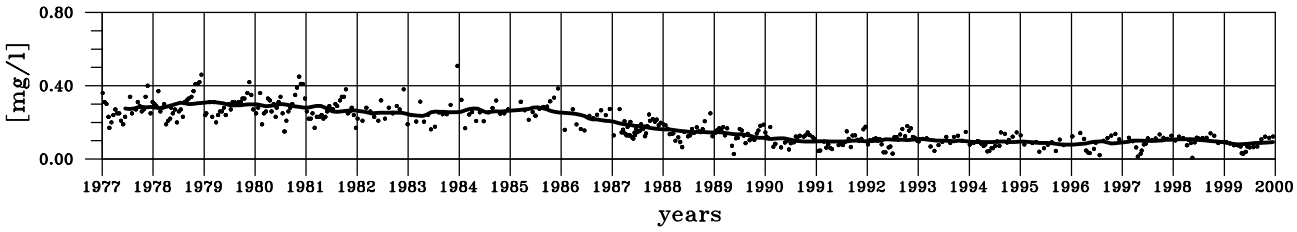


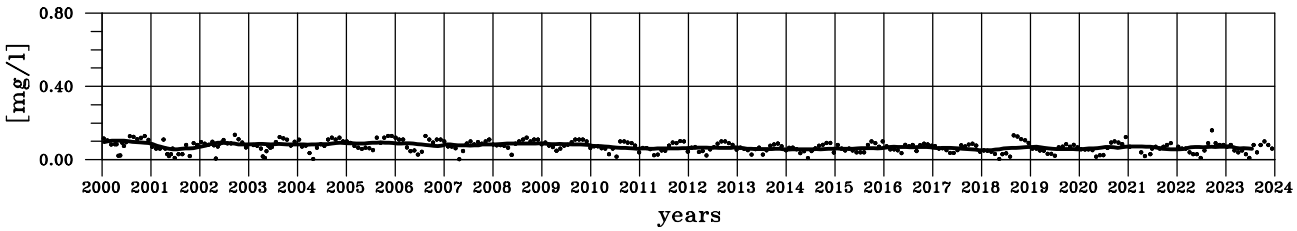
Phosphate from Haringvliet

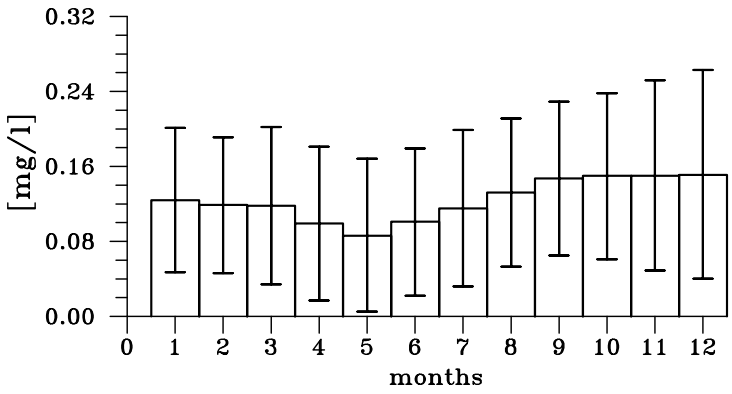
TIME SERIES
number of data: 761
mean: 0.14 mg/l
relative standard deviation: 0.69
minimum: 0.00 mg/l April 24, 2007
maximum: 0.51 mg/l December 20, 1983

LOW PASS
minimum: 0.05 mg/l February 2018
maximum: 0.31 mg/l February 1979

ANNUAL CYCLE
minimum: 0.09 mg/l May, rel. stdev: 0.94
maximum: 0.15 mg/l December, rel. stdev: 0.74





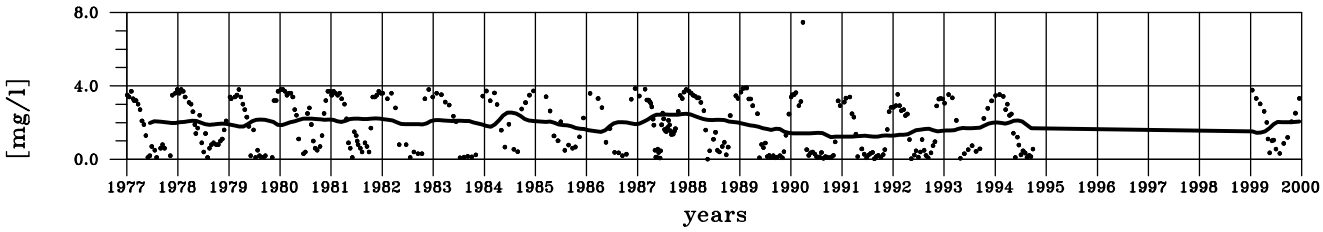


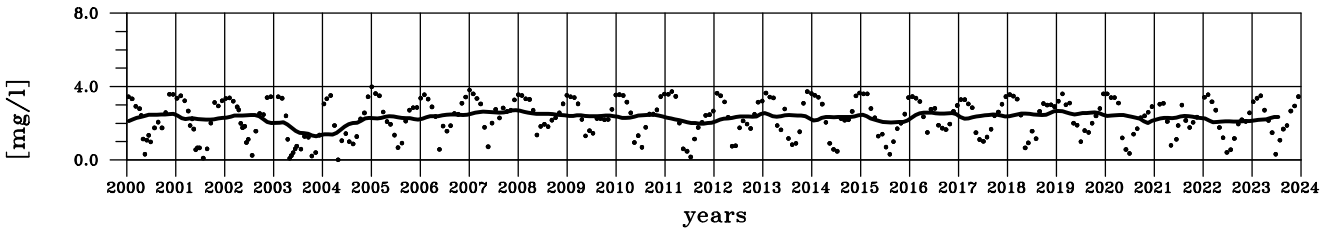
Silicate from Haringvliet

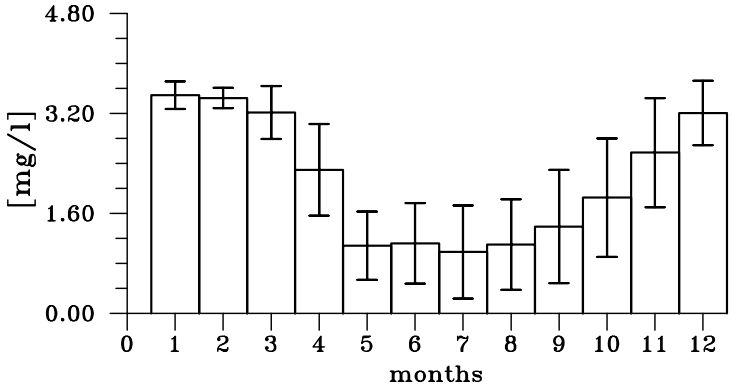
TIME SERIES
number of data: 701
mean: 2.04 mg/l
relative standard deviation: 0.61
minimum: 0.01 mg/l May 16, 1988
maximum: 7.46 mg/l March 28, 1990

LOW PASS
minimum: 1.21 mg/l October 1990
maximum: 2.72 mg/l December 2007

ANNUAL CYCLE
minimum: 0.98 mg/l July, rel. stdev: 0.76
maximum: 3.49 mg/l January, rel. stdev: 0.06





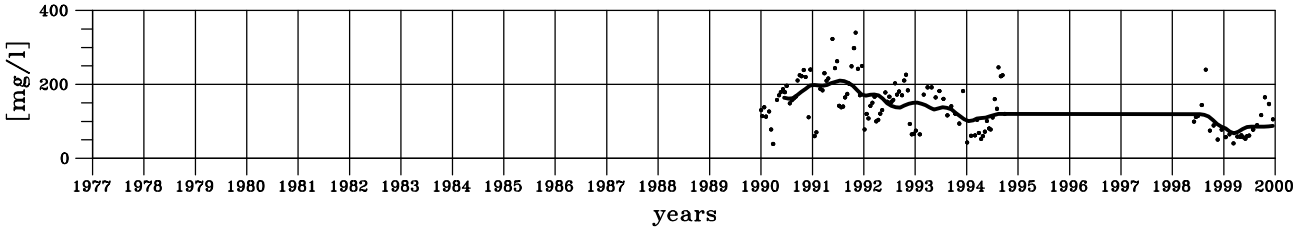


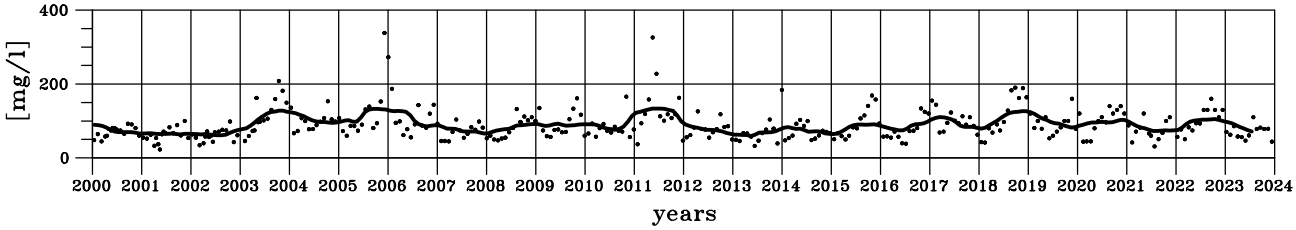
Chloride from Haringvliet

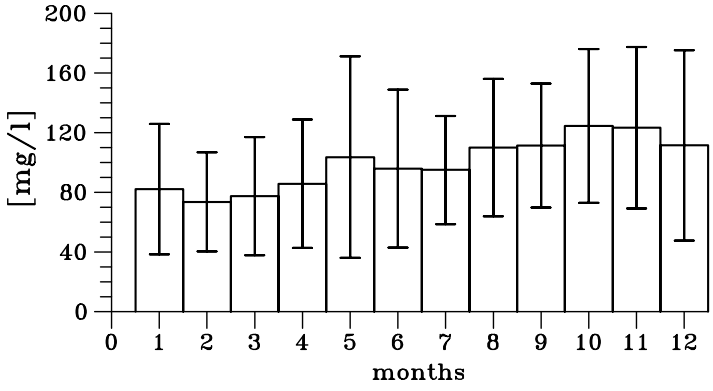
TIME SERIES
number of data: 450
mean: 104 mg/l
relative standard deviation: 0.53
minimum: 23 mg/l May 15, 2001
maximum: 340 mg/l November 4, 1991

LOW PASS
minimum: 59 mg/l May 2013
maximum: 210 mg/l July 1991

ANNUAL CYCLE
minimum: 74 mg/l February, rel. stdev: 0.45
maximum: 125 mg/l October, rel. stdev: 0.41







3.2.5 River Scheldt

The river Scheldt actually originates from Belgium. Rijkswaterstaat in the Netherlands could therefore only provide data for the Belgium/Dutch border at location Schaar van Ouden Doel. The discharge data were available every 10 days whereas all concentrations were measured every two weeks.
Chloride data were not available for 2021 and 2022. We used salinity data instead and calculated the chloride data using the following formula:

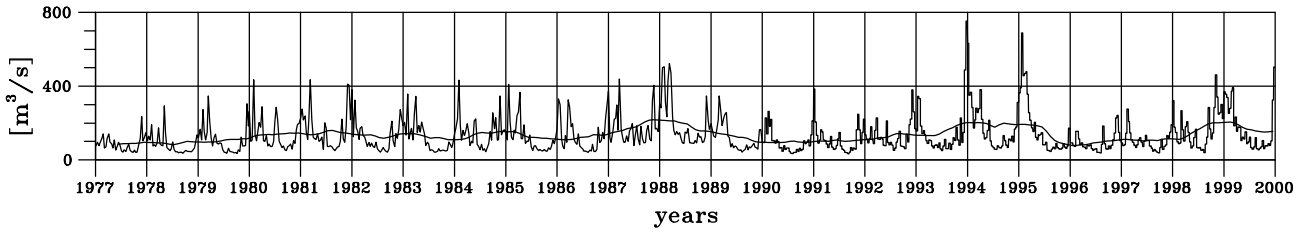
CL = (1000 * SAL -0.03)/1.805 (SAL >= 10)
CL = (1000 * SAL -0.092)/1.80183 (SAL < 10)

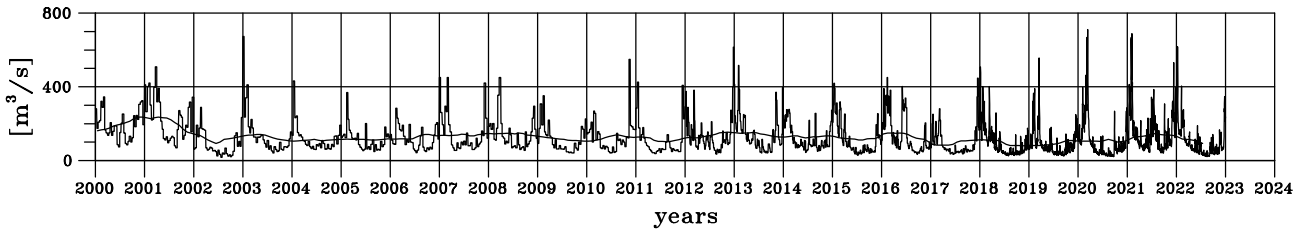
Discharge from River Scheldt

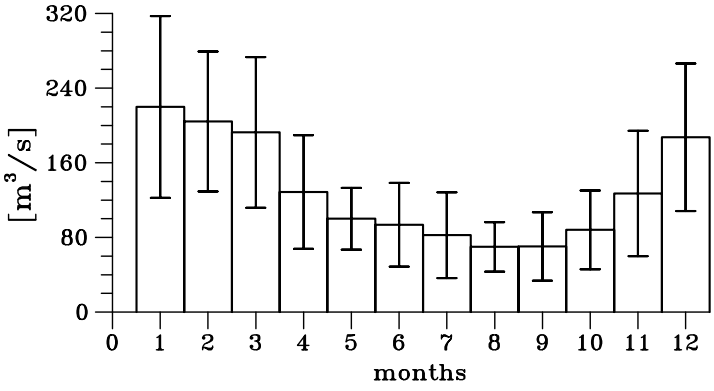
TIME SERIES
number of data: 12881
mean: 130 m^3/s
relative standard deviation: 0.75
minimum: 17 m^3/s July 21, 2002
maximum: 753 m^3/s December 21, 1993

LOW PASS
minimum: 79 m^3/s January 1996
maximum: 236 m^3/s April 2001

ANNUAL CYCLE
minimum: 70 m^3/s August, rel. stdev: 0.38
maximum: 220 m^3/s January, rel. stdev: 0.44





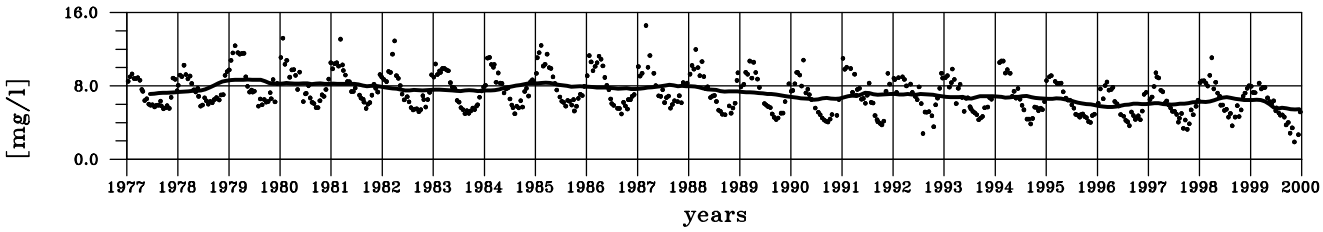


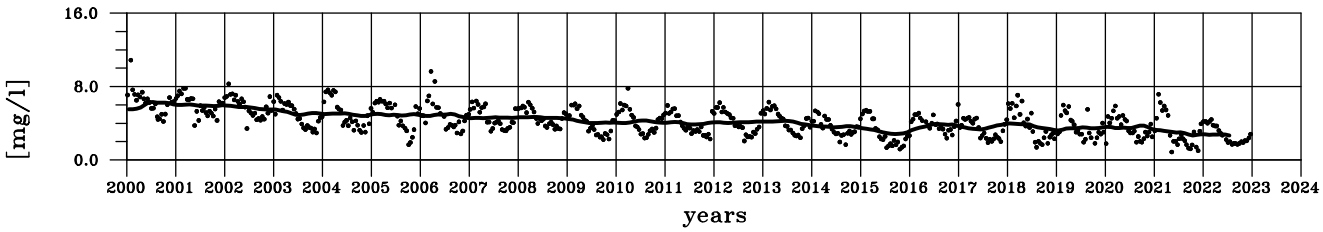
Total Nitrogen from River Scheldt

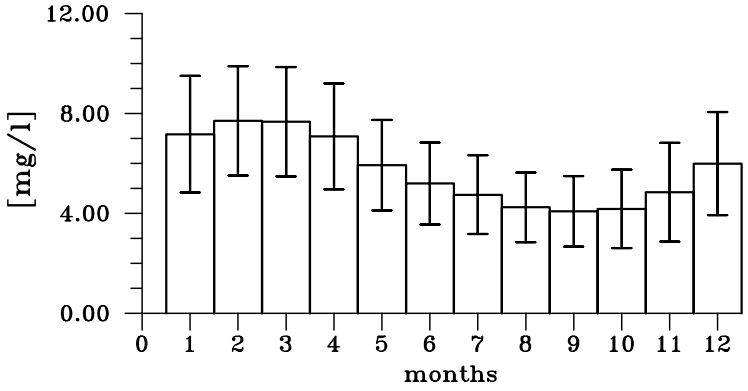
TIME SERIES
number of data: 1169
mean: 5.71 mg/l
relative standard deviation: 0.41
minimum: 0.86 mg/l May 11, 2021
maximum: 14.58 mg/l March 2, 1987

LOW PASS
minimum: 2.67 mg/l October 2021
maximum: 8.69 mg/l May 1979

ANNUAL CYCLE
minimum: 4.08 mg/l September, rel. stdev: 0.35
maximum: 7.71 mg/l February, rel. stdev: 0.28





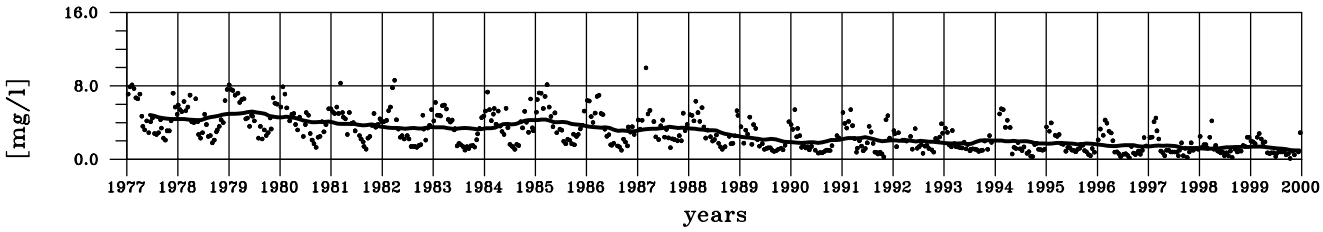


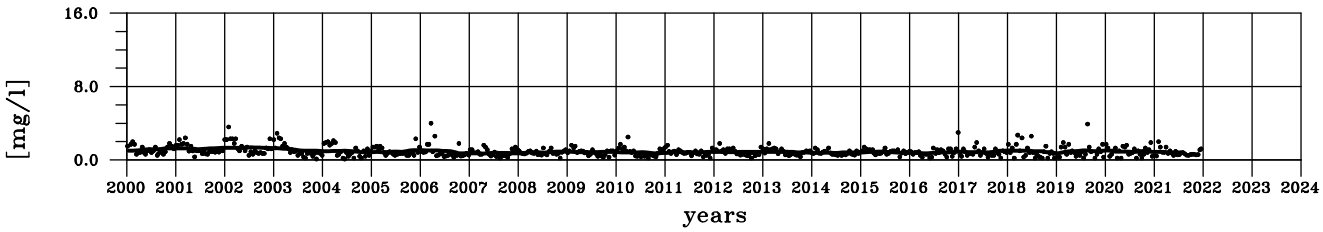
Kjeldahl Nitrogen from River Scheldt

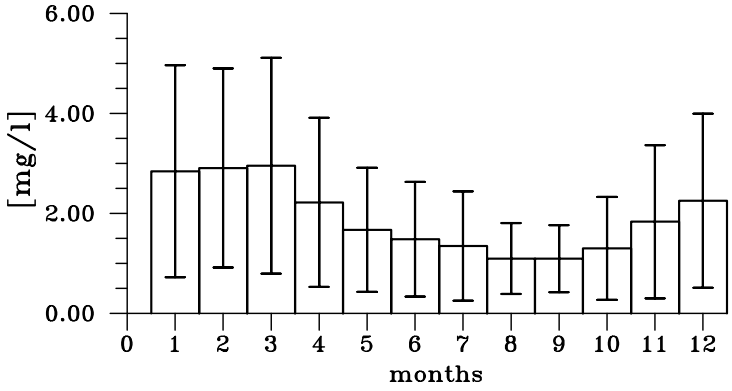
TIME SERIES
number of data: 1149
mean: 1.91 mg/l
relative standard deviation: 0.90
minimum: 0.10 mg/l October 11, 1999
maximum: 9.96 mg/l March 2, 1987

LOW PASS
minimum: 0.71 mg/l April 2007
maximum: 5.20 mg/l June 1979

ANNUAL CYCLE
minimum: 1.09 mg/l September, rel. stdev: 0.61
maximum: 2.95 mg/l March, rel. stdev: 0.73





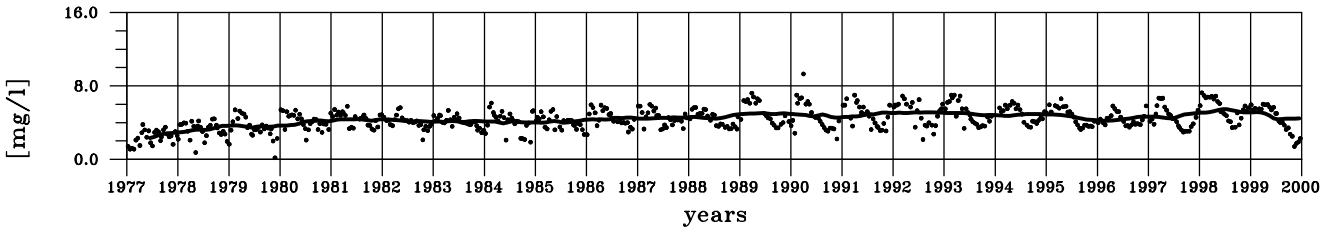


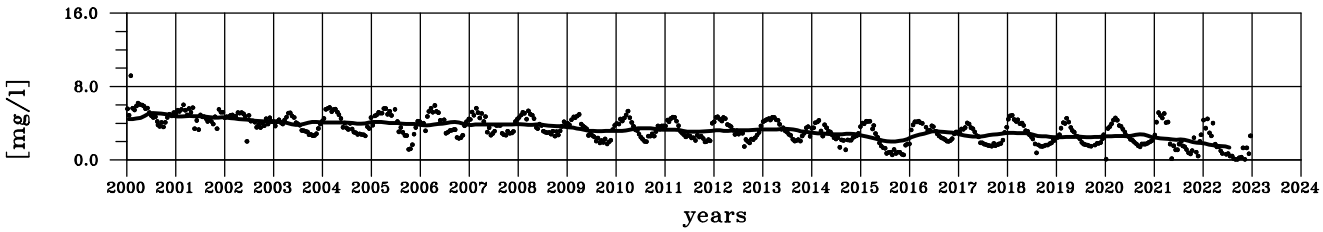
Nitrate + Nitrite from River Scheldt

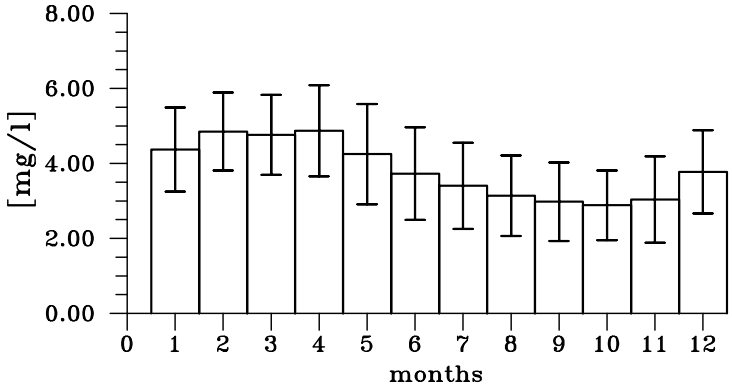
TIME SERIES
number of data: 1180
mean: 3.82 mg/l
relative standard deviation: 0.36
minimum: 0.06 mg/l August 30, 2022
maximum: 9.30 mg/l April 2, 1990

LOW PASS
minimum: 1.36 mg/l July 2022
maximum: 5.47 mg/l June 1998

ANNUAL CYCLE
minimum: 2.88 mg/l October, rel. stdev: 0.32
maximum: 4.87 mg/l April, rel. stdev: 0.25





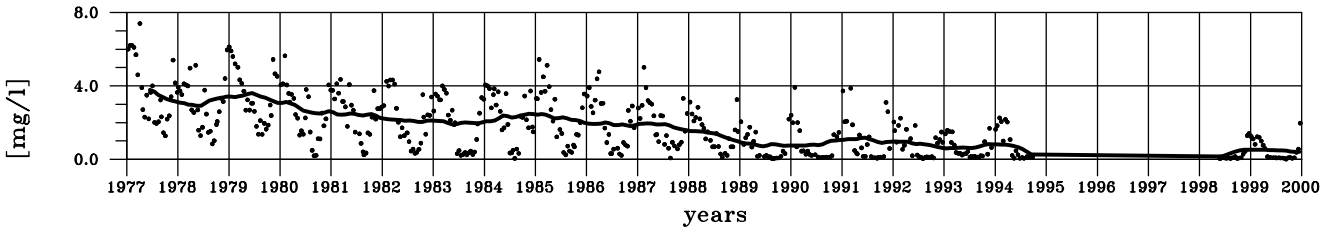


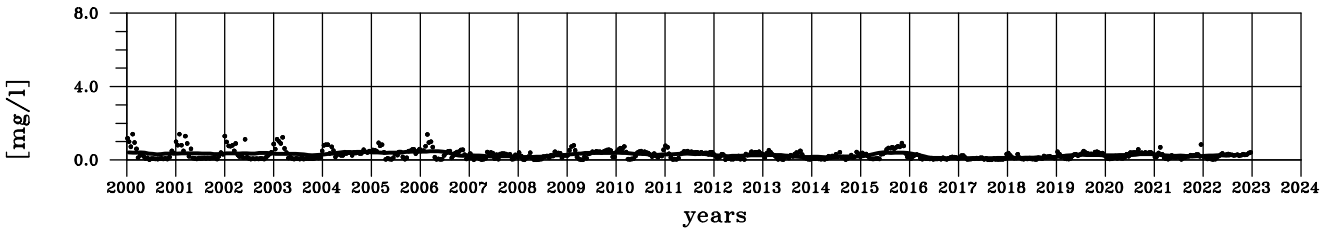
Ammonium from River Scheldt

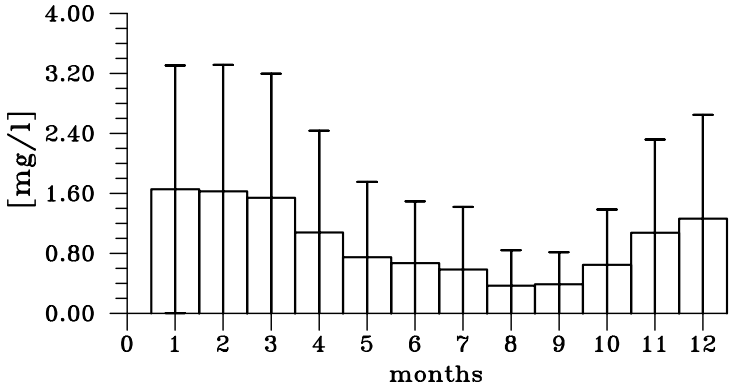
TIME SERIES
number of data: 1094
mean: 0.97 mg/l
relative standard deviation: 1.33
minimum: 0.01 mg/l September 13, 1999
maximum: 7.40 mg/l April 4, 1977

LOW PASS
minimum: 0.08 mg/l June 2017
maximum: 3.78 mg/l June 1977

ANNUAL CYCLE
minimum: 0.37 mg/l August, rel. stdev: 1.28
maximum: 1.66 mg/l January, rel. stdev: 1.00





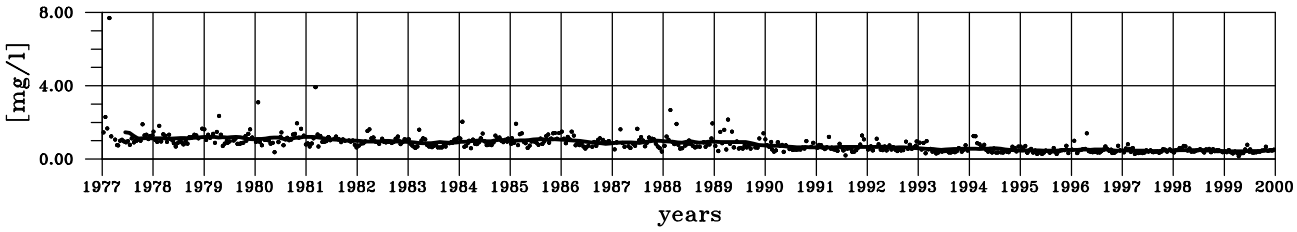


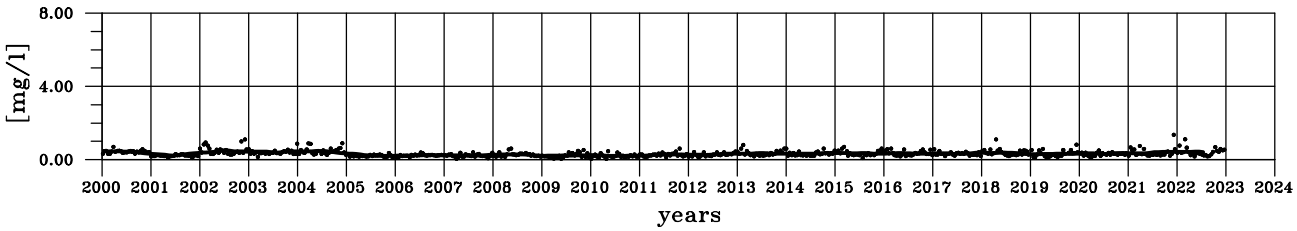
Total Phosphorus from River Scheldt

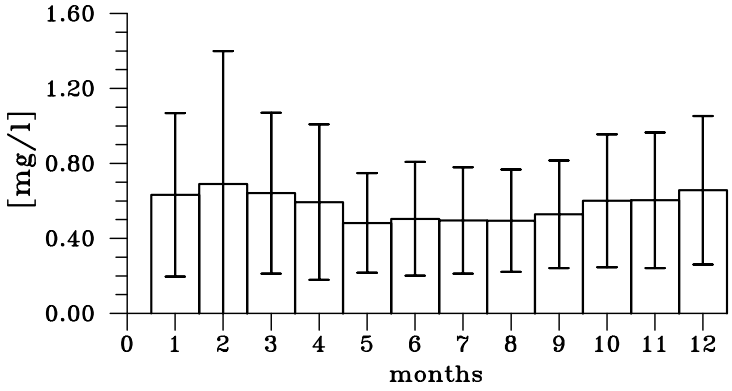
TIME SERIES
number of data: 1200
mean: 0.57 mg/l
relative standard deviation: 0.77
minimum: 0.05 mg/l April 4, 2007
maximum: 7.70 mg/l February 21, 1977

LOW PASS
minimum: 0.20 mg/l June 2010
maximum: 1.46 mg/l June 1977

ANNUAL CYCLE
minimum: 0.48 mg/l May, rel. stdev: 0.55
maximum: 0.69 mg/l February, rel. stdev: 1.03





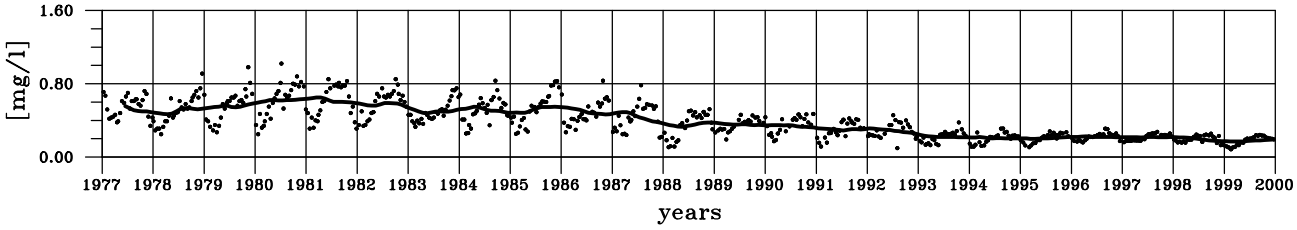


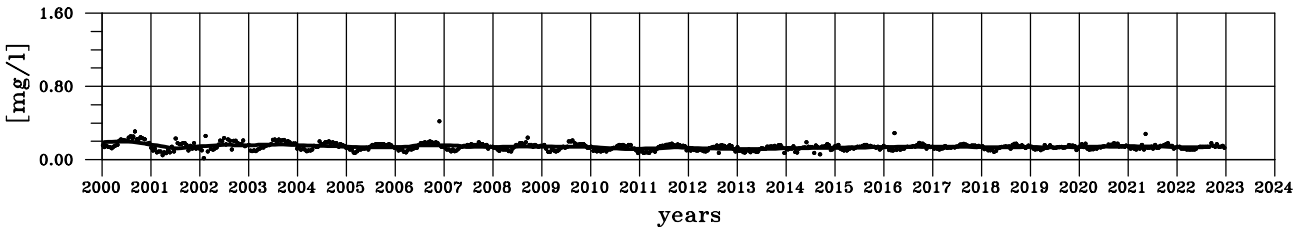
Phosphate from River Scheldt

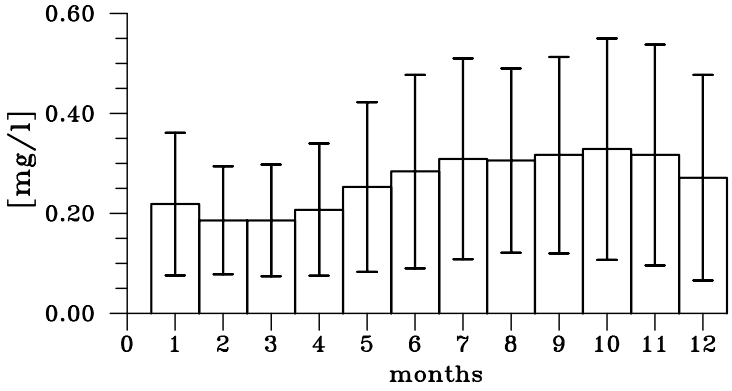
TIME SERIES
number of data: 1179
mean: 0.27 mg/l
relative standard deviation: 0.70
minimum: 0.02 mg/l January 31, 2002
maximum: 1.02 mg/l July 7, 1980

LOW PASS
minimum: 0.12 mg/l April 2013
maximum: 0.65 mg/l April 1981

ANNUAL CYCLE
minimum: 0.19 mg/l March, rel. stdev: 0.60
maximum: 0.33 mg/l October, rel. stdev: 0.67





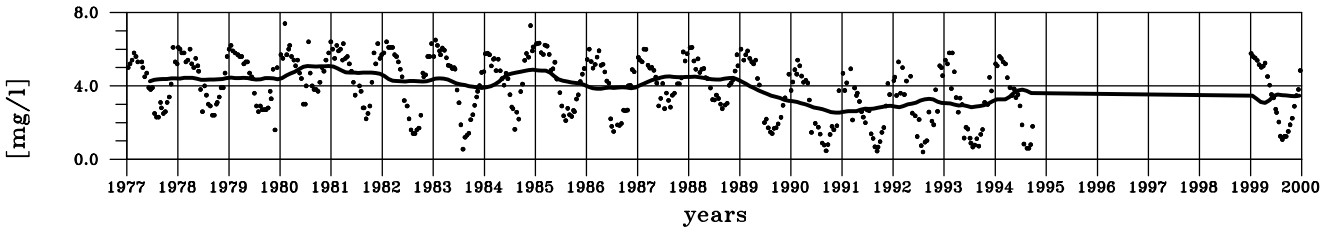


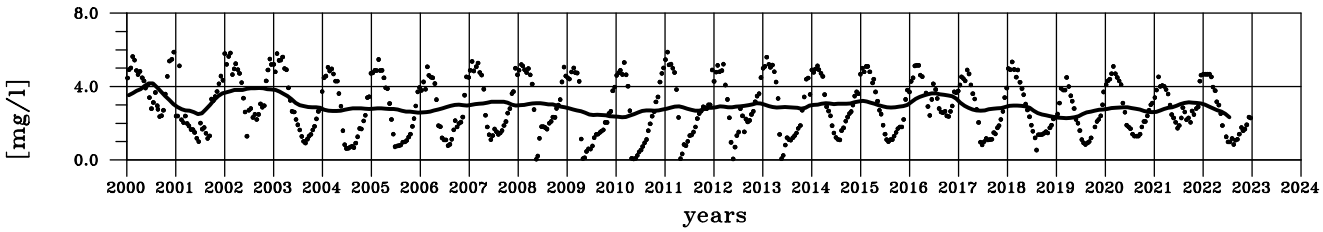
Silicate from River Scheldt

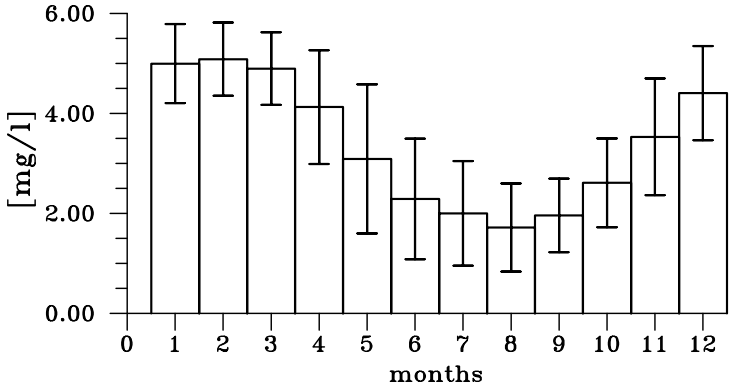
TIME SERIES
number of data: 1077
mean: 3.39 mg/l
relative standard deviation: 0.48
minimum: 0.04 mg/l May 15, 2008
maximum: 7.40 mg/l February 4, 1980

LOW PASS
minimum: 2.28 mg/l March 2019
maximum: 5.09 mg/l July 1980

ANNUAL CYCLE
minimum: 1.72 mg/l August, rel. stdev: 0.51
maximum: 5.09 mg/l February, rel. stdev: 0.14





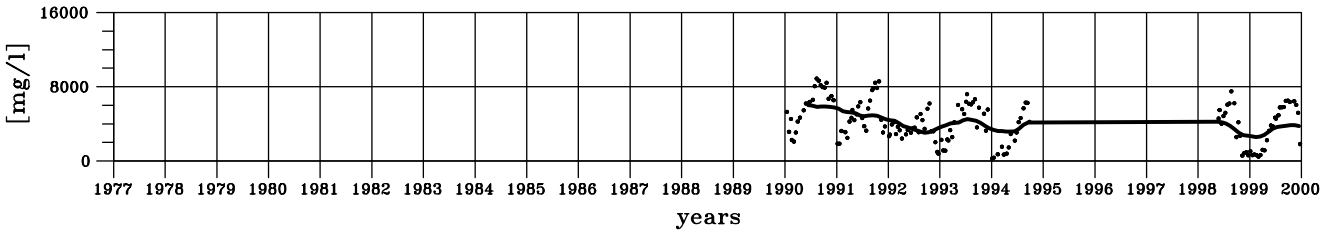


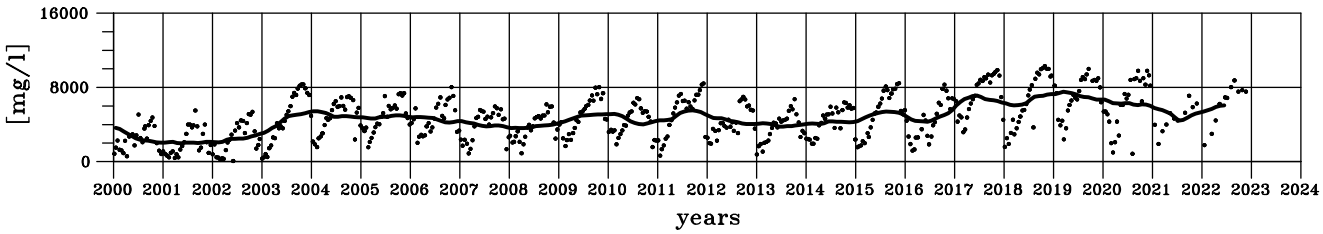
Chloride from River Scheldt

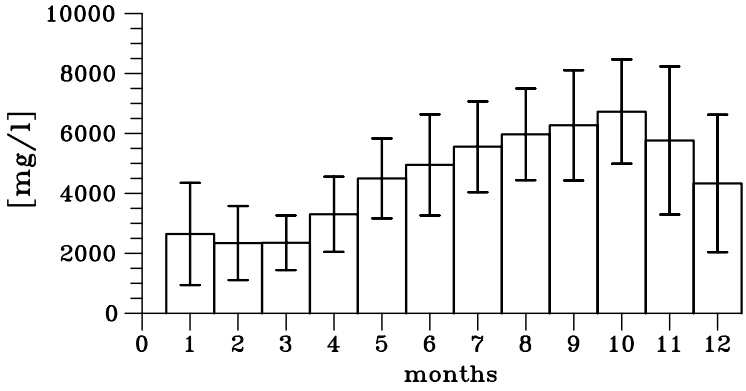
TIME SERIES
number of data: 719
mean: 4579 mg/l
relative standard deviation: 0.51
minimum: 61 mg/l June 3, 2002
maximum: 10300 mg/l October 29, 2018

LOW PASS
minimum: 1968 mg/l May 2001
maximum: 7525 mg/l March 2019

ANNUAL CYCLE
minimum: 2345 mg/l February, rel. stdev: 0.53
maximum: 6729 mg/l October, rel. stdev: 0.26







4 Methods for river load estimation

In this chapter a method for calculating daily nutrient loads will be presented. Based on a comparison of different methods for the calculation of yearly load estimates by De Vries & Klavers (1994), an appropriate method for calculating daily river loads of nutrients was deduced (de Vries, pers. com.) and the adopted method will be demonstrated.

There are several problems when calculating load estimates for substances transported by a river. Firstly there exists a spatially inhomogeneous distribution of the concentration across the river. A single inlet of kali salt, e.g. from an incoming river at the bank of the river Elbe, can be identified by a cross section tenth of kilometers downstream of the inlet (Bergemann, pers. comm.). Since in most cases only point measurements are available, we have to ignore this problem by simply assuming a spatially homogeneous distribution across the river. We therefore take the available discrete point measurements as representative for the whole cross-section of the river.

Secondly, one cannot expect to represent the inhomogenities of concentration values in time by one, two or four measurements per month. The question of temporal interpolation of concentration measurements in order to calculate yearly load estimates is dealt with in the paper by De Vries & Klavers (1994). For these yearly load estimates 7 interpolation methods were tested by De Vries & Klavers (1994), of which 3 will be discussed here. Finally a modified method for the use of calculating daily load estimates and the resulting formulae will be presented, using the following abbreviations:

C_i:	mean concentration at day i
Q_i:	mean discharge at day i
C_i^{LI}:	C_i if a concentration value is available for day i, otherwise linearly temporal interpolated concentration value
Q_i^{LI}:	Q_i if a discharge value is available for day i, otherwise linearly temporal interpolated discharge value
n:	number of days per year with concentration values
m:	number of days per year with discharge values
k:	number of days per year
L:	yearly load

(1) **Simple method**, using mean annual values for concentration and discharge

$$L = k(\frac{1}{n}\sum_{i=1}^{n} C_i)(\frac{1}{m}\sum_{i=1}^{m} Q_i)$$

(2) **Direct method**, using daily discharge and concentration values when available

$$L = \frac{k}{n} \sum_{i=1}^{n} C_i \cdot Q_i$$

For method (2) the discharge values have to be available for the same day as the concentration measurements. Only when both data are available for the same day the product for that day can be calculated.

(3) **Linear interpolation method**, using interpolated concentrations

$$L = \sum_{i=1}^{k} C_i^{LI} Q_i$$

For method (3) it has to be assumed that daily discharge values are available. Since the discharge data as presented in chapter 3 are not always available on a daily basis for all rivers an extended method of the linear interpolation method is presented:

(4) Double linear interpolation method, using daily interpolated values for discharge and concentration

$$L = \sum_{i=1}^{k} C_i^{LI} Q_i^{LI}$$

De Vries & Klavers (1994) investigated the quality of their load estimates using the terms accuracy and precision. Accuracy determines the distance from the yearly load as it would be measured. Precision is determined by the scattering of repeated calculations with randomly chosen days of measurement.

For the calculation of daily loads a maximum of temporal resolution and a maximum of accuracy and precision have to be combined. Because of this the **Double linear interpolation method** (4) has been chosen. The i-th term of the sum is identified with the daily load L_i

$$L_i = C_i^{LI} Q_i^{LI}$$

The **Simple method** (1) would not be appropriate as it smears out all temporal variability while the **Direct method** (2) has the disadvantage that a lot of discharge as well as concentration measurements have to be ignored. When daily values of discharge are available the discussion by De Vries & Klavers (1994) concerning the **Linear interpolation method** (3) can be adopted: In case of positive correlation between concentration and discharge the load will be underestimated. In case of negative correlation the load will be overestimated. If the concentration does not vary with varying discharge this method results in load estimates which would be similar to those resulting from calculations with daily concentration measurements. The reason for the systematical under- or overestimation results from the frequency distribution of the discharge values of almost all rivers: it is not symmetric and exhibits rare large events.

In the first report (Lenhart *et al.*, 1996) the correlation between discharge and nutrient concentration had been plotted for all the parameters. From these figures one can see that the correlation between nitrogen compounds and discharge is weakly positiv in most cases. Phosphorus compounds show in most cases a negative correlation. Silicate exhibits in most cases strongly positiv correlation. Following the discussion above we can conclude that the load estimates of nitrogen compounds will not result in a systematic error. The load estimates of phosphorus compounds may be overestimated. Silicate loads may be underestimated.

In the following chapter the resulting time series of daily load estimates together with the low-pass filtered curve will be presented in combination with their statistical properties, as it was done for the presentation of the raw data. In a separate figure, the climatological monthly means are added. In order to allow comparisons with literature values, e.g. the Quality Status Report 2000 (OSPAR, 2000), the results of the daily load calculations are given as yearly integrals for all available years.

Two final comments should be made. First, in the calculation of the mass, the units refer to the relevant elements N, P or Si, e.g. tons $NO_3 - N$ per day. Second, there are differences between the presented data and those from Lenhart *et al.* (1996), which are related to zero values for the load minimum. Since these values stem from zero discharge values which enter the load calculation, the related zero loads in this report should be taken as the realistic ones. Additionally negative discharge values for the Nieuwe Waterweg exist. They represent short events of North Sea outflow into the river system. These events could be found in the time series of discharge illustrated. The corresponding loads however were defined as zero.

5 Resulting river load estimates

5.1 Loads of River Elbe

Total Nitrogen load for River Elbe

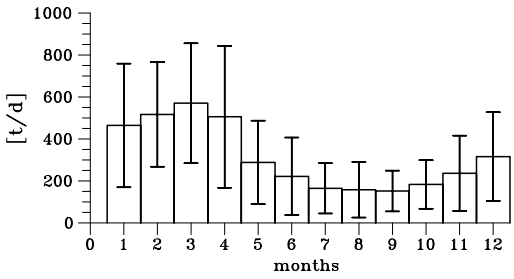
ANNUAL LOADS

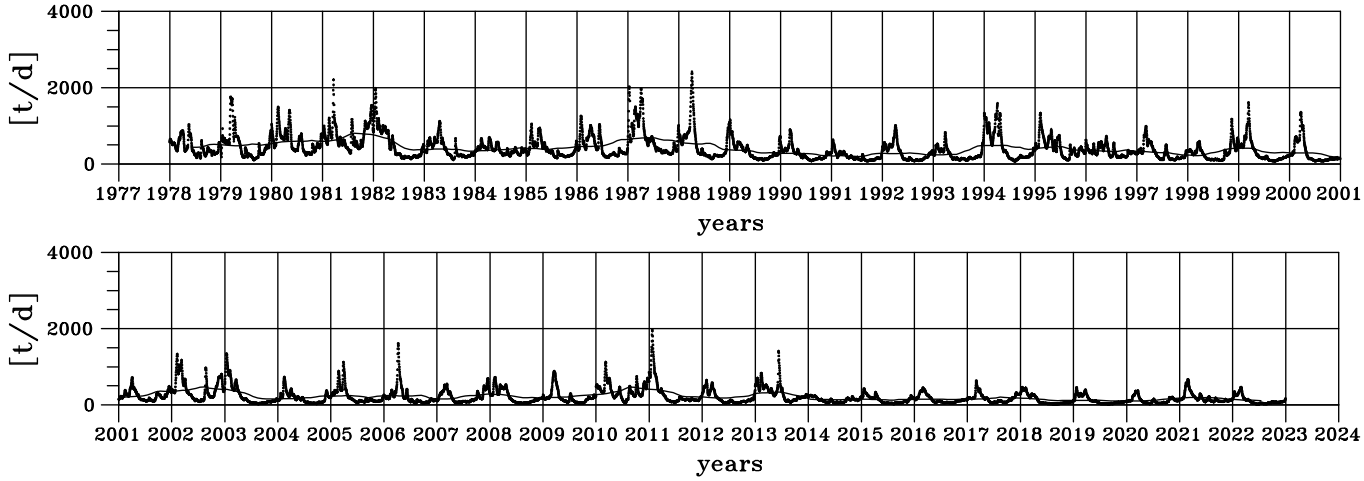
year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y
		1985	140.3	1993	94.3	2001	89.6	2009	74.6	2017	64.5
1978	160.6	1986	168.5	1994	175.1	2002	157.8	2010	138.8	2018	46.8
1979	182.6	1987	255.2	1995	165.3	2003	91.3	2011	111.3	2019	44.4
1980	217.4	1988	195.9	1996	121.8	2004	66.0	2012	66.8	2020	43.4
1981	273.7	1989	119.6	1997	109.3	2005	84.2	2013	121.8	2021	69.0
1982	185.1	1990	97.7	1998	110.0	2006	84.0	2014	47.9	2022	42.5
1983	140.4	1991	72.0	1999	116.7	2007	82.1	2015	48.7		
1984	138.3	1992	106.0	2000	103.7	2008	76.8	2016	53.8		

TIME SERIES
mean: 306.9 t/d
relative standard deviation: 0.92
minimum: 21.0 t/d July 1, 2022
maximum: 2419.3 t/d April 5, 1988

LOW PASS
minimum: 95.1 t/d December 2019
maximum: 805.6 t/d August 1981

ANNUAL CYCLE
minimum: 152.1 t/d September, rel. stdev: 0.64
maximum: 570.4 t/d March, rel. stdev: 0.50





Nitrate load for River Elbe

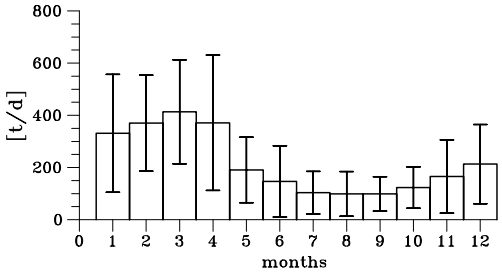
ANNUAL LOADS

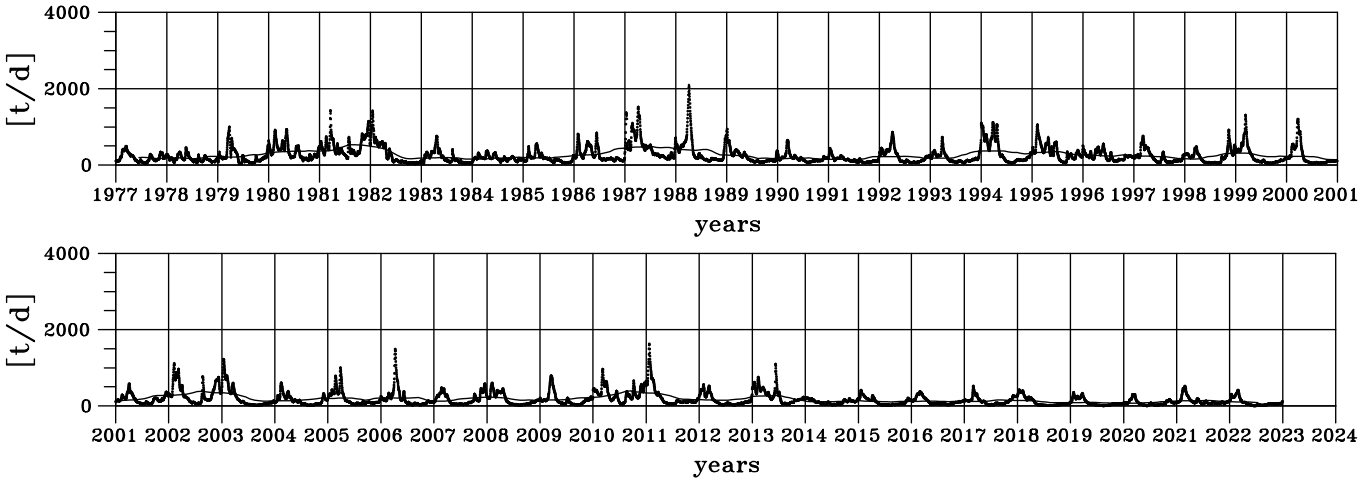
year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y
1977	71.0	1985	63.9	1993	69.7	2001	65.2	2009	60.9	2017	49.0
1978	62.1	1986	101.5	1994	132.6	2002	127.3	2010	118.5	2018	38.0
1979	83.1	1987	179.4	1995	127.8	2003	77.4	2011	91.1	2019	33.1
1980	131.8	1988	145.0	1996	87.9	2004	54.0	2012	53.8	2020	30.5
1981	180.6	1989	79.3	1997	78.5	2005	70.8	2013	99.4	2021	48.5
1982	102.0	1990	65.9	1998	81.0	2006	73.5	2014	38.0	2022	33.9
1983	70.3	1991	51.5	1999	87.0	2007	67.6	2015	41.7		
1984	67.5	1992	83.8	2000	79.6	2008	61.1	2016	44.2		

TIME SERIES
mean: 217.9 t/d
relative standard deviation: 0.96
minimum: 7.0 t/d June 9, 2020
maximum: 2090.8 t/d April 5, 1988

LOW PASS
minimum: 66.5 t/d December 2019
maximum: 537.7 t/d August 1981

ANNUAL CYCLE
minimum: 98.9 t/d September, rel. stdev: 0.67
maximum: 413.5 t/d March, rel. stdev: 0.48





Ammonium load for River Elbe

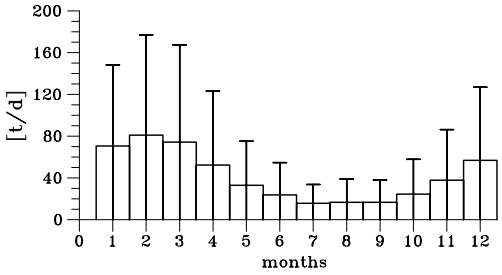
ANNUAL LOADS

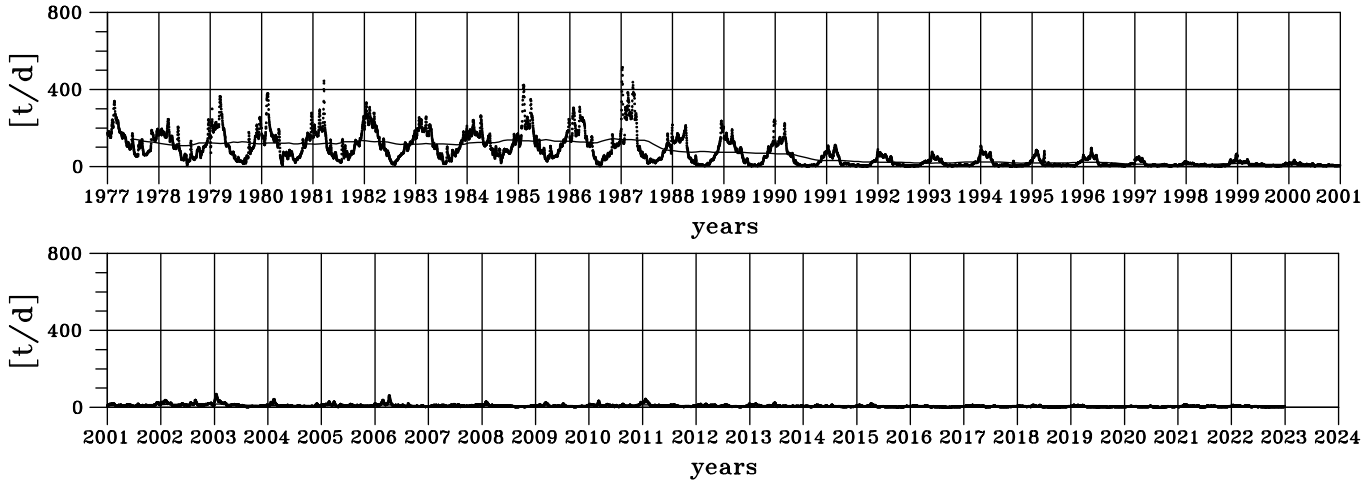
year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y
1977	51.3	1985	49.7	1993	7.1	2001	4.0	2009	2.8	2017	1.9
1978	39.3	1986	43.7	1994	7.7	2002	5.9	2010	3.8	2018	1.6
1979	46.3	1987	49.2	1995	7.0	2003	4.9	2011	3.9	2019	1.5
1980	43.7	1988	28.8	1996	7.2	2004	3.5	2012	2.9	2020	1.2
1981	43.3	1989	26.0	1997	4.7	2005	3.8	2013	3.0	2021	1.9
1982	45.4	1990	18.6	1998	4.5	2006	4.4	2014	2.0	2022	1.6
1983	43.0	1991	10.2	1999	4.2	2007	3.2	2015	1.9		
1984	45.0	1992	7.9	2000	3.4	2008	2.9	2016	1.4		

TIME SERIES
mean: 41.7 t/d
relative standard deviation: 1.55
minimum: 0.5 t/d August 31, 2020
maximum: 515.1 t/d January 10, 1987

LOW PASS
minimum: 3.0 t/d November 2019
maximum: 143.8 t/d November 1986

ANNUAL CYCLE
minimum: 15.6 t/d July, rel. stdev: 1.17
maximum: 81.0 t/d February, rel. stdev: 1.19





Total Phosphorus load for River Elbe

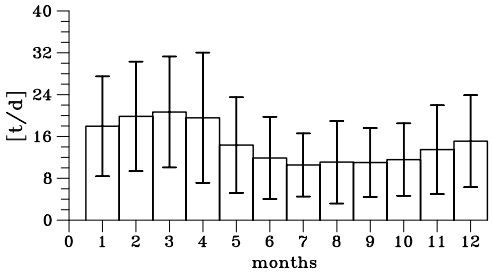
ANNUAL LOADS

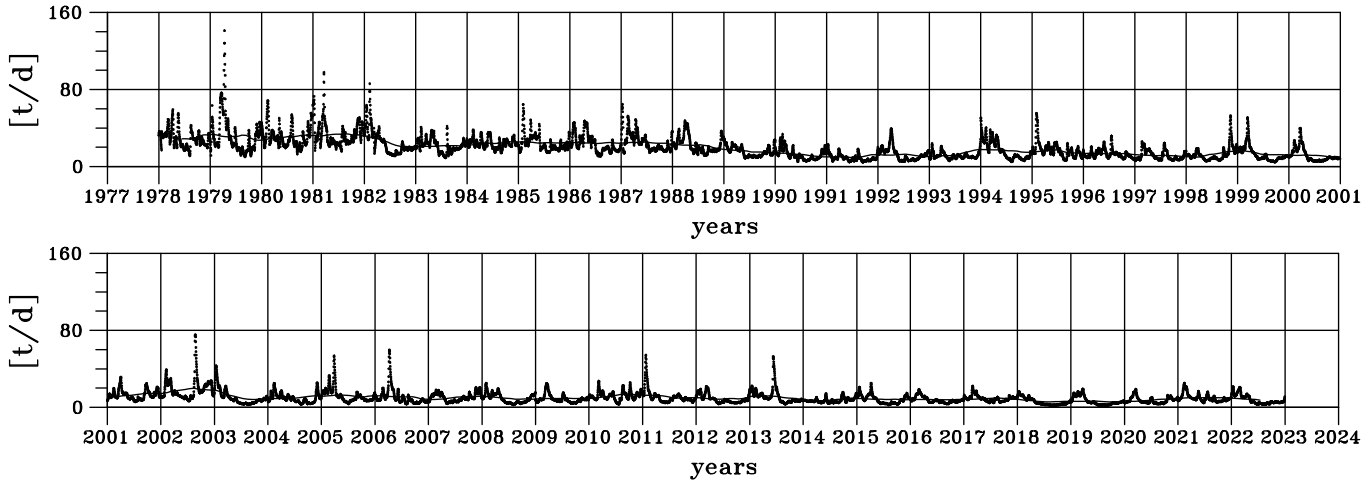
year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y
		1985	8.9	1993	4.1	2001	4.7	2009	3.2	2017	3.4
1978	10.5	1986	8.6	1994	6.1	2002	6.8	2010	4.4	2018	2.1
1979	11.6	1987	9.2	1995	6.2	2003	3.6	2011	4.0	2019	2.4
1980	11.3	1988	8.2	1996	4.8	2004	3.5	2012	3.2	2020	2.7
1981	12.2	1989	5.7	1997	4.2	2005	4.5	2013	4.2	2021	3.6
1982	8.9	1990	4.5	1998	4.6	2006	3.9	2014	2.7	2022	2.9
1983	7.9	1991	3.3	1999	4.6	2007	3.8	2015	3.1		
1984	8.8	1992	4.7	2000	4.3	2008	3.4	2016	2.8		

TIME SERIES
mean: 15.3 t/d
relative standard deviation: 4.27
minimum: 2.0 t/d September 4, 2019
maximum: 141.0 t/d April 12, 1979

LOW PASS
minimum: 5.6 t/d August 2018
maximum: 34.0 t/d August 1981

ANNUAL CYCLE
minimum: 10.6 t/d July, rel. stdev: 0.57
maximum: 20.7 t/d March, rel. stdev: 0.51





Phosphate load for River Elbe

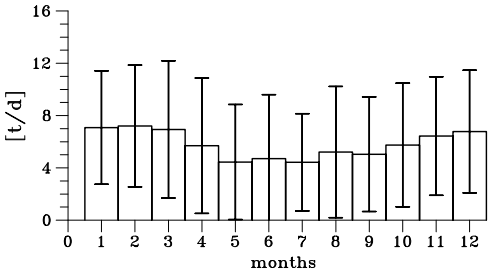
ANNUAL LOADS

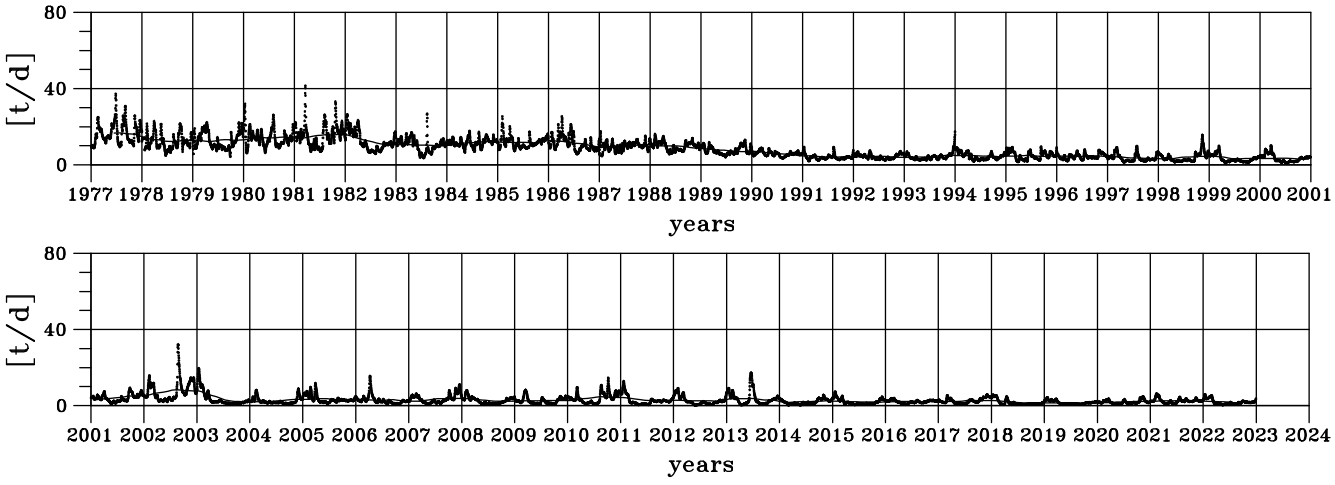
year	t/y	year	t/y	year	t/y	year	t/y	year	t/y	year	t/y
1977	6046	1985	4306	1993	1537	2001	1503	2009	949	2017	926
1978	4456	1986	4147	1994	1642	2002	2828	2010	1502	2018	581
1979	4651	1987	3609	1995	1786	2003	1277	2011	1007	2019	570
1980	5152	1988	3624	1996	1624	2004	894	2012	927	2020	705
1981	5649	1989	2767	1997	1318	2005	1280	2013	1383	2021	924
1982	4501	1990	2120	1998	1450	2006	1044	2014	704	2022	700
1983	3775	1991	1457	1999	1155	2007	1322	2015	738		
1984	4283	1992	1598	2000	1267	2008	967	2016	770		

TIME SERIES
mean: 5.8 t/d
relative standard deviation: 0.87
minimum: 0.2 t/d March 3, 2014
maximum: 41.4 t/d March 20, 1981

LOW PASS
minimum: 1.4 t/d September 2019
maximum: 16.7 t/d July 1977

ANNUAL CYCLE
minimum: 4.4 t/d July, rel. stdev: 0.84
maximum: 7.2 t/d February, rel. stdev: 0.65





Silicate load for River Elbe

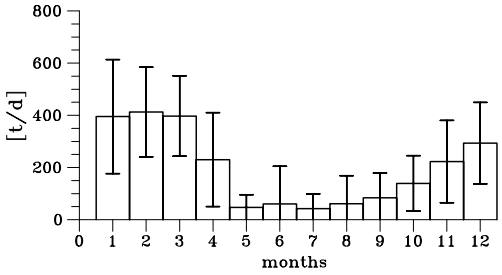
ANNUAL LOADS

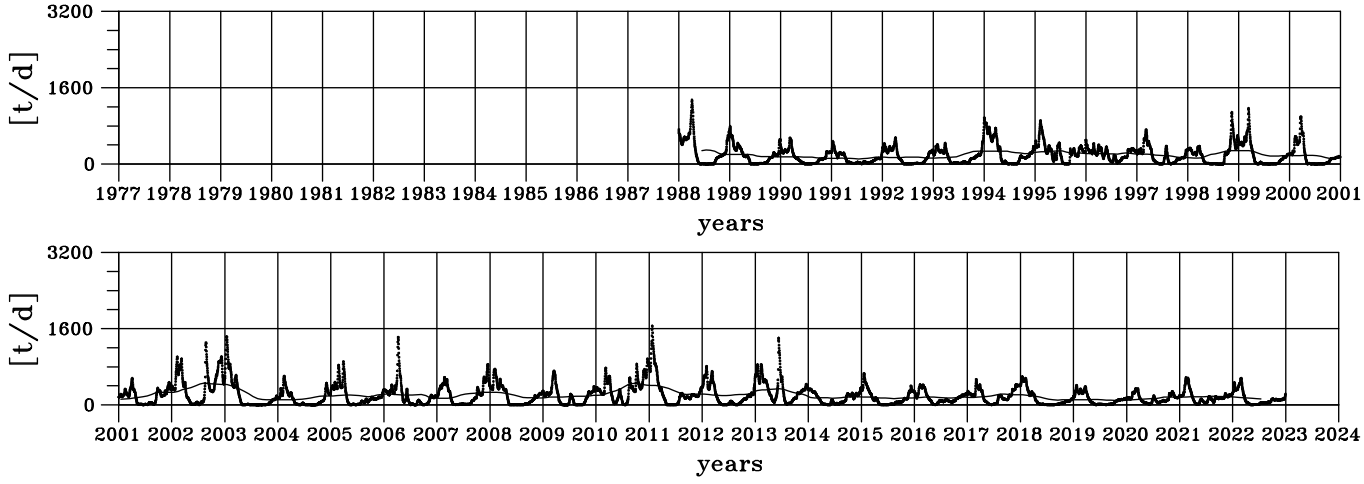
year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y
				1993	57.5	2001	65.7	2009	62.1	2017	72.2
				1994	95.8	2002	150.2	2010	127.0	2018	46.6
				1995	100.4	2003	75.2	2011	105.3	2019	41.5
		1988	106.9	1996	78.0	2004	46.8	2012	71.8	2020	48.8
		1989	66.9	1997	63.8	2005	72.1	2013	123.4	2021	61.7
		1990	53.0	1998	76.3	2006	74.4	2014	49.7	2022	47.8
		1991	38.9	1999	68.1	2007	80.7	2015	54.2		
		1992	54.7	2000	64.3	2008	68.5	2016	55.9		

TIME SERIES
mean: 151.7 t/d
relative standard deviation: 1.34
minimum: 0.5 t/d July 3, 2000
maximum: 1655.9 t/d January 23, 2011

LOW PASS
minimum: 93.0 t/d November 2019
maximum: 459.9 t/d August 2002

ANNUAL CYCLE
minimum: 41.9 t/d July, rel. stdev: 1.37
maximum: 412.2 t/d February, rel. stdev: 0.42





Total Alkalinity load for River Elbe

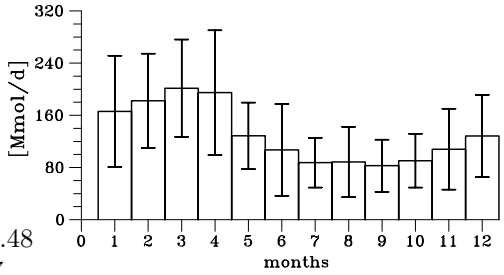
ANNUAL LOADS

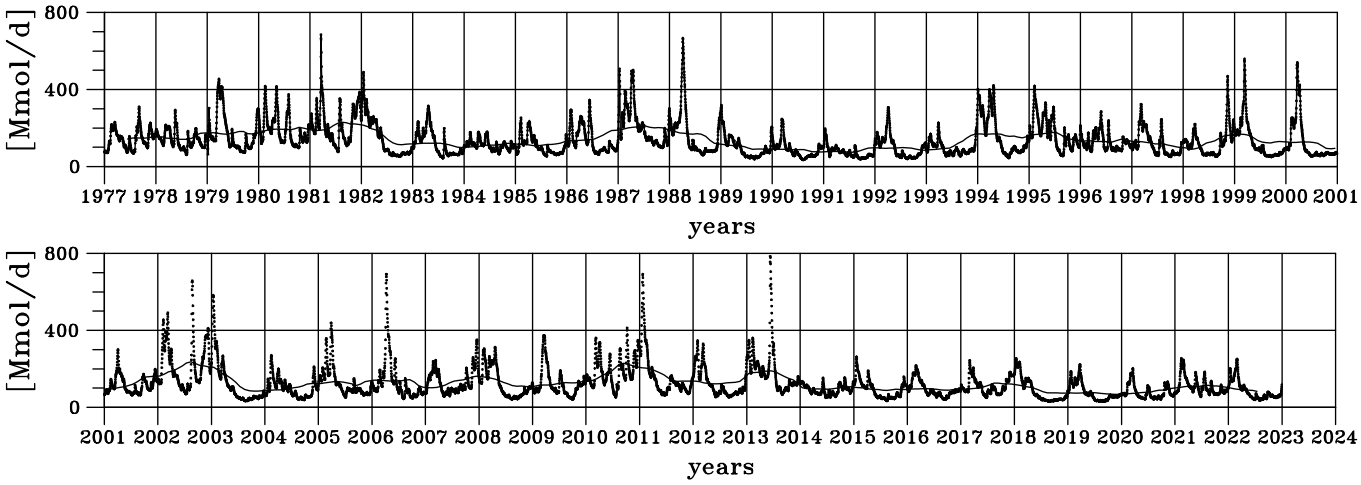
year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y
1977	52.2	1985	39.2	1993	35.9	2001	42.5	2009	44.8	2017	40.6
1978	51.3	1986	50.4	1994	60.5	2002	80.0	2010	69.4	2018	31.1
1979	63.9	1987	77.1	1995	63.9	2003	44.2	2011	58.6	2019	28.4
1980	70.1	1988	61.8	1996	47.2	2004	36.1	2012	44.9	2020	28.8
1981	79.7	1989	36.6	1997	42.8	2005	47.1	2013	69.2	2021	39.9
1982	52.8	1990	31.4	1998	45.7	2006	49.7	2014	33.4	2022	31.2
1983	43.8	1991	26.9	1999	47.4	2007	49.1	2015	34.0		
1984	41.1	1992	36.4	2000	45.8	2008	45.4	2016	34.4		

TIME SERIES
mean: 130.1 Mmol/d
relative standard deviation: 0.65
minimum: 30.8 Mmol/d September 8, 2019
maximum: 784.5 Mmol/d June 11, 2013

LOW PASS
minimum: 66.9 Mmol/d December 2019
maximum: 237.0 Mmol/d August 2002

ANNUAL CYCLE
minimum: 82.7 Mmol/d September, rel. stdev: 0.48
maximum: 201.5 Mmol/d March, rel. stdev: 0.37





Dissolved Inorganic Carbon load for River Elbe

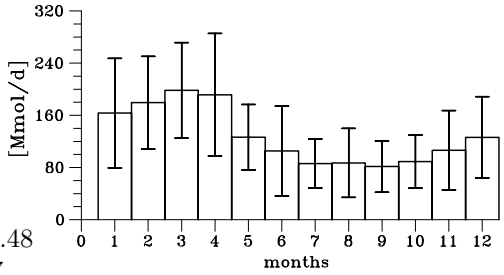
ANNUAL LOADS

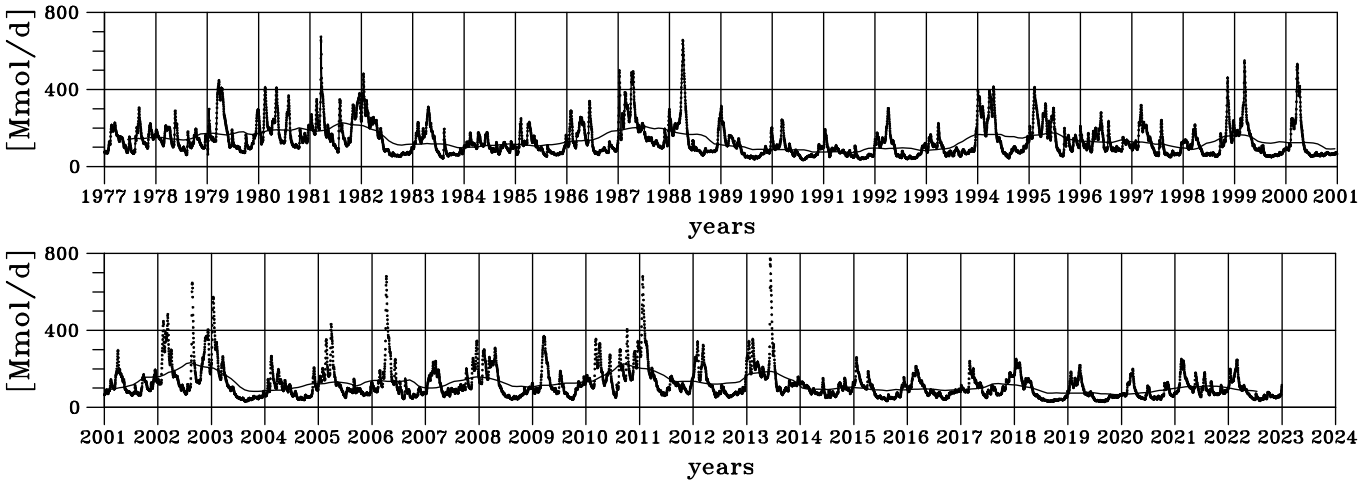
year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y
1977	51.4	1985	38.6	1993	35.3	2001	41.8	2009	44.0	2017	40.0
1978	50.4	1986	49.5	1994	59.6	2002	78.7	2010	68.2	2018	30.6
1979	62.9	1987	75.8	1995	62.9	2003	43.5	2011	57.7	2019	27.9
1980	68.9	1988	60.8	1996	46.5	2004	35.5	2012	44.2	2020	28.3
1981	78.4	1989	36.0	1997	42.1	2005	46.4	2013	68.1	2021	39.2
1982	52.0	1990	30.9	1998	44.9	2006	48.9	2014	32.9	2022	30.7
1983	43.1	1991	26.4	1999	46.6	2007	48.3	2015	33.4		
1984	40.4	1992	35.8	2000	45.1	2008	44.7	2016	33.9		

TIME SERIES
mean: 128.0 Mmol/d
relative standard deviation: 0.65
minimum: 30.3 Mmol/d September 8, 2019
maximum: 771.9 Mmol/d June 11, 2013

LOW PASS
minimum: 65.8 Mmol/d December 2019
maximum: 233.1 Mmol/d August 2002

ANNUAL CYCLE
minimum: 81.4 Mmol/d September, rel. stdev: 0.48
maximum: 198.2 Mmol/d March, rel. stdev: 0.37





Dissolved Organic Carbon load for River Elbe

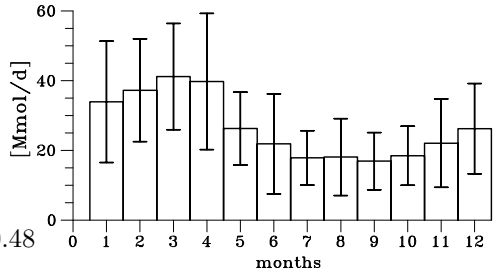
ANNUAL LOADS

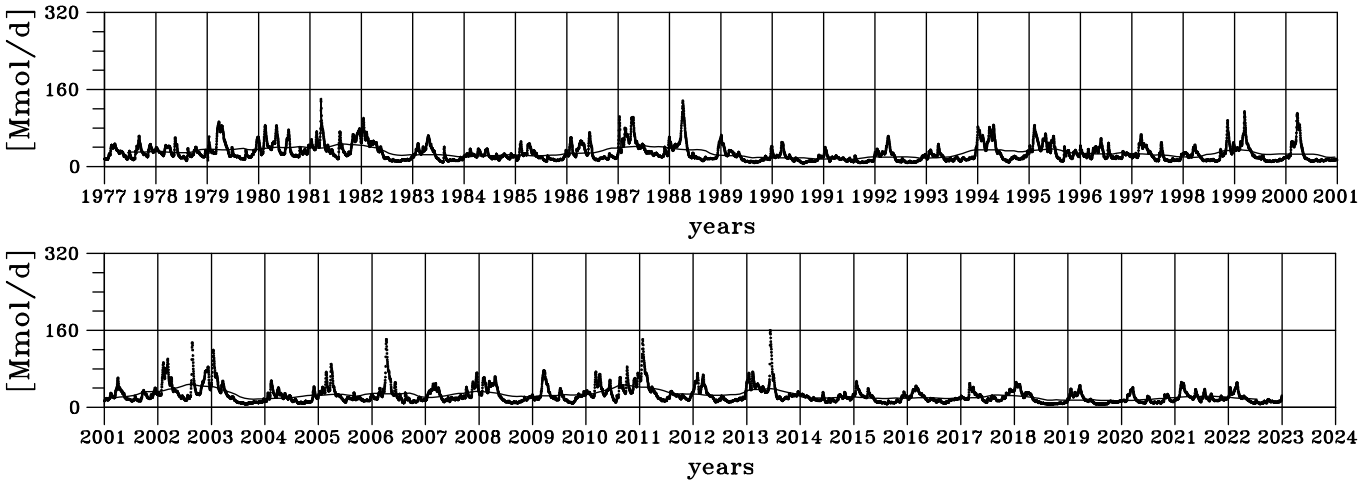
year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y
1977	10.7	1985	8.0	1993	7.3	2001	8.7	2009	9.2	2017	8.3
1978	10.5	1986	10.3	1994	12.4	2002	16.3	2010	14.2	2018	6.3
1979	13.1	1987	15.7	1995	13.1	2003	9.0	2011	12.0	2019	5.8
1980	14.3	1988	12.6	1996	9.7	2004	7.4	2012	9.2	2020	5.9
1981	16.3	1989	7.5	1997	8.8	2005	9.6	2013	14.1	2021	8.2
1982	10.8	1990	6.4	1998	9.3	2006	10.2	2014	6.8	2022	6.4
1983	9.0	1991	5.5	1999	9.7	2007	10.0	2015	6.9		
1984	8.4	1992	7.4	2000	9.4	2008	9.3	2016	7.0		

TIME SERIES
mean: 26.6 Mmol/d
relative standard deviation: 0.65
minimum: 6.3 Mmol/d September 8, 2019
maximum: 160.4 Mmol/d June 11, 2013

LOW PASS
minimum: 13.7 Mmol/d December 2019
maximum: 48.4 Mmol/d August 2002

ANNUAL CYCLE
minimum: 16.9 Mmol/d September, rel. stdev: 0.48
maximum: 41.2 Mmol/d March, rel. stdev: 0.37





5.2 Loads of River Weser

Total Nitrogen load for River Weser

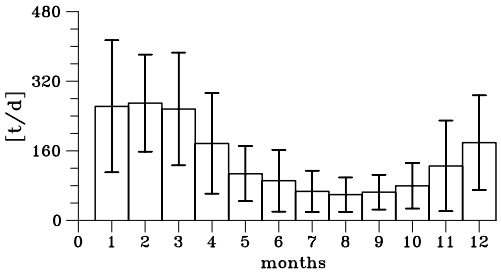
ANNUAL LOADS

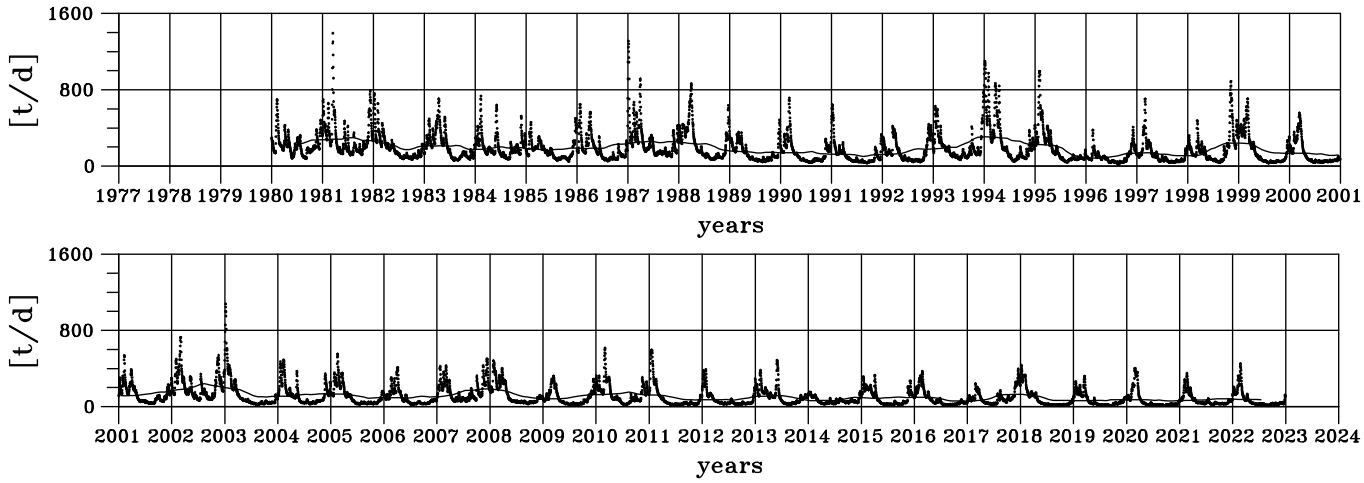
year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y
		1985	59.4	1993	73.5	2001	47.1	2009	33.6	2017	36.0
		1986	64.7	1994	103.4	2002	78.4	2010	50.0	2018	29.8
		1987	96.8	1995	71.8	2003	47.4	2011	33.7	2019	24.9
1980	81.5	1988	87.1	1996	35.9	2004	47.7	2012	27.7	2020	24.6
1981	109.2	1989	50.8	1997	44.1	2005	40.9	2013	42.1	2021	25.6
1982	70.1	1990	50.9	1998	67.8	2006	32.4	2014	23.2	2022	26.9
1983	76.2	1991	43.3	1999	60.2	2007	60.4	2015	34.7		
1984	75.2	1992	55.6	2000	45.9	2008	46.5	2016	29.6		

TIME SERIES
mean: 136.6 t/d
relative standard deviation: 1.00
minimum: 10.3 t/d September 6, 2022
maximum: 1392.4 t/d March 16, 1981

LOW PASS
minimum: 56.3 t/d January 2017
maximum: 308.0 t/d January 1994

ANNUAL CYCLE
minimum: 59.4 t/d August, rel. stdev: 0.66
maximum: 269.5 t/d February, rel. stdev: 0.41





Nitrate load for River Weser

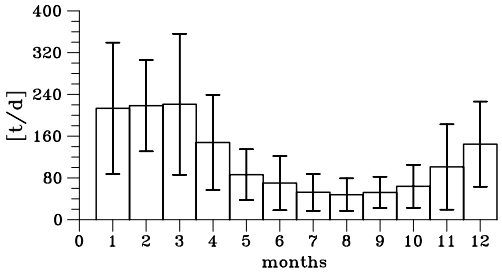
ANNUAL LOADS

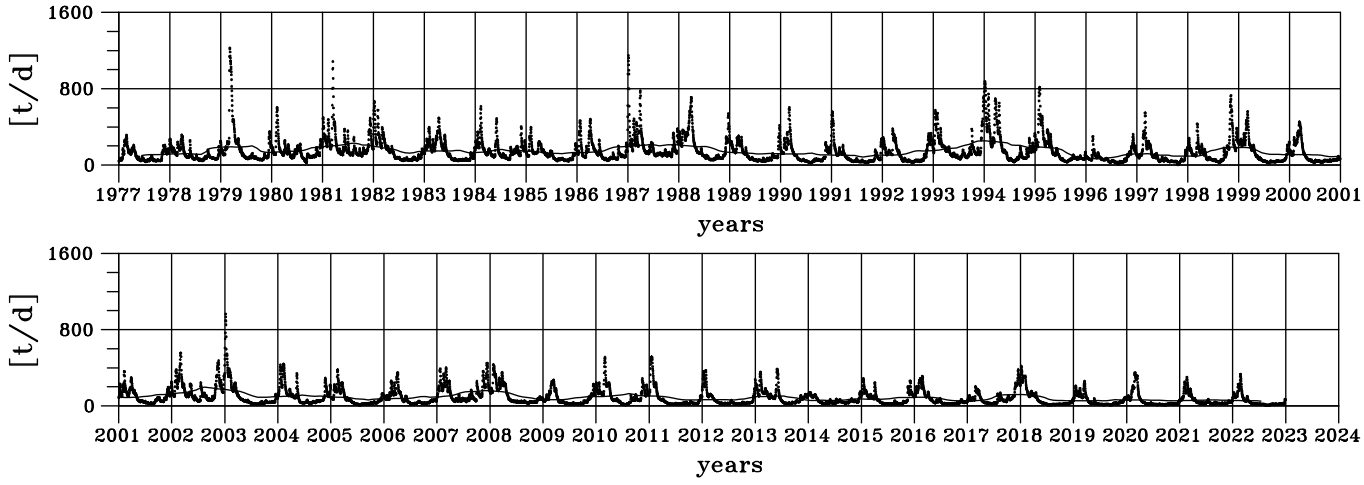
year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y
1977	36.7	1985	42.2	1993	67.2	2001	36.1	2009	27.0	2017	32.4
1978	41.6	1986	51.1	1994	81.3	2002	61.4	2010	40.5	2018	27.7
1979	70.9	1987	79.8	1995	59.7	2003	41.6	2011	28.1	2019	20.5
1980	52.0	1988	72.1	1996	29.3	2004	42.1	2012	24.4	2020	21.6
1981	80.9	1989	42.6	1997	36.3	2005	27.1	2013	37.7	2021	22.0
1982	54.2	1990	41.5	1998	57.0	2006	27.7	2014	20.3	2022	18.5
1983	53.1	1991	35.8	1999	45.1	2007	53.4	2015	27.9		
1984	60.1	1992	44.9	2000	38.1	2008	40.6	2016	27.4		

TIME SERIES
mean: 117.8 t/d
relative standard deviation: 0.97
minimum: 3.7 t/d October 23, 1997
maximum: 1227.0 t/d March 7, 1979

LOW PASS
minimum: 49.7 t/d July 2022
maximum: 253.3 t/d December 1993

ANNUAL CYCLE
minimum: 48.0 t/d August, rel. stdev: 0.65
maximum: 221.0 t/d March, rel. stdev: 0.61





Ammonium load for River Weser

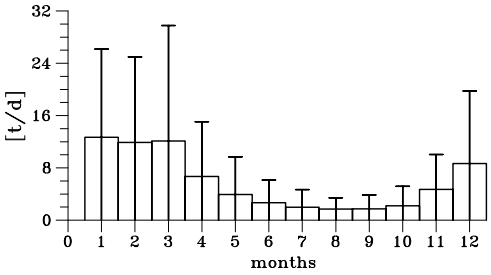
ANNUAL LOADS

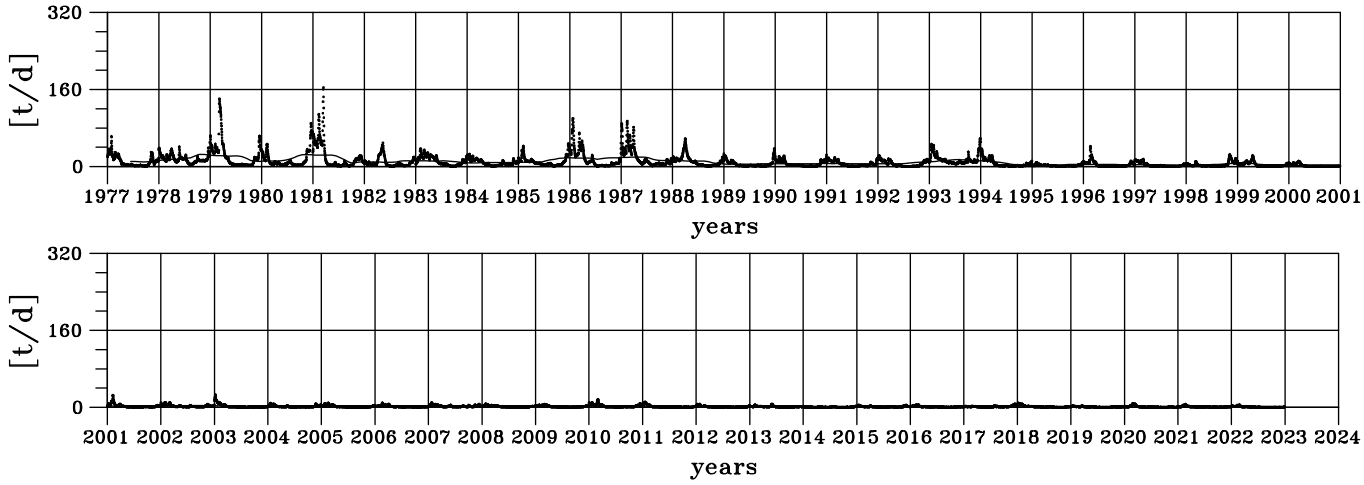
year	t/y	year	t/y	year	t/y	year	t/y	year	t/y	year	t/y
1977	3882	1985	3781	1993	5457	2001	1048	2009	634	2017	595
1978	5909	1986	5796	1994	2378	2002	1065	2010	1088	2018	608
1979	8198	1987	6997	1995	868	2003	974	2011	582	2019	359
1980	5117	1988	4097	1996	1599	2004	778	2012	476	2020	459
1981	7208	1989	1980	1997	1251	2005	722	2013	572	2021	408
1982	3104	1990	2028	1998	1556	2006	656	2014	228	2022	348
1983	4198	1991	2036	1999	1448	2007	950	2015	480		
1984	2882	1992	2145	2000	824	2008	654	2016	465		

TIME SERIES
mean: 5.9 t/d
relative standard deviation: 1.82
minimum: 0.2 t/d September 6, 2022
maximum: 163.8 t/d March 16, 1981

LOW PASS
minimum: 0.6 t/d June 2014
maximum: 24.9 t/d November 1978

ANNUAL CYCLE
minimum: 1.7 t/d August, rel. stdev: 1.02
maximum: 12.7 t/d January, rel. stdev: 1.06





Total Phosphorus load for River Weser

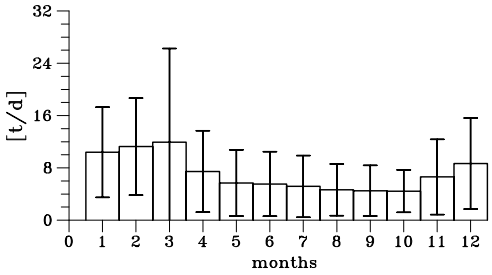
ANNUAL LOADS

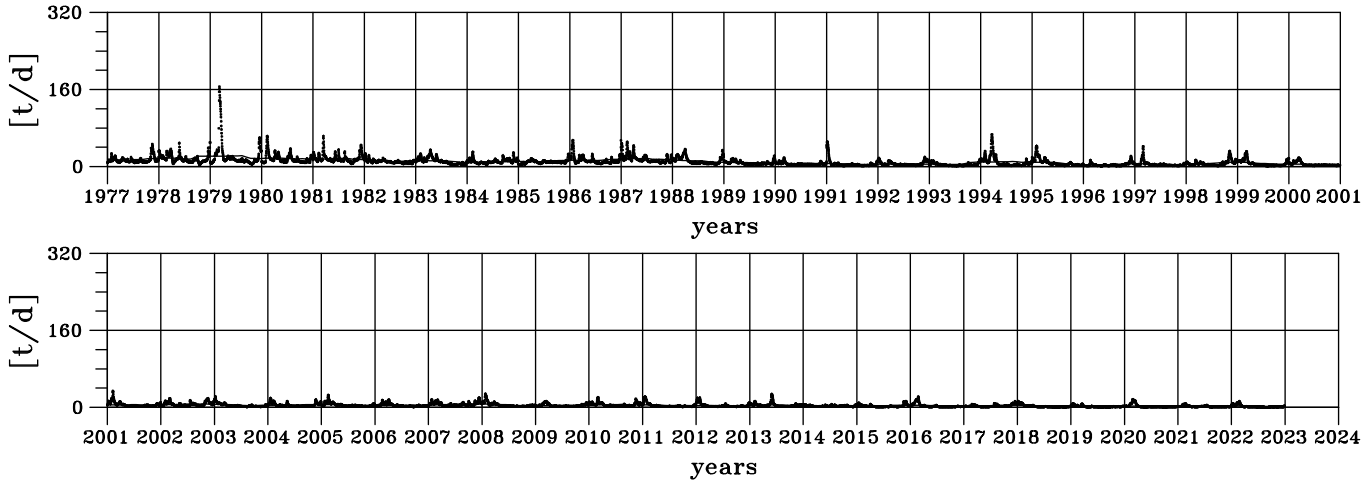
year	t/y	year	t/y	year	t/y	year	t/y	year	t/y	year	t/y
1977	5031	1985	3505	1993	1469	2001	1973	2009	1447	2017	1180
1978	5996	1986	4793	1994	3593	2002	2488	2010	1977	2018	888
1979	8088	1987	5952	1995	2958	2003	1481	2011	1389	2019	694
1980	5837	1988	4465	1996	1434	2004	1856	2012	1416	2020	908
1981	6289	1989	2790	1997	1759	2005	1847	2013	1788	2021	714
1982	3806	1990	1964	1998	2443	2006	1484	2014	1079	2022	762
1983	4181	1991	2058	1999	2278	2007	2427	2015	1076		
1984	4048	1992	2179	2000	1662	2008	1815	2016	1202		

TIME SERIES
mean: 7.2 t/d
relative standard deviation: 1.13
minimum: 0.3 t/d September 6, 2022
maximum: 165.7 t/d March 7, 1979

LOW PASS
minimum: 1.6 t/d October 2020
maximum: 22.4 t/d August 1979

ANNUAL CYCLE
minimum: 4.4 t/d October, rel. stdev: 0.73
maximum: 11.9 t/d March, rel. stdev: 1.20





Phosphate load for River Weser

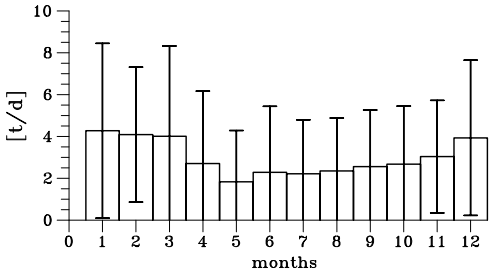
ANNUAL LOADS

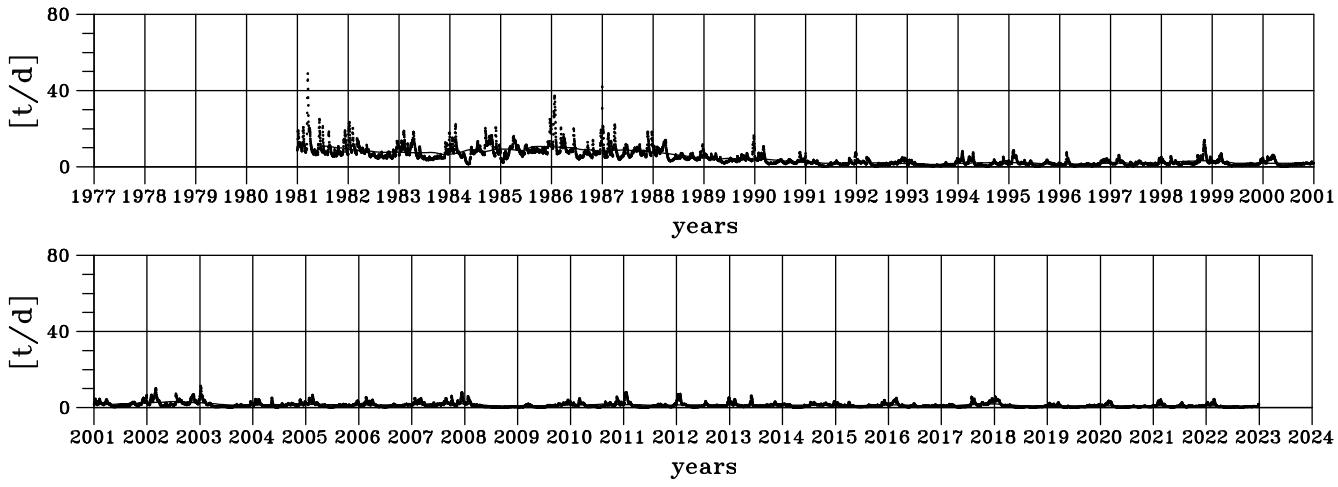
year	t/y	year	t/y	year	t/y	year	t/y	year	t/y	year	t/y
		1985	3260	1993	420	2001	715	2009	383	2017	547
		1986	3541	1994	774	2002	1112	2010	547	2018	356
		1987	3165	1995	711	2003	539	2011	472	2019	287
		1988	2240	1996	595	2004	596	2012	533	2020	285
1981	3953	1989	1597	1997	682	2005	569	2013	539	2021	364
1982	2914	1990	1176	1998	1069	2006	494	2014	457	2022	284
1983	2691	1991	670	1999	656	2007	848	2015	405		
1984	3259	1992	774	2000	694	2008	317	2016	424		

TIME SERIES
mean: 3.4 t/d
relative standard deviation: 2.64
minimum: 0.1 t/d April 16, 2014
maximum: 48.9 t/d March 16, 1981

LOW PASS
minimum: 0.5 t/d December 2008
maximum: 10.9 t/d July 1981

ANNUAL CYCLE
minimum: 1.8 t/d May, rel. stdev: 1.33
maximum: 4.3 t/d January, rel. stdev: 0.98





Silicate load for River Weser

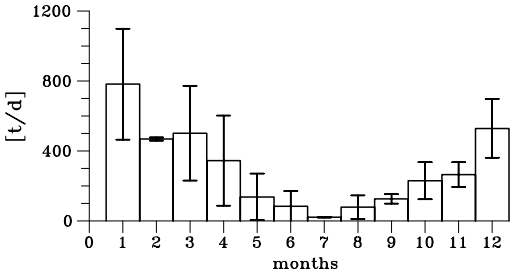
ANNUAL LOADS

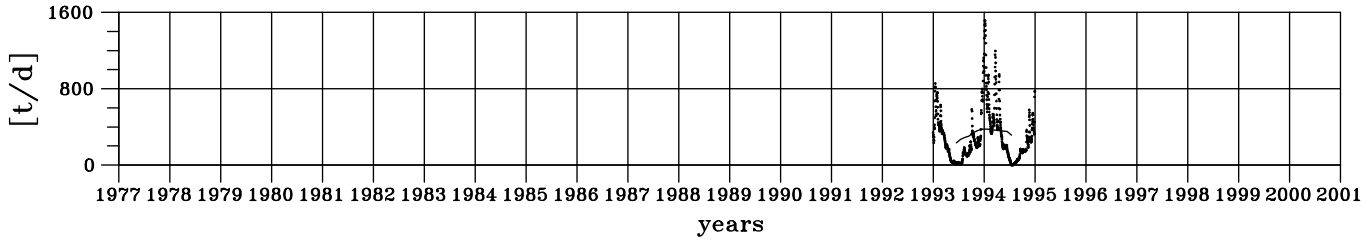
year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y
				1993	91.6						
				1994	125.0						

TIME SERIES
mean: 35.9 t/d
relative standard deviation: 3.70
minimum: 1.7 t/d July 14, 1994
maximum: 1514.5 t/d January 7, 1994

LOW PASS
minimum: 234.3 t/d June 1993
maximum: 378.1 t/d January 1994

ANNUAL CYCLE
minimum: 21.1 t/d July, rel. stdev: 0.12
maximum: 782.1 t/d January, rel. stdev: 0.41





5.3 Loads of River Ems

Total Nitrogen load for River Ems

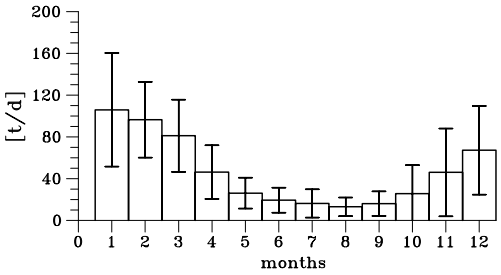
ANNUAL LOADS

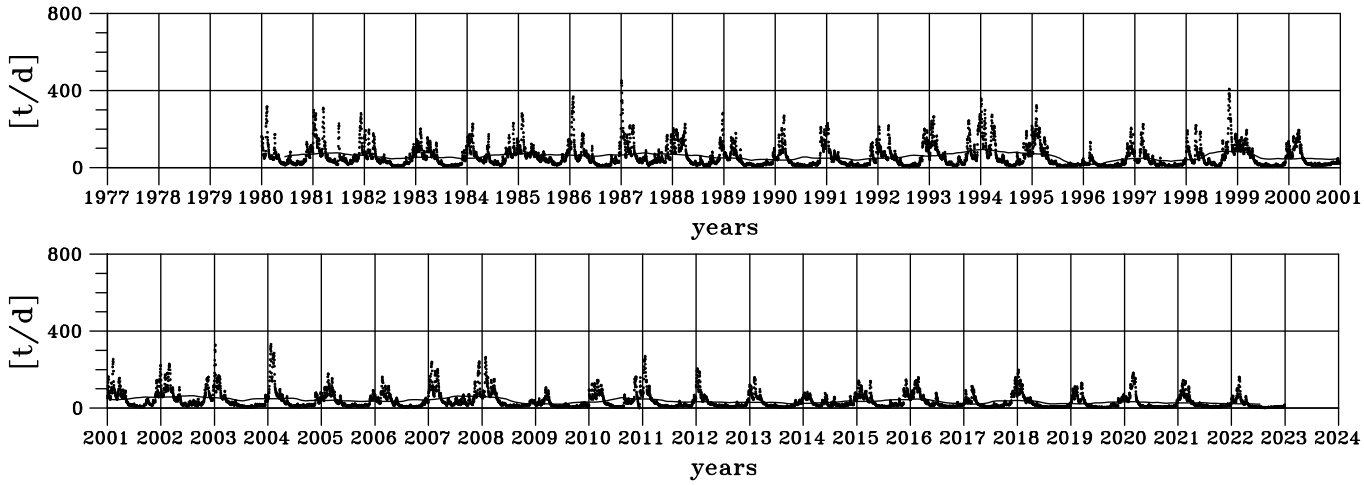
year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y
		1985	22.9	1993	27.5	2001	19.4	2009	6.9	2017	11.3
		1986	21.4	1994	28.5	2002	22.1	2010	16.9	2018	9.8
		1987	28.2	1995	19.6	2003	13.7	2011	12.6	2019	10.0
1980	20.8	1988	24.5	1996	11.8	2004	18.9	2012	11.9	2020	10.3
1981	29.3	1989	13.8	1997	12.0	2005	14.2	2013	10.6	2021	9.9
1982	16.5	1990	18.8	1998	28.3	2006	11.6	2014	10.3	2022	7.3
1983	18.5	1991	14.9	1999	17.1	2007	22.9	2015	14.7		
1984	24.0	1992	20.6	2000	16.2	2008	15.5	2016	13.0		

TIME SERIES
mean: 45.7 t/d
relative standard deviation: 2.12
minimum: 0.4 t/d December 9, 2010
maximum: 451.0 t/d January 4, 1987

LOW PASS
minimum: 17.1 t/d February 1996
maximum: 93.3 t/d January 1994

ANNUAL CYCLE
minimum: 13.1 t/d August, rel. stdev: 0.68
maximum: 105.9 t/d January, rel. stdev: 0.51





Nitrate load for River Ems

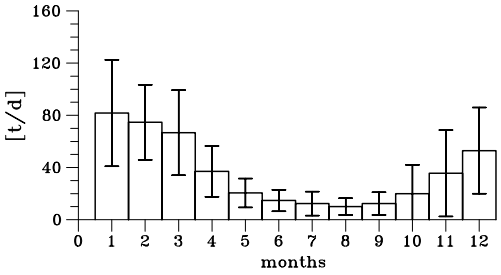
ANNUAL LOADS

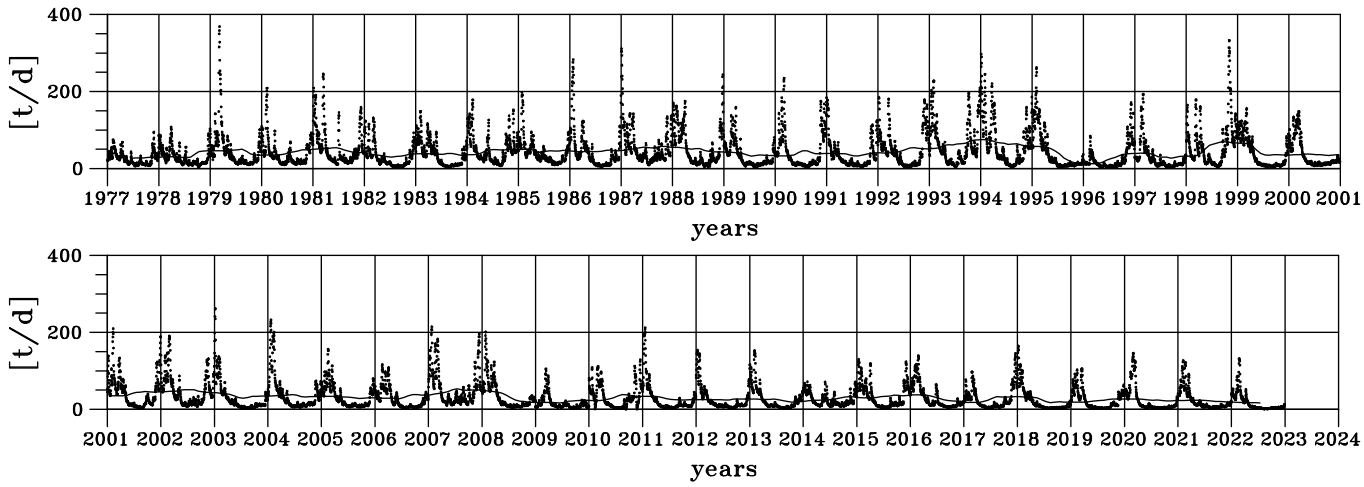
year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y
1977	9.4	1985	15.0	1993	22.5	2001	15.9	2009	5.9	2017	9.7
1978	10.7	1986	16.0	1994	23.3	2002	17.5	2010	11.6	2018	8.0
1979	17.6	1987	20.5	1995	15.4	2003	10.6	2011	9.6	2019	8.5
1980	13.9	1988	19.8	1996	9.4	2004	14.5	2012	9.4	2020	8.3
1981	20.2	1989	11.7	1997	9.8	2005	11.8	2013	9.4	2021	8.4
1982	10.6	1990	16.0	1998	23.1	2006	9.6	2014	8.9	2022	6.1
1983	13.2	1991	12.1	1999	13.5	2007	19.8	2015	12.4		
1984	18.0	1992	17.4	2000	12.9	2008	12.3	2016	11.0		

TIME SERIES
mean: 36.4 t/d
relative standard deviation: 1.11
minimum: 0.2 t/d September 9, 2010
maximum: 368.5 t/d March 8, 1979

LOW PASS
minimum: 12.6 t/d February 1996
maximum: 75.4 t/d January 1994

ANNUAL CYCLE
minimum: 10.0 t/d August, rel. stdev: 0.64
maximum: 81.7 t/d January, rel. stdev: 0.50





Ammonium load for River Ems

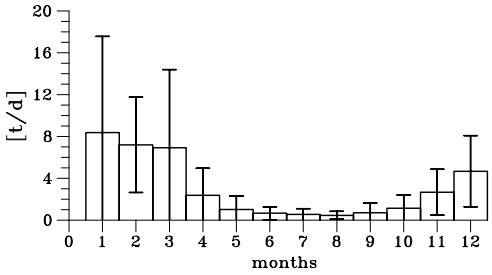
ANNUAL LOADS

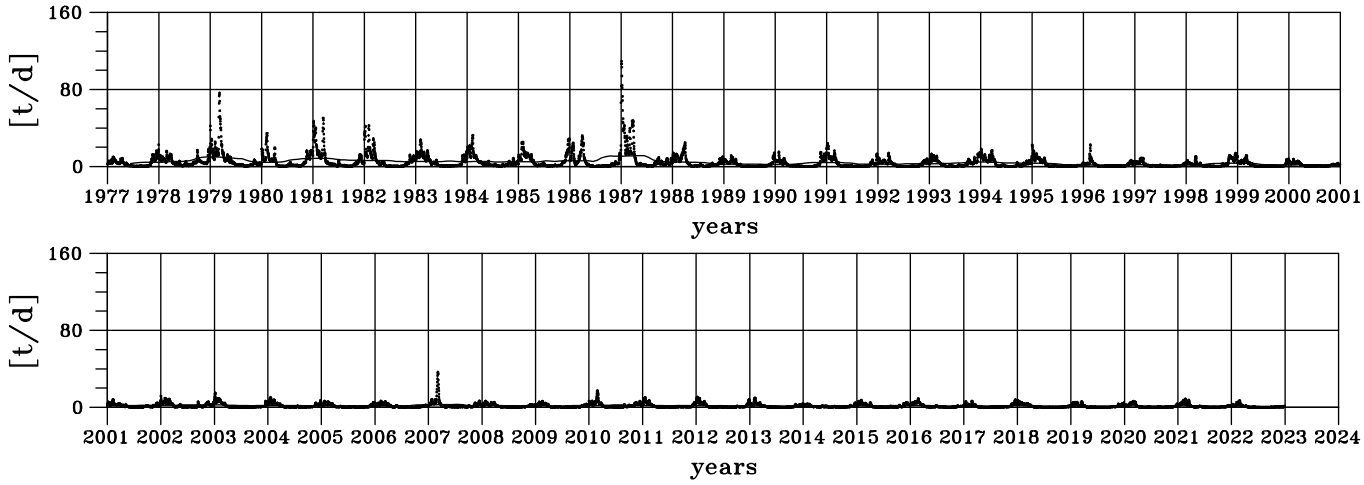
year	t/y	year	t/y	year	t/y	year	t/y	year	t/y	year	t/y
1977	1294	1985	2175	1993	1340	2001	658	2009	473	2017	515
1978	1886	1986	1824	1994	1326	2002	870	2010	863	2018	434
1979	3122	1987	4090	1995	996	2003	694	2011	583	2019	482
1980	2057	1988	1604	1996	695	2004	718	2012	632	2020	414
1981	2714	1989	866	1997	607	2005	516	2013	554	2021	517
1982	2308	1990	1034	1998	1098	2006	519	2014	372	2022	348
1983	1868	1991	1267	1999	722	2007	1088	2015	602		
1984	1814	1992	935	2000	619	2008	565	2016	562		

TIME SERIES
mean: 3.0 t/d
relative standard deviation: 1.80
minimum: 0.1 t/d August 5, 1990
maximum: 109.2 t/d January 4, 1987

LOW PASS
minimum: 0.9 t/d July 2022
maximum: 11.4 t/d May 1987

ANNUAL CYCLE
minimum: 0.5 t/d August, rel. stdev: 0.81
maximum: 8.4 t/d January, rel. stdev: 1.09





Total Phosphorus load for River Ems

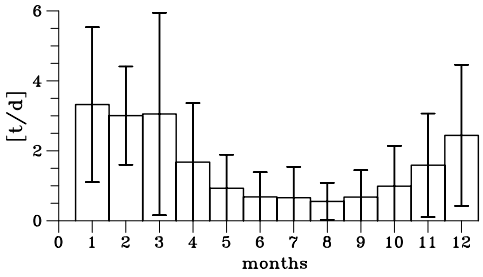
ANNUAL LOADS

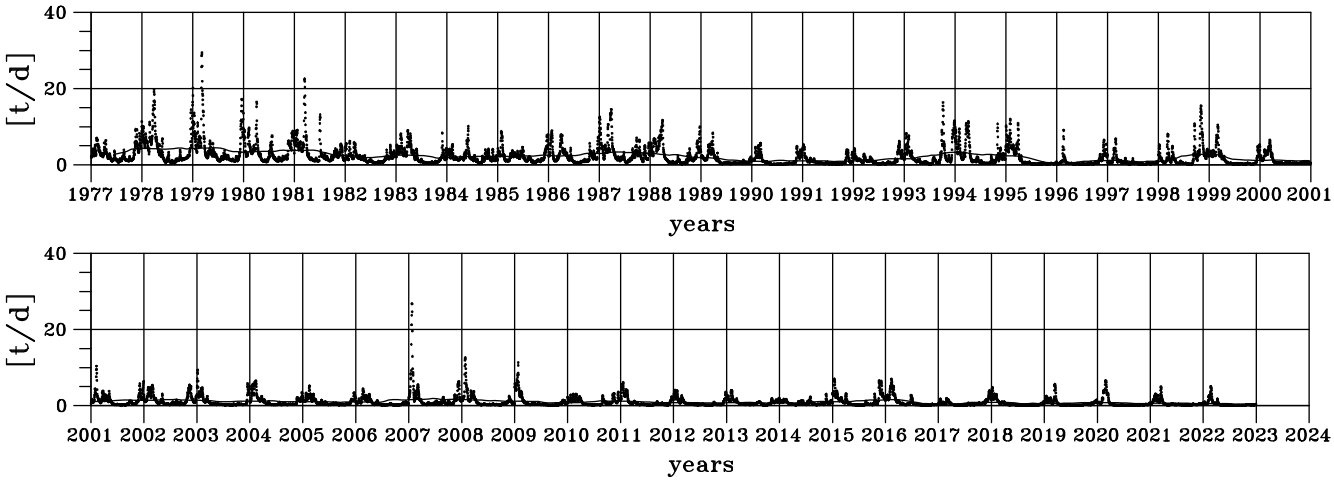
year	t/y	year	t/y	year	t/y	year	t/y	year	t/y	year	t/y
1977	1028	1985	827	1993	896	2001	520	2009	385	2017	233
1978	1495	1986	870	1994	929	2002	546	2010	375	2018	215
1979	1653	1987	1214	1995	637	2003	389	2011	337	2019	236
1980	1257	1988	1004	1996	336	2004	434	2012	279	2020	250
1981	1285	1989	459	1997	268	2005	365	2013	303	2021	224
1982	675	1990	410	1998	851	2006	276	2014	243	2022	174
1983	880	1991	353	1999	538	2007	738	2015	500		
1984	762	1992	439	2000	397	2008	457	2016	370		

TIME SERIES
mean: 1.6 t/d
relative standard deviation: 1.36
minimum: 0.0 t/d July 17, 2019
maximum: 29.4 t/d March 8, 1979

LOW PASS
minimum: 0.4 t/d February 2017
maximum: 4.4 t/d June 1979

ANNUAL CYCLE
minimum: 0.6 t/d August, rel. stdev: 0.96
maximum: 3.3 t/d January, rel. stdev: 0.67





Phosphate load for River Ems

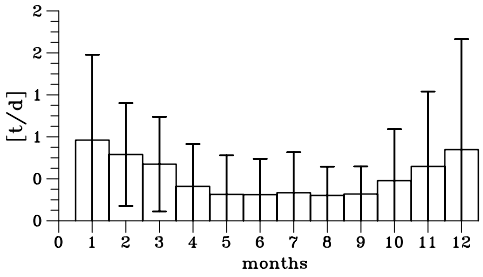
ANNUAL LOADS

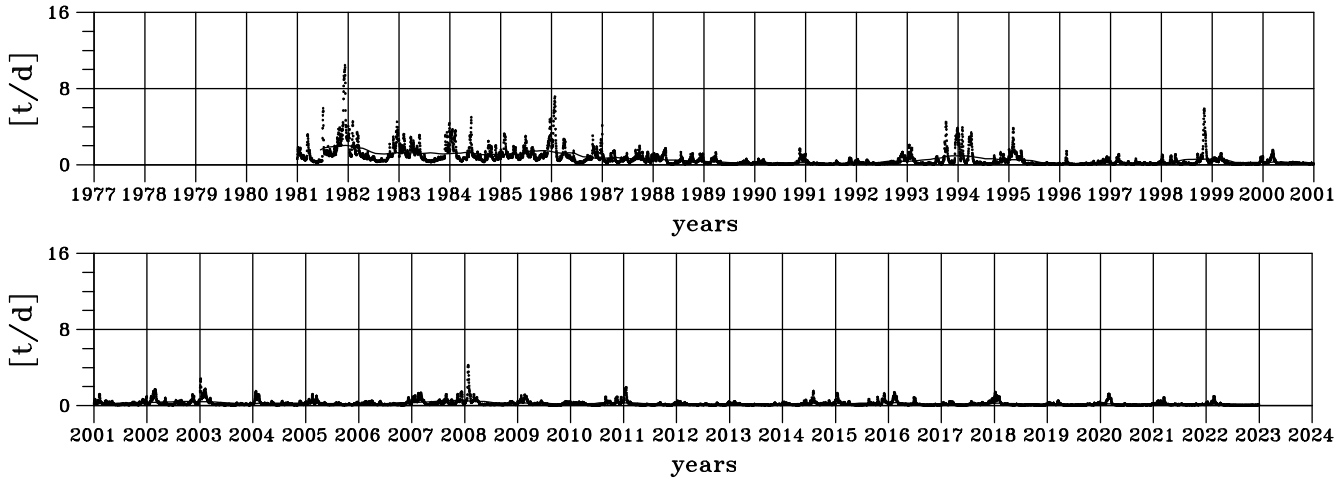
year	t/y	year	t/y	year	t/y	year	t/y	year	t/y	year	t/y
		1985	466	1993	238	2001	95	2009	93	2017	67
		1986	421	1994	237	2002	136	2010	84	2018	64
		1987	225	1995	149	2003	115	2011	71	2019	46
		1988	185	1996	69	2004	93	2012	49	2020	59
1981	642	1989	78	1997	65	2005	83	2013	43	2021	56
1982	446	1990	84	1998	200	2006	68	2014	81	2022	43
1983	428	1991	52	1999	95	2007	168	2015	97		
1984	430	1992	101	2000	90	2008	134	2016	78		

TIME SERIES
mean: 0.5 t/d
relative standard deviation: 4.38
minimum: 0.0 t/d September 15, 1991
maximum: 10.5 t/d December 8, 1981

LOW PASS
minimum: 0.1 t/d March 2019
maximum: 2.0 t/d December 1981

ANNUAL CYCLE
minimum: 0.2 t/d August, rel. stdev: 1.13
maximum: 0.8 t/d January, rel. stdev: 1.06





Silicate load for River Ems

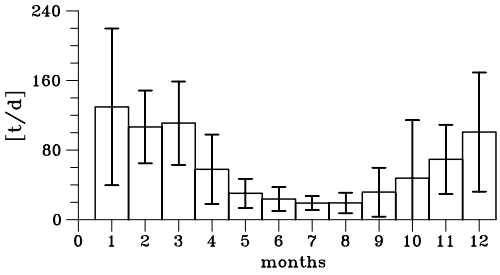
ANNUAL LOADS

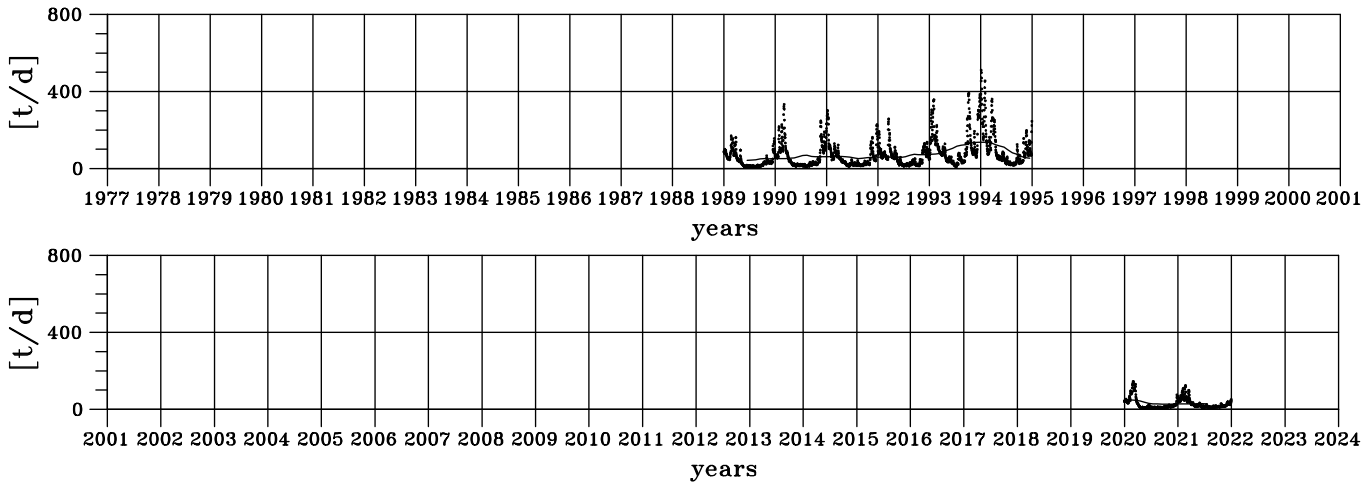
year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y
				1993	40.9						
				1994	38.8						
										2020	10.3
		1989	15.6							2021	10.6
		1990	22.8								
		1991	21.4								
		1992	21.0								

TIME SERIES
mean: 24.9 t/d
relative standard deviation: 1.42
minimum: 5.4 t/d August 6, 2020
maximum: 510.4 t/d January 5, 1994

LOW PASS
minimum: 26.4 t/d October 2020
maximum: 136.6 t/d January 1994

ANNUAL CYCLE
minimum: 19.1 t/d July, rel. stdev: 0.41
maximum: 129.7 t/d January, rel. stdev: 0.69





Total Alkalinity load for River Ems

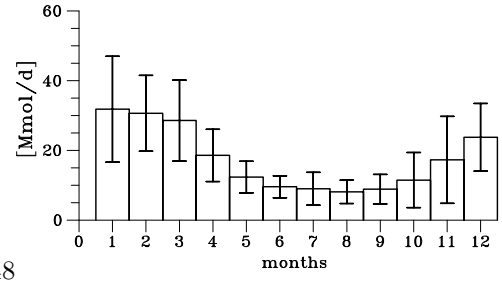
ANNUAL LOADS

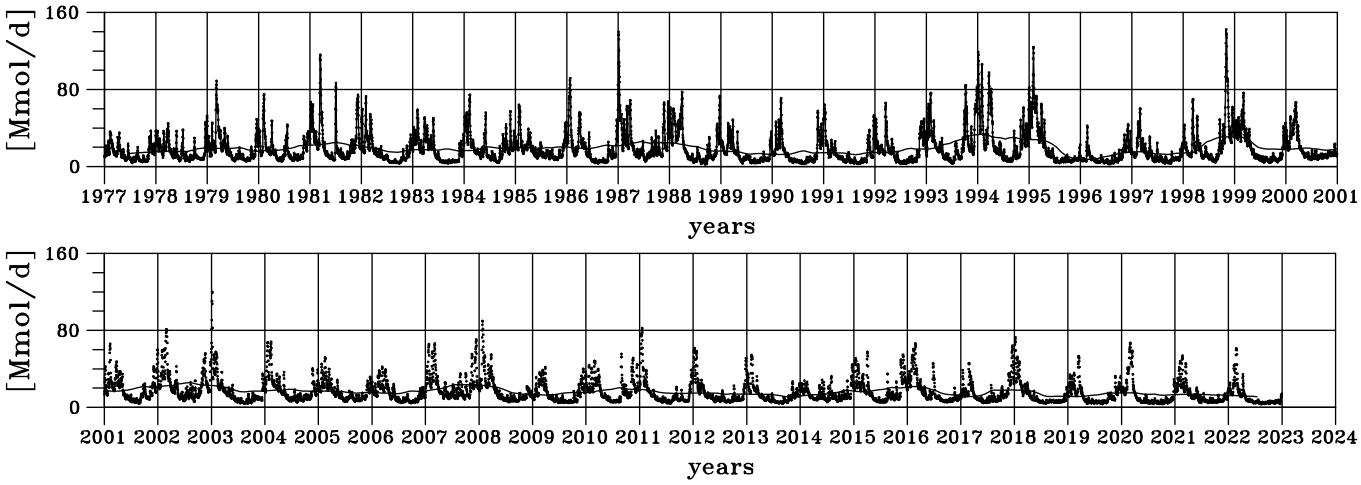
year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y
1977	4.9	1985	6.6	1993	9.0	2001	6.8	2009	5.1	2017	5.5
1978	5.8	1986	6.8	1994	10.6	2002	8.8	2010	6.7	2018	4.9
1979	7.0	1987	9.6	1995	8.0	2003	6.2	2011	5.5	2019	4.8
1980	6.3	1988	7.9	1996	3.9	2004	6.9	2012	5.4	2020	4.9
1981	9.3	1989	4.7	1997	4.6	2005	5.9	2013	4.8	2021	4.9
1982	5.6	1990	5.4	1998	9.6	2006	5.0	2014	5.0	2022	4.1
1983	6.1	1991	4.9	1999	7.0	2007	8.5	2015	6.7		
1984	7.5	1992	5.9	2000	6.8	2008	6.5	2016	6.4		

TIME SERIES
mean: 17.4 Mmol/d
relative standard deviation: 0.85
minimum: 2.3 Mmol/d September 11, 1988
maximum: 142.3 Mmol/d November 3, 1998

LOW PASS
minimum: 7.5 Mmol/d March 1996
maximum: 33.3 Mmol/d January 1994

ANNUAL CYCLE
minimum: 8.1 Mmol/d August, rel. stdev: 0.41
maximum: 31.8 Mmol/d January, rel. stdev: 0.48





Dissolved Inorganic Carbon load for River Ems

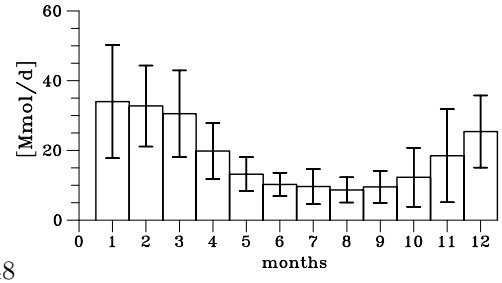
ANNUAL LOADS

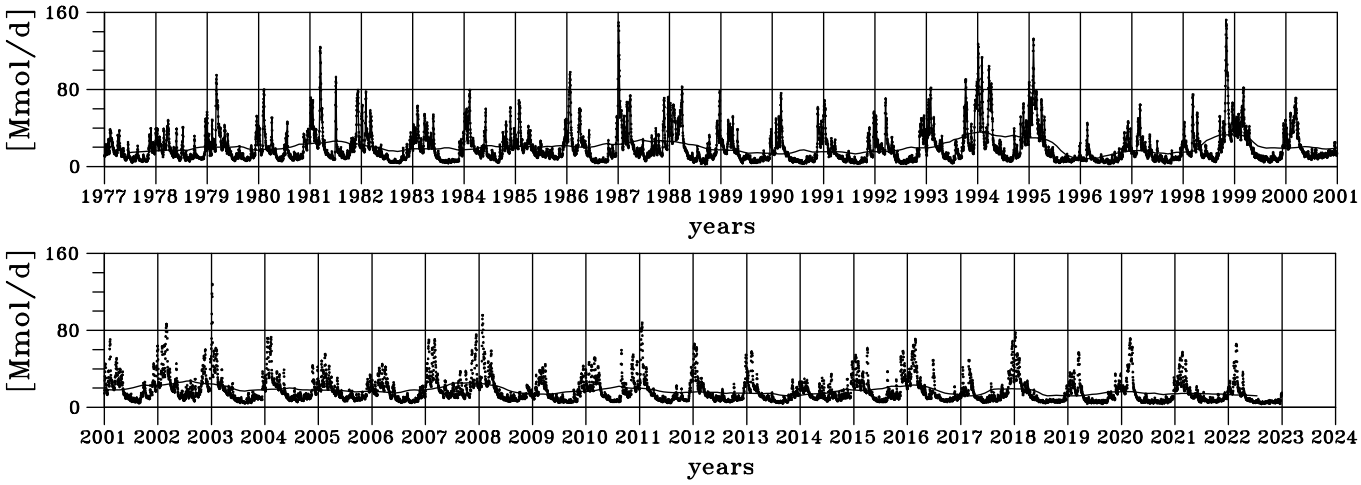
year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y
1977	5.2	1985	7.1	1993	9.7	2001	7.3	2009	5.4	2017	5.9
1978	6.2	1986	7.3	1994	11.3	2002	9.4	2010	7.2	2018	5.2
1979	7.5	1987	10.3	1995	8.6	2003	6.6	2011	5.9	2019	5.1
1980	6.7	1988	8.4	1996	4.1	2004	7.4	2012	5.8	2020	5.2
1981	9.9	1989	5.1	1997	5.0	2005	6.3	2013	5.1	2021	5.2
1982	6.0	1990	5.8	1998	10.3	2006	5.3	2014	5.4	2022	4.3
1983	6.5	1991	5.2	1999	7.5	2007	9.1	2015	7.2		
1984	8.0	1992	6.3	2000	7.3	2008	7.0	2016	6.8		

TIME SERIES
mean: 18.6 Mmol/d
relative standard deviation: 0.85
minimum: 2.5 Mmol/d September 11, 1988
maximum: 152.1 Mmol/d November 3, 1998

LOW PASS
minimum: 8.1 Mmol/d March 1996
maximum: 35.6 Mmol/d January 1994

ANNUAL CYCLE
minimum: 8.7 Mmol/d August, rel. stdev: 0.41
maximum: 34.0 Mmol/d January, rel. stdev: 0.48





Dissolved Organic Carbon load for River Ems

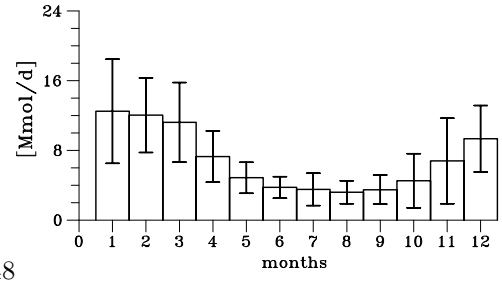
ANNUAL LOADS

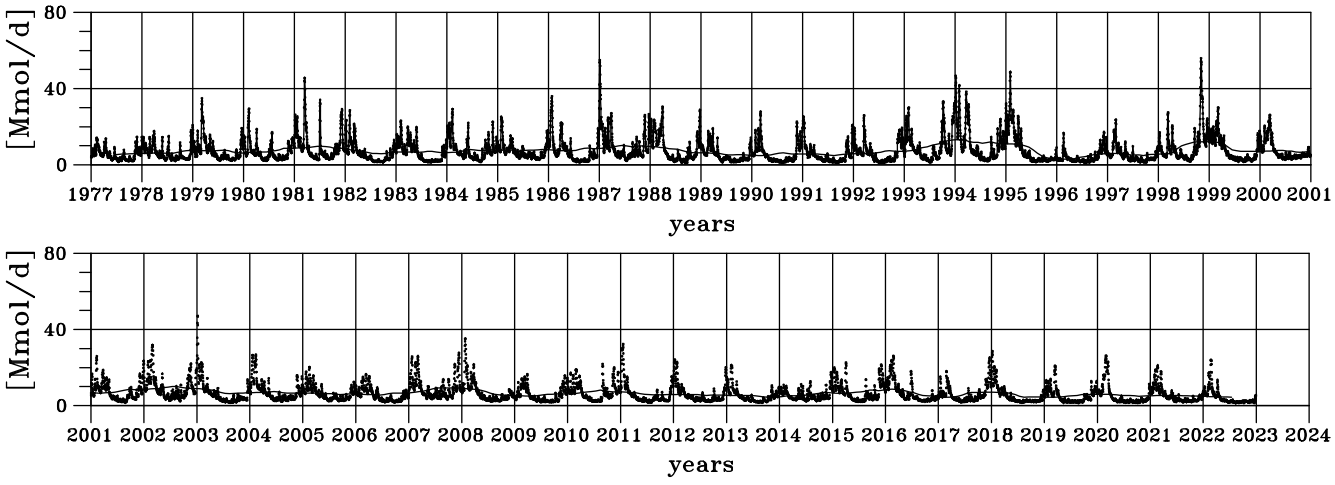
year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y
1977	1.9	1985	2.6	1993	3.5	2001	2.7	2009	2.0	2017	2.2
1978	2.3	1986	2.7	1994	4.2	2002	3.5	2010	2.6	2018	1.9
1979	2.7	1987	3.8	1995	3.2	2003	2.4	2011	2.2	2019	1.9
1980	2.5	1988	3.1	1996	1.5	2004	2.7	2012	2.1	2020	1.9
1981	3.6	1989	1.9	1997	1.8	2005	2.3	2013	1.9	2021	1.9
1982	2.2	1990	2.1	1998	3.8	2006	2.0	2014	2.0	2022	1.6
1983	2.4	1991	1.9	1999	2.8	2007	3.3	2015	2.6		
1984	2.9	1992	2.3	2000	2.7	2008	2.6	2016	2.5		

TIME SERIES
mean: 6.9 Mmol/d
relative standard deviation: 0.85
minimum: 0.9 Mmol/d September 11, 1988
maximum: 55.9 Mmol/d November 3, 1998

LOW PASS
minimum: 3.0 Mmol/d March 1996
maximum: 13.1 Mmol/d January 1994

ANNUAL CYCLE
minimum: 3.2 Mmol/d August, rel. stdev: 0.41
maximum: 12.5 Mmol/d January, rel. stdev: 0.48





5.4 Loads of Kornwederzand

Total Nitrogen load for Kornwederzand

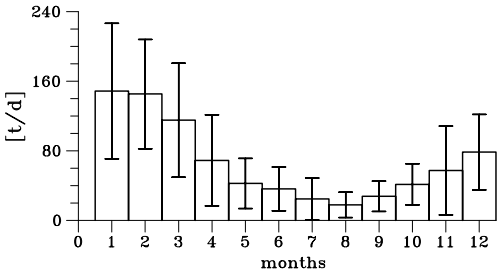
ANNUAL LOADS

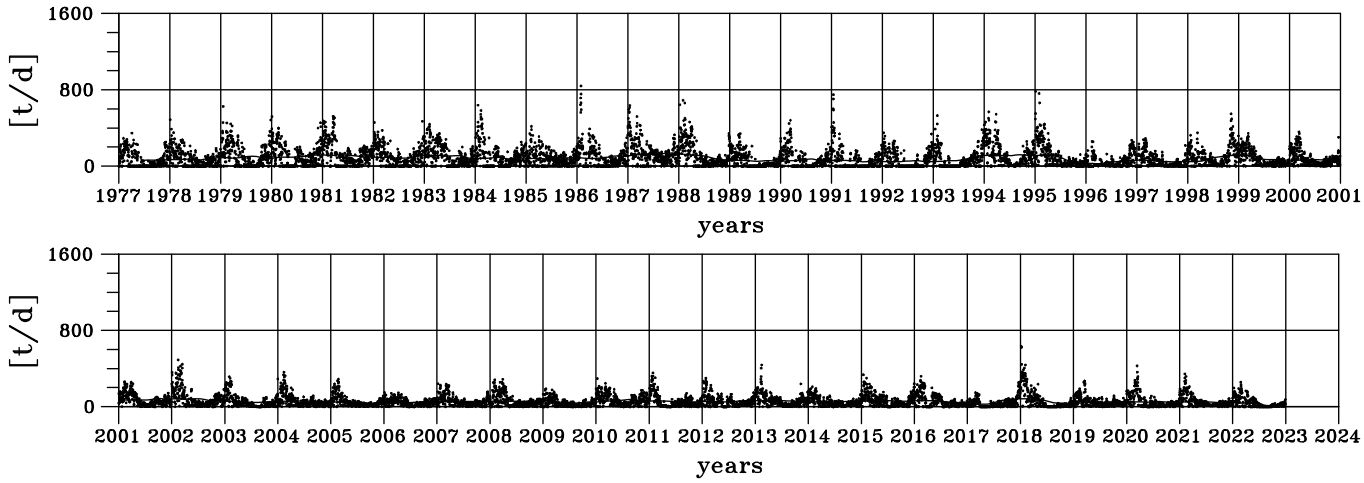
year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y
1977	21.3	1985	25.5	1993	20.8	2001	24.5	2009	12.7	2017	13.1
1978	24.2	1986	31.0	1994	40.5	2002	29.1	2010	24.2	2018	22.9
1979	36.1	1987	46.5	1995	33.6	2003	16.8	2011	19.0	2019	16.2
1980	34.6	1988	39.3	1996	15.7	2004	21.0	2012	19.5	2020	17.6
1981	41.8	1989	18.6	1997	15.5	2005	17.1	2013	23.2	2021	18.5
1982	31.2	1990	23.8	1998	33.4	2006	15.0	2014	16.5	2022	12.4
1983	37.7	1991	20.4	1999	25.5	2007	20.1	2015	23.5		
1984	34.0	1992	20.2	2000	26.1	2008	20.0	2016	20.1		

TIME SERIES
mean: 66.7 t/d
relative standard deviation: 1.29
minimum: 0.0 t/d January 1, 1977
maximum: 839.7 t/d January 29, 1986

LOW PASS
minimum: 23.1 t/d February 2017
maximum: 139.2 t/d November 1987

ANNUAL CYCLE
minimum: 17.9 t/d August, rel. stdev: 0.82
maximum: 148.7 t/d January, rel. stdev: 0.52





Nitrate + Nitrite load for Kornwederzand

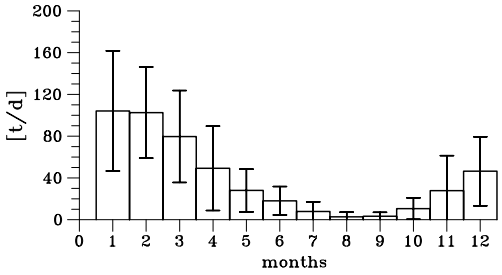
ANNUAL LOADS

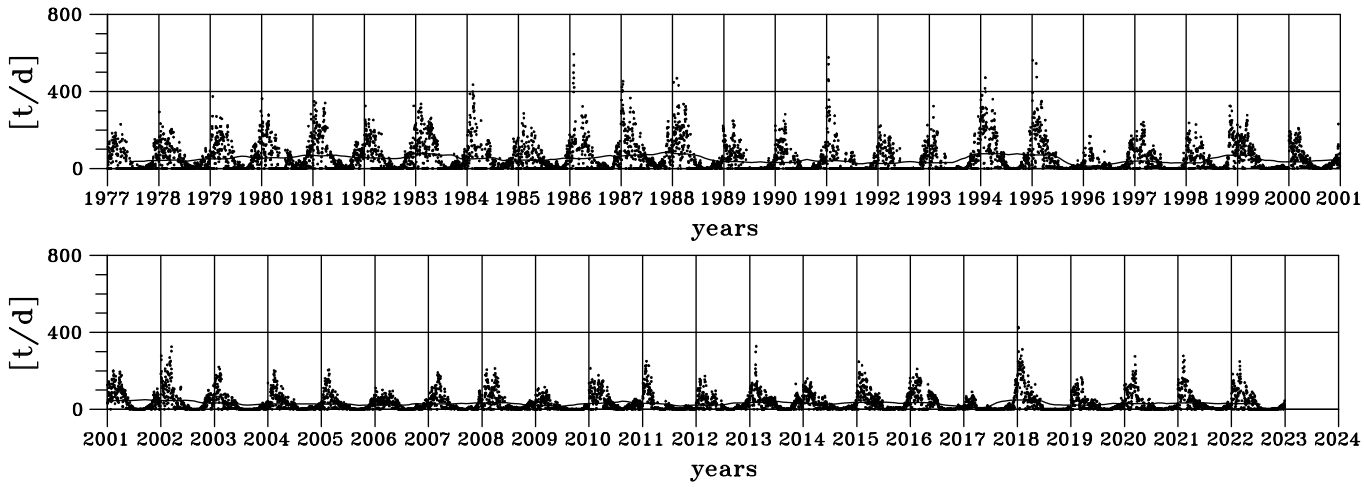
year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y
1977	12.8	1985	13.7	1993	11.6	2001	16.1	2009	5.9	2017	5.7
1978	14.5	1986	19.5	1994	27.2	2002	16.7	2010	13.0	2018	14.5
1979	21.4	1987	27.8	1995	21.9	2003	9.6	2011	9.6	2019	9.0
1980	20.1	1988	24.6	1996	8.3	2004	10.4	2012	9.2	2020	10.3
1981	24.8	1989	11.5	1997	10.3	2005	10.1	2013	14.2	2021	12.1
1982	19.1	1990	13.3	1998	20.2	2006	8.2	2014	9.4	2022	10.4
1983	25.1	1991	13.2	1999	15.6	2007	10.8	2015	14.3		
1984	20.8	1992	12.9	2000	15.2	2008	12.0	2016	11.2		

TIME SERIES
mean: 39.8 t/d
relative standard deviation: 1.55
minimum: 0.0 t/d January 1, 1977
maximum: 593.4 t/d January 29, 1986

LOW PASS
minimum: 8.8 t/d March 2017
maximum: 84.1 t/d November 1987

ANNUAL CYCLE
minimum: 2.7 t/d August, rel. stdev: 1.66
maximum: 104.2 t/d January, rel. stdev: 0.55





Ammonium load for Kornwederzand

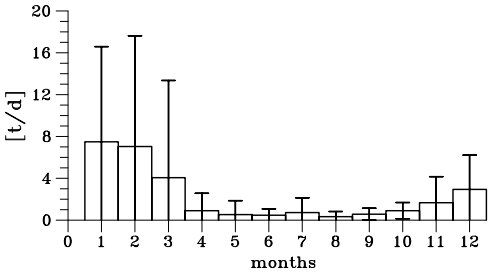
ANNUAL LOADS

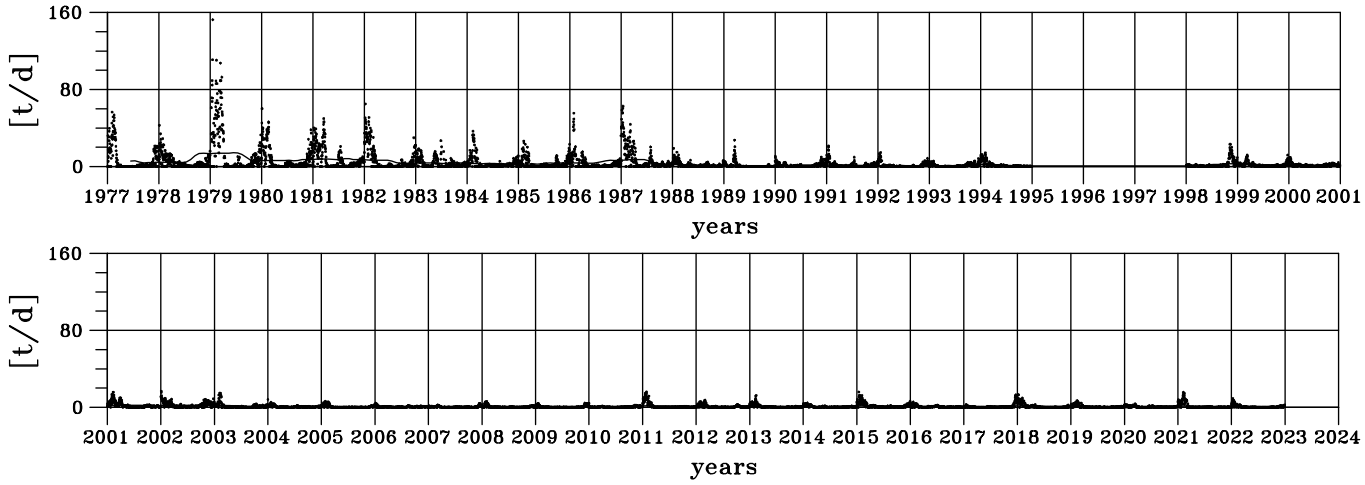
year	t/y	year	t/y	year	t/y	year	t/y	year	t/y	year	t/y
1977	2112	1985	1020	1993	367	2001	759	2009	185	2017	281
1978	1391	1986	1152	1994	548	2002	868	2010	140	2018	407
1979	5277	1987	2584			2003	440	2011	505	2019	266
1980	2403	1988	587			2004	243	2012	295	2020	194
1981	2521	1989	333			2005	243	2013	350	2021	450
1982	2415	1990	458	1998	768	2006	184	2014	229	2022	250
1983	1174	1991	505	1999	584	2007	180	2015	616		
1984	1202	1992	417	2000	481	2008	200	2016	251		

TIME SERIES
mean: 2.4 t/d
relative standard deviation: 2.67
minimum: 0.0 t/d January 1, 1977
maximum: 152.5 t/d January 19, 1979

LOW PASS
minimum: 0.3 t/d May 2017
maximum: 14.4 t/d June 1979

ANNUAL CYCLE
minimum: 0.3 t/d August, rel. stdev: 1.42
maximum: 7.5 t/d January, rel. stdev: 1.21





Total Phosphorus load for Kornwederzand

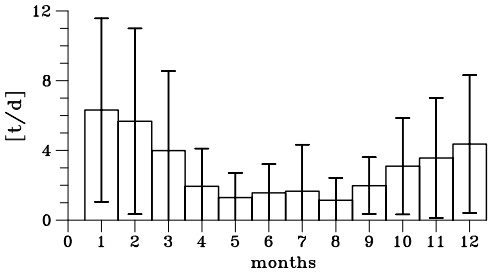
ANNUAL LOADS

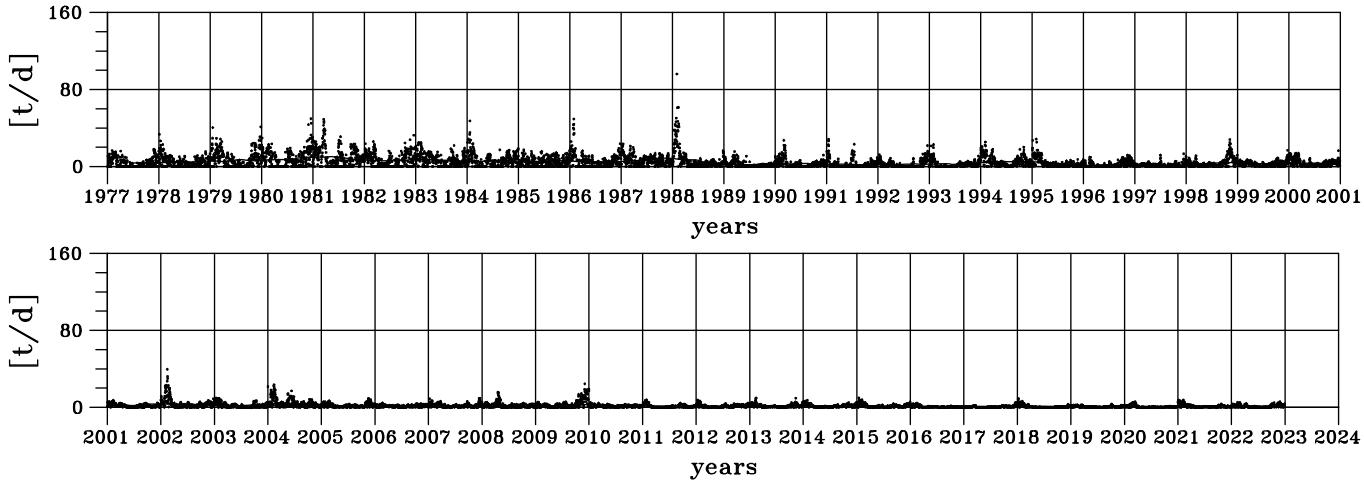
year	t/y	year	t/y	year	t/y	year	t/y	year	t/y	year	t/y
1977	1270	1985	1659	1993	756	2001	637	2009	1053	2017	214
1978	1512	1986	1847	1994	1876	2002	1348	2010	456	2018	310
1979	2555	1987	2161	1995	1227	2003	646	2011	389	2019	228
1980	2801	1988	2497	1996	726	2004	1472	2012	482	2020	247
1981	3356	1989	675	1997	452	2005	654	2013	550	2021	429
1982	2271	1990	1053	1998	1313	2006	468	2014	507	2022	402
1983	2288	1991	828	1999	965	2007	691	2015	530		
1984	2190	1992	865	2000	1274	2008	684	2016	226		

TIME SERIES
mean: 3.0 t/d
relative standard deviation: 1.62
minimum: 0.0 t/d January 1, 1977
maximum: 96.0 t/d February 1, 1988

LOW PASS
minimum: 0.3 t/d January 2017
maximum: 10.2 t/d May 1981

ANNUAL CYCLE
minimum: 1.1 t/d August, rel. stdev: 1.12
maximum: 6.3 t/d January, rel. stdev: 0.83





Phosphate load for Kornwederzand

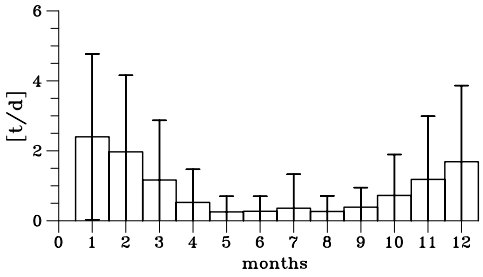
ANNUAL LOADS

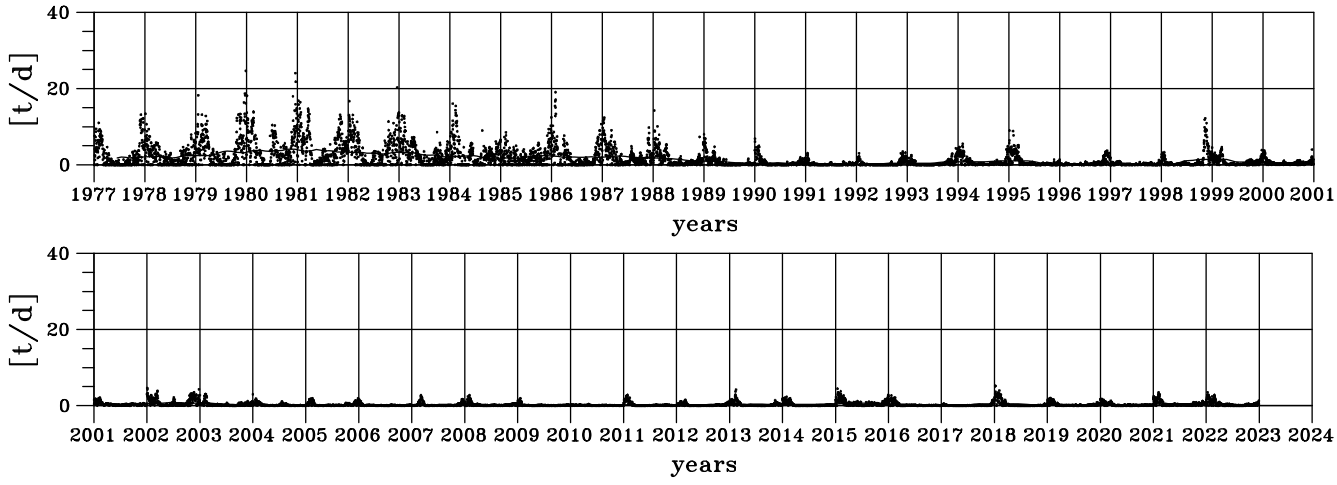
year	t/y	year	t/y	year	t/y	year	t/y	year	t/y	year	t/y
1977	715	1985	678	1993	144	2001	125	2009	37	2017	34
1978	666	1986	710	1994	282	2002	318	2010	21	2018	150
1979	1213	1987	759	1995	309	2003	107	2011	91	2019	87
1980	1312	1988	532	1996	140	2004	68	2012	62	2020	75
1981	1350	1989	234	1997	56	2005	98	2013	122	2021	168
1982	1128	1990	193	1998	407	2006	31	2014	92	2022	140
1983	915	1991	66	1999	264	2007	89	2015	248		
1984	887	1992	128	2000	186	2008	81	2016	83		

TIME SERIES
mean: 0.9 t/d
relative standard deviation: 2.17
minimum: 0.0 t/d January 1, 1977
maximum: 24.7 t/d December 27, 1979

LOW PASS
minimum: 0.0 t/d May 2017
maximum: 4.0 t/d November 1980

ANNUAL CYCLE
minimum: 0.3 t/d May, rel. stdev: 1.75
maximum: 2.4 t/d January, rel. stdev: 0.99





Silicate load for Kornwederzand

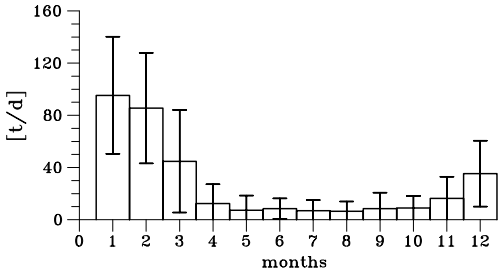
ANNUAL LOADS

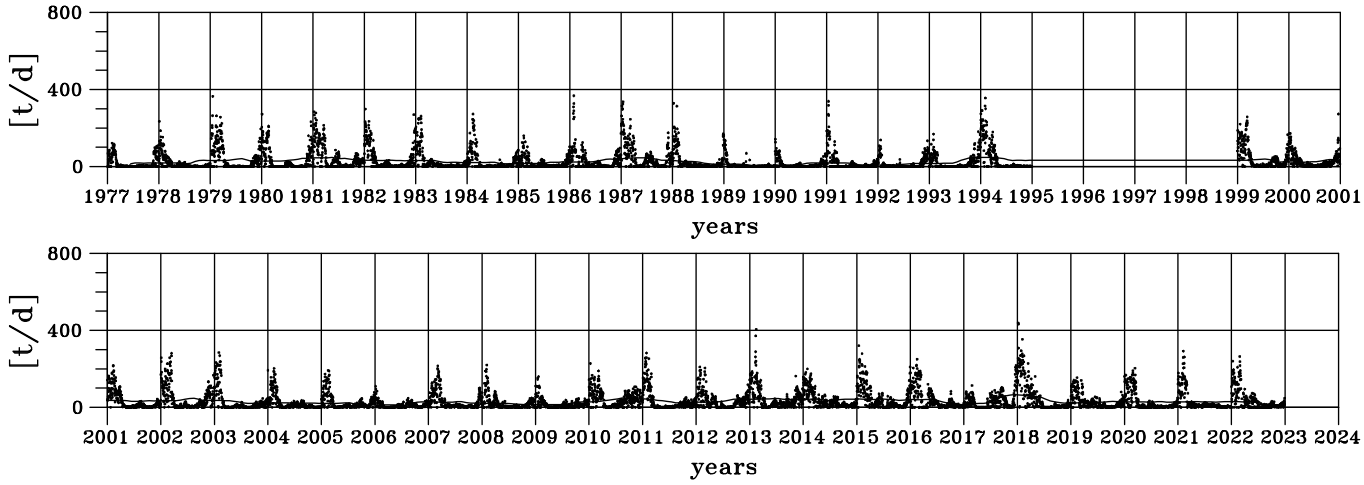
year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y
1977	5.7	1985	5.6	1993	6.6	2001	10.8	2009	5.4	2017	10.4
1978	5.2	1986	9.2	1994	13.5	2002	15.9	2010	14.8	2018	17.2
1979	14.1	1987	16.8			2003	9.7	2011	11.2	2019	9.2
1980	11.3	1988	9.1			2004	7.7	2012	11.7	2020	9.7
1981	15.2	1989	2.8			2005	8.7	2013	16.2	2021	10.0
1982	12.5	1990	3.6			2006	3.8	2014	12.3	2022	11.1
1983	8.8	1991	6.3	1999	14.5	2007	10.4	2015	16.2		
1984	8.5	1992	4.8	2000	9.4	2008	7.0	2016	12.8		

TIME SERIES
mean: 27.4 t/d
relative standard deviation: 1.68
minimum: 0.0 t/d January 1, 1977
maximum: 438.3 t/d January 7, 2018

LOW PASS
minimum: 6.5 t/d August 1989
maximum: 65.8 t/d December 2017

ANNUAL CYCLE
minimum: 6.4 t/d August, rel. stdev: 1.19
maximum: 95.3 t/d January, rel. stdev: 0.47





5.5 Loads of Den Oever

Total Nitrogen load for Den Oever

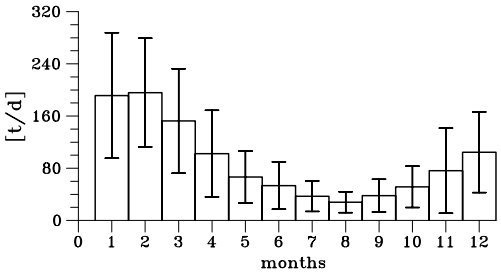
ANNUAL LOADS

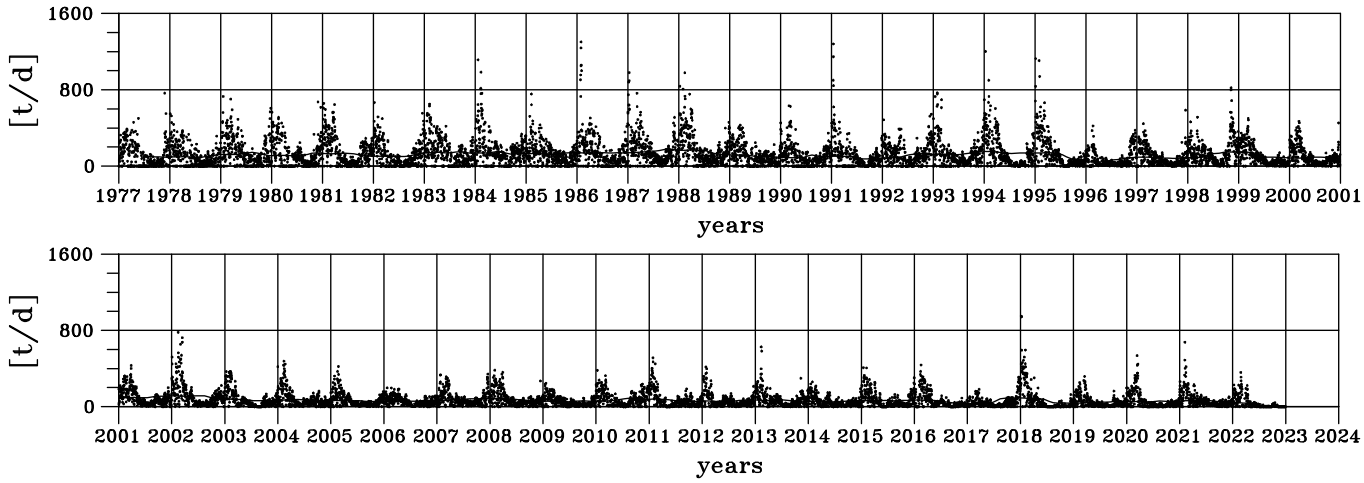
year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y
1977	34.2	1985	40.3	1993	42.4	2001	33.1	2009	18.4	2017	16.4
1978	32.7	1986	50.6	1994	48.4	2002	41.3	2010	27.8	2018	25.0
1979	49.7	1987	57.7	1995	46.7	2003	24.2	2011	22.9	2019	16.5
1980	40.5	1988	59.9	1996	23.4	2004	26.4	2012	21.4	2020	18.9
1981	48.9	1989	36.7	1997	29.0	2005	23.1	2013	25.8	2021	23.5
1982	36.8	1990	34.7	1998	48.5	2006	19.8	2014	17.6	2022	11.4
1983	49.3	1991	34.2	1999	34.8	2007	28.1	2015	24.5		
1984	56.7	1992	42.7	2000	34.8	2008	27.1	2016	20.6		

TIME SERIES
mean: 90.9 t/d
relative standard deviation: 1.26
minimum: 0.0 t/d January 1, 1977
maximum: 1301.4 t/d January 31, 1986

LOW PASS
minimum: 27.0 t/d February 2017
maximum: 175.3 t/d October 1987

ANNUAL CYCLE
minimum: 28.0 t/d August, rel. stdev: 0.57
maximum: 195.9 t/d February, rel. stdev: 0.43





Nitrate + Nitrite load for Den Oever

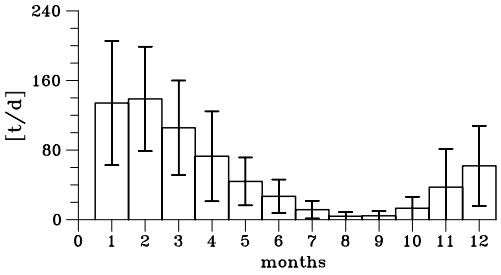
ANNUAL LOADS

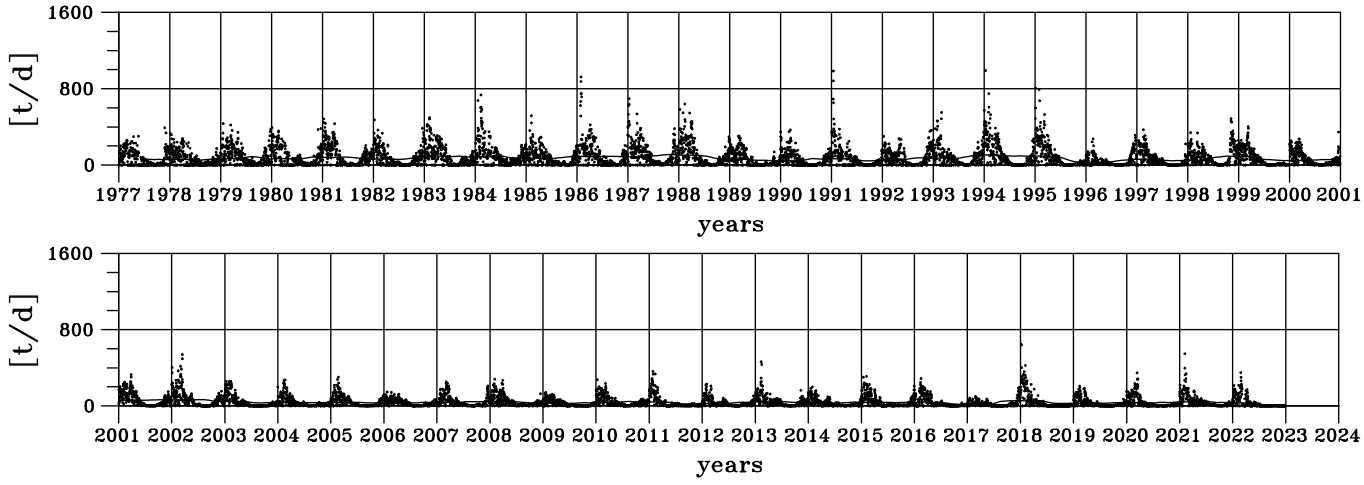
year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y
1977	20.5	1985	22.6	1993	24.7	2001	21.5	2009	8.5	2017	8.1
1978	19.5	1986	32.4	1994	34.8	2002	23.8	2010	14.1	2018	16.2
1979	29.2	1987	36.0	1995	30.6	2003	13.7	2011	11.9	2019	9.8
1980	24.1	1988	35.2	1996	13.3	2004	12.4	2012	10.2	2020	11.4
1981	30.4	1989	18.4	1997	17.6	2005	13.8	2013	15.9	2021	15.4
1982	22.7	1990	18.7	1998	29.4	2006	11.0	2014	10.0	2022	10.1
1983	31.0	1991	21.9	1999	20.7	2007	14.8	2015	14.8		
1984	35.1	1992	24.6	2000	20.2	2008	15.7	2016	12.2		

TIME SERIES
mean: 54.1 t/d
relative standard deviation: 1.52
minimum: 0.0 t/d January 1, 1977
maximum: 990.6 t/d January 11, 1994

LOW PASS
minimum: 13.6 t/d March 2017
maximum: 110.0 t/d November 1987

ANNUAL CYCLE
minimum: 3.9 t/d August, rel. stdev: 1.20
maximum: 138.7 t/d February, rel. stdev: 0.43





Ammonium load for Den Oever

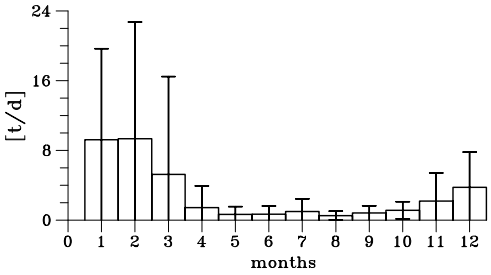
ANNUAL LOADS

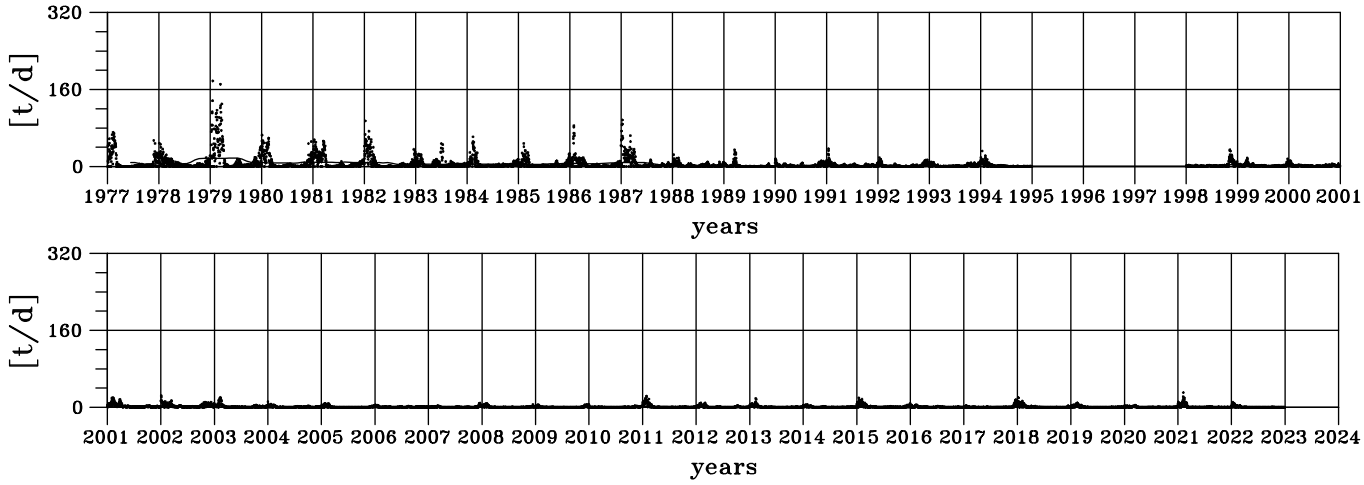
year	t/y	year	t/y	year	t/y	year	t/y	year	t/y	year	t/y
1977	2928	1985	1544	1993	641	2001	1032	2009	247	2017	338
1978	1820	1986	1884	1994	721	2002	1192	2010	166	2018	467
1979	6461	1987	2987			2003	654	2011	630	2019	291
1980	2816	1988	944			2004	333	2012	340	2020	198
1981	2820	1989	568			2005	304	2013	405	2021	569
1982	2917	1990	718	1998	1042	2006	254	2014	249	2022	223
1983	1600	1991	800	1999	790	2007	279	2015	680		
1984	1916	1992	783	2000	628	2008	296	2016	225		

TIME SERIES
mean: 3.1 t/d
relative standard deviation: 2.61
minimum: 0.0 t/d January 1, 1977
maximum: 177.6 t/d January 19, 1979

LOW PASS
minimum: 0.3 t/d March 2017
maximum: 17.7 t/d June 1979

ANNUAL CYCLE
minimum: 0.5 t/d August, rel. stdev: 0.95
maximum: 9.3 t/d February, rel. stdev: 1.43





Total Phosphorus load for Den Oever

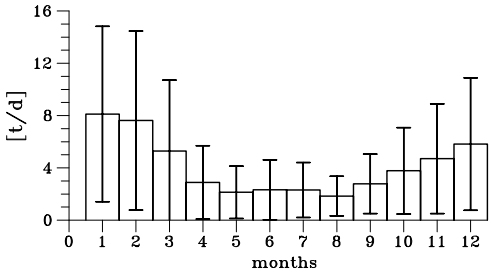
ANNUAL LOADS

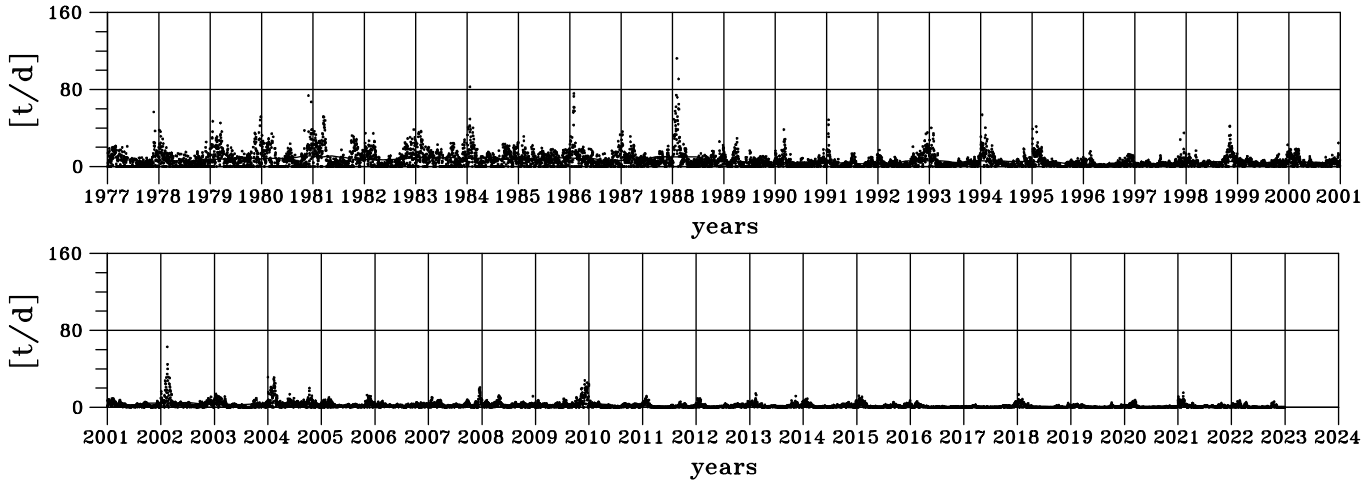
year	t/y	year	t/y	year	t/y	year	t/y	year	t/y	year	t/y
1977	2005	1985	2474	1993	1463	2001	876	2009	1393	2017	248
1978	2029	1986	2894	1994	2041	2002	1812	2010	532	2018	345
1979	3421	1987	2517	1995	1666	2003	941	2011	468	2019	235
1980	3169	1988	3714	1996	998	2004	1821	2012	526	2020	267
1981	3617	1989	1589	1997	1047	2005	871	2013	622	2021	529
1982	2687	1990	1538	1998	1845	2006	623	2014	536	2022	288
1983	3152	1991	1220	1999	1337	2007	1010	2015	581		
1984	3491	1992	1929	2000	1644	2008	911	2016	222		

TIME SERIES
mean: 4.1 t/d
relative standard deviation: 1.53
minimum: 0.0 t/d January 1, 1977
maximum: 112.3 t/d February 1, 1988

LOW PASS
minimum: 0.3 t/d February 2017
maximum: 10.9 t/d May 1981

ANNUAL CYCLE
minimum: 1.8 t/d August, rel. stdev: 0.82
maximum: 8.1 t/d January, rel. stdev: 0.83





Phosphate load for Den Oever

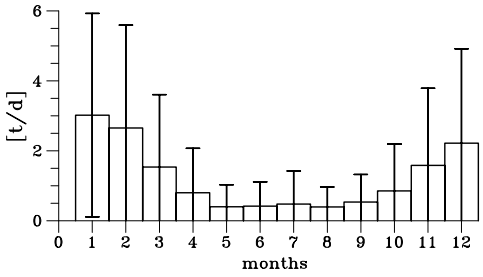
ANNUAL LOADS

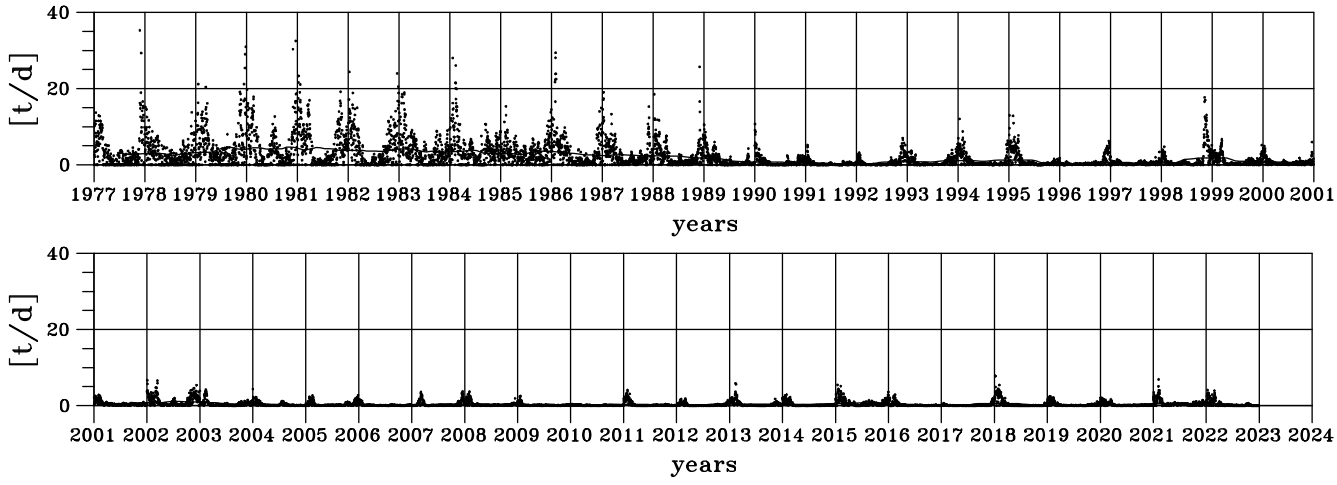
year	t/y	year	t/y	year	t/y	year	t/y	year	t/y	year	t/y
1977	1071	1985	1015	1993	245	2001	173	2009	52	2017	40
1978	886	1986	1069	1994	344	2002	434	2010	23	2018	177
1979	1544	1987	918	1995	418	2003	158	2011	112	2019	95
1980	1481	1988	845	1996	194	2004	97	2012	70	2020	80
1981	1572	1989	394	1997	124	2005	127	2013	142	2021	211
1982	1354	1990	280	1998	543	2006	43	2014	96	2022	130
1983	1223	1991	104	1999	344	2007	136	2015	265		
1984	1414	1992	259	2000	240	2008	117	2016	78		

TIME SERIES
mean: 1.2 t/d
relative standard deviation: 2.12
minimum: 0.0 t/d January 1, 1977
maximum: 35.3 t/d November 26, 1977

LOW PASS
minimum: 0.0 t/d February 2017
maximum: 4.6 t/d November 1980

ANNUAL CYCLE
minimum: 0.4 t/d August, rel. stdev: 1.44
maximum: 3.0 t/d January, rel. stdev: 0.96





Silicate load for Den Oever

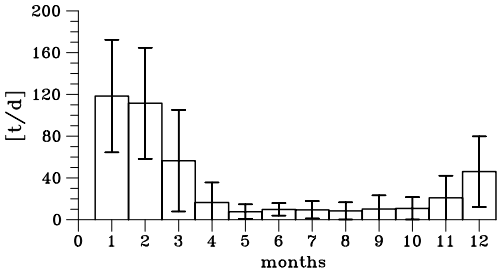
ANNUAL LOADS

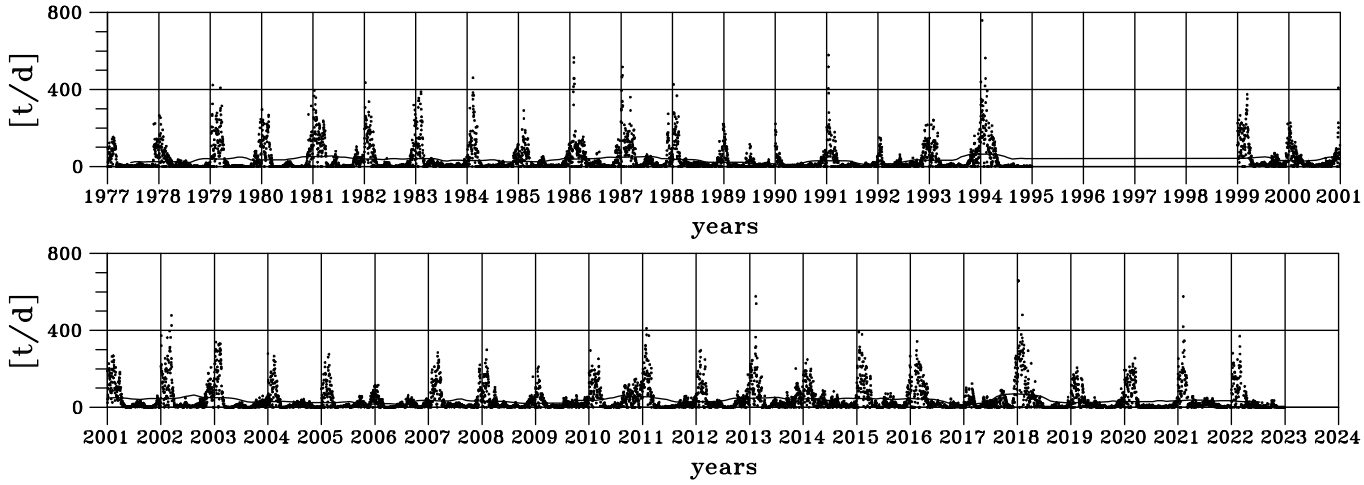
year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y
1977	8.1	1985	8.8	1993	11.6	2001	14.7	2009	7.9	2017	11.1
1978	6.8	1986	14.8	1994	17.9	2002	21.1	2010	18.8	2018	18.9
1979	17.0	1987	19.4			2003	13.7	2011	13.7	2019	9.7
1980	13.2	1988	12.8			2004	10.0	2012	12.8	2020	10.5
1981	17.9	1989	5.6			2005	11.1	2013	18.5	2021	13.0
1982	15.2	1990	5.2			2006	5.5	2014	12.9	2022	10.9
1983	11.4	1991	9.8	1999	18.8	2007	14.5	2015	17.7		
1984	13.3	1992	9.7	2000	11.9	2008	10.1	2016	13.4		

TIME SERIES
mean: 35.0 t/d
relative standard deviation: 1.70
minimum: 0.0 t/d January 1, 1977
maximum: 758.5 t/d January 11, 1994

LOW PASS
minimum: 10.5 t/d April 1990
maximum: 70.0 t/d December 2017

ANNUAL CYCLE
minimum: 7.7 t/d May, rel. stdev: 0.91
maximum: 118.5 t/d January, rel. stdev: 0.45





5.6 Loads of Nordzeekanaal

Total Nitrogen load for Nordzeekanaal

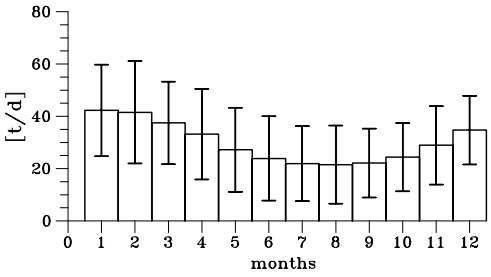
ANNUAL LOADS

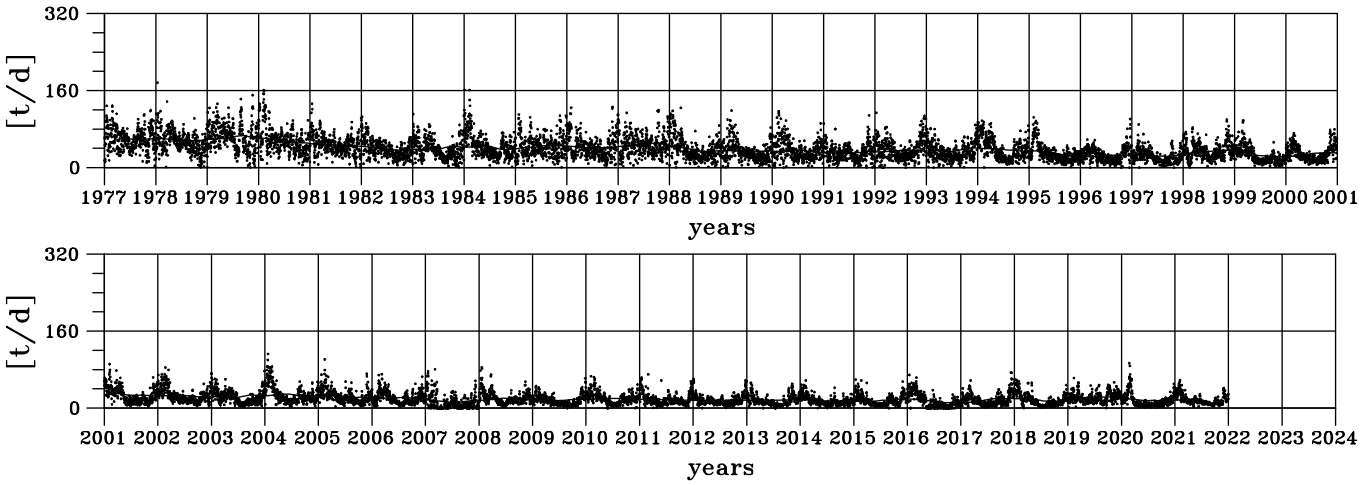
year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y
1977	21.7	1985	16.0	1993	11.9	2001	9.6	2009	5.6	2017	6.3
1978	19.6	1986	15.4	1994	14.0	2002	9.4	2010	7.2	2018	5.9
1979	23.3	1987	17.4	1995	10.9	2003	8.1	2011	6.5	2019	8.0
1980	20.7	1988	13.8	1996	9.5	2004	10.3	2012	5.8	2020	5.6
1981	17.4	1989	11.9	1997	8.3	2005	9.1	2013	5.6	2021	6.2
1982	13.9	1990	13.2	1998	12.5	2006	7.7	2014	5.5		
1983	13.5	1991	11.2	1999	9.0	2007	4.1	2015	5.8		
1984	16.4	1992	13.4	2000	10.7	2008	7.7	2016	5.2		

TIME SERIES
mean: 29.9 t/d
relative standard deviation: 0.72
minimum: 0.0 t/d March 24, 1990
maximum: 176.2 t/d January 13, 1978

LOW PASS
minimum: 11.1 t/d November 2016
maximum: 66.5 t/d September 1979

ANNUAL CYCLE
minimum: 21.5 t/d August, rel. stdev: 0.69
maximum: 42.2 t/d January, rel. stdev: 0.42





Nitrate + Nitrite load for Nordzeekanaal

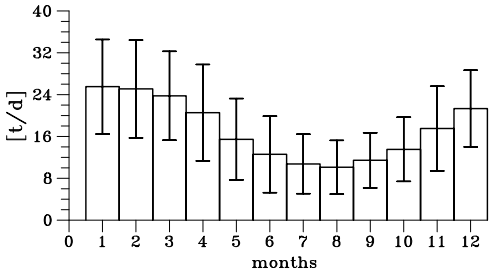
ANNUAL LOADS

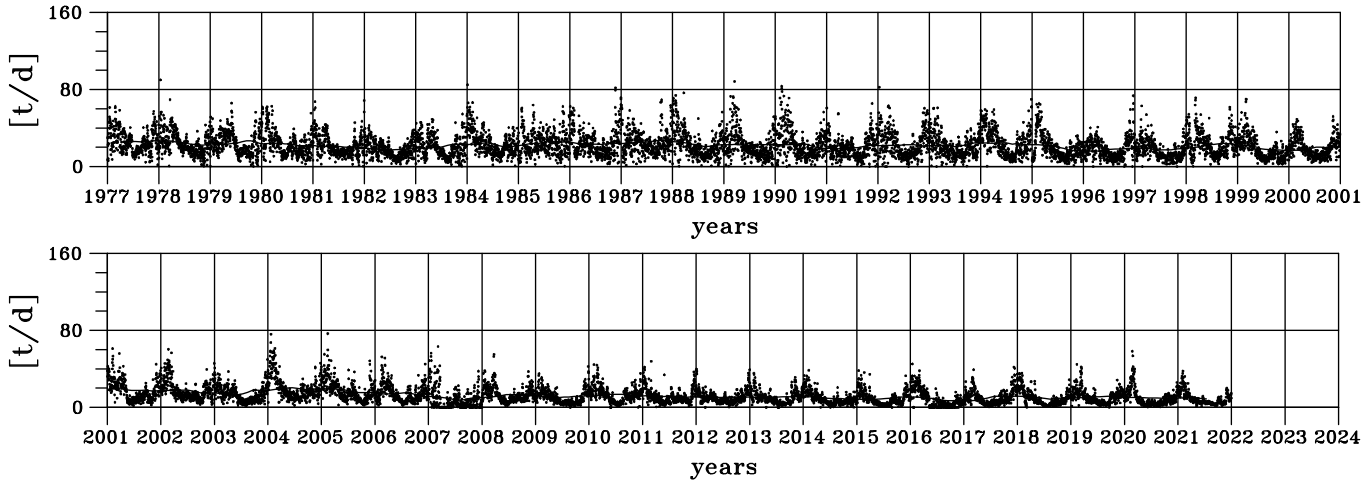
year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y
1977	9.5	1985	9.0	1993	7.4	2001	6.4	2009	3.8	2017	3.8
1978	8.8	1986	8.7	1994	9.1	2002	6.3	2010	4.8	2018	3.4
1979	8.8	1987	9.0	1995	7.2	2003	4.9	2011	4.2	2019	4.0
1980	8.5	1988	8.4	1996	6.6	2004	7.4	2012	3.8	2020	3.5
1981	7.7	1989	8.0	1997	6.0	2005	6.5	2013	3.7	2021	3.3
1982	6.3	1990	8.6	1998	8.5	2006	5.3	2014	3.4		
1983	7.2	1991	7.0	1999	6.6	2007	2.9	2015	3.3		
1984	8.8	1992	8.4	2000	7.2	2008	4.9	2016	3.1		

TIME SERIES
mean: 17.3 t/d
relative standard deviation: 0.70
minimum: 0.0 t/d March 24, 1990
maximum: 90.0 t/d January 13, 1978

LOW PASS
minimum: 6.7 t/d November 2016
maximum: 27.1 t/d February 1978

ANNUAL CYCLE
minimum: 10.1 t/d August, rel. stdev: 0.51
maximum: 25.5 t/d January, rel. stdev: 0.35





Ammonium load for Nordzeekanaal

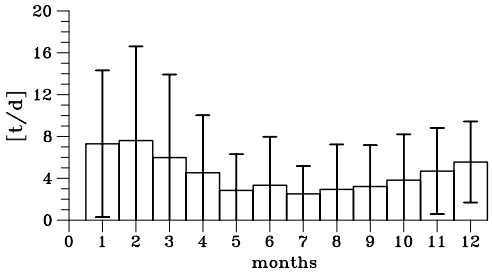
ANNUAL LOADS

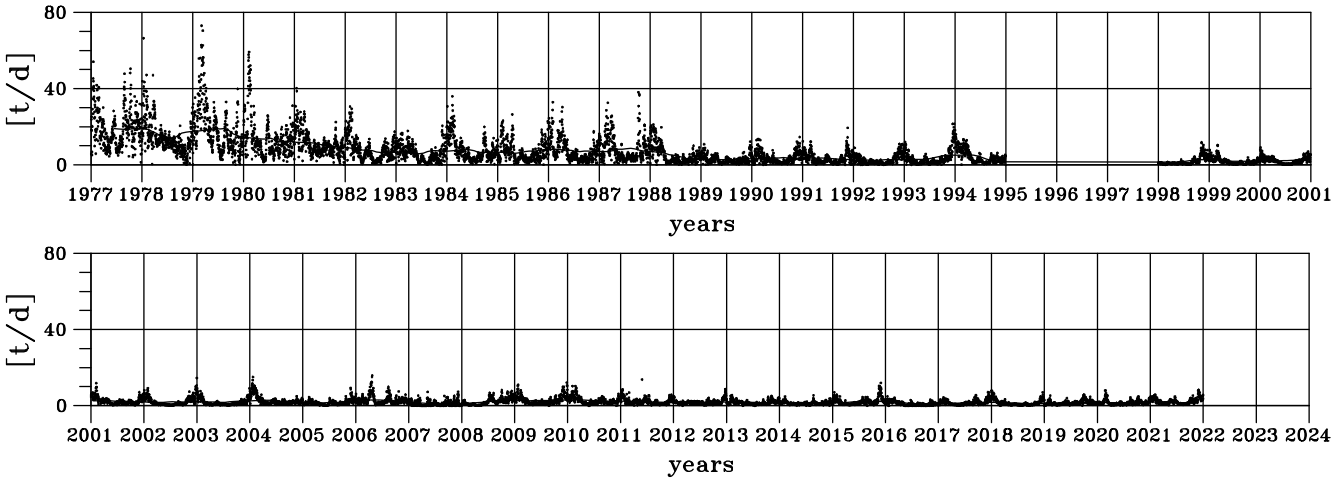
year	t/y	year	t/y	year	t/y	year	t/y	year	t/y	year	t/y
1977	6883	1985	2407	1993	1196	2001	883	2009	1020	2017	557
1978	5150	1986	2720	1994	1510	2002	718	2010	912	2018	513
1979	6802	1987	2971			2003	586	2011	798	2019	544
1980	4990	1988	1803			2004	992	2012	643	2020	553
1981	3920	1989	995			2005	560	2013	599	2021	827
1982	2782	1990	1307	1998	650	2006	1075	2014	447		
1983	2125	1991	1245	1999	669	2007	367	2015	785		
1984	2853	1992	922	2000	819	2008	750	2016	367		

TIME SERIES
mean: 4.7 t/d
relative standard deviation: 1.29
minimum: 0.0 t/d March 24, 1990
maximum: 72.9 t/d March 5, 1979

LOW PASS
minimum: 0.8 t/d November 2016
maximum: 19.1 t/d November 1977

ANNUAL CYCLE
minimum: 2.5 t/d July, rel. stdev: 1.06
maximum: 7.6 t/d February, rel. stdev: 1.19





Total Phosphorus load for Nordzeekanaal

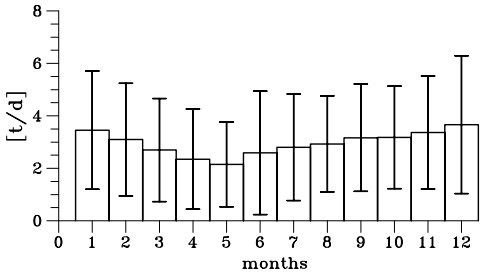
ANNUAL LOADS

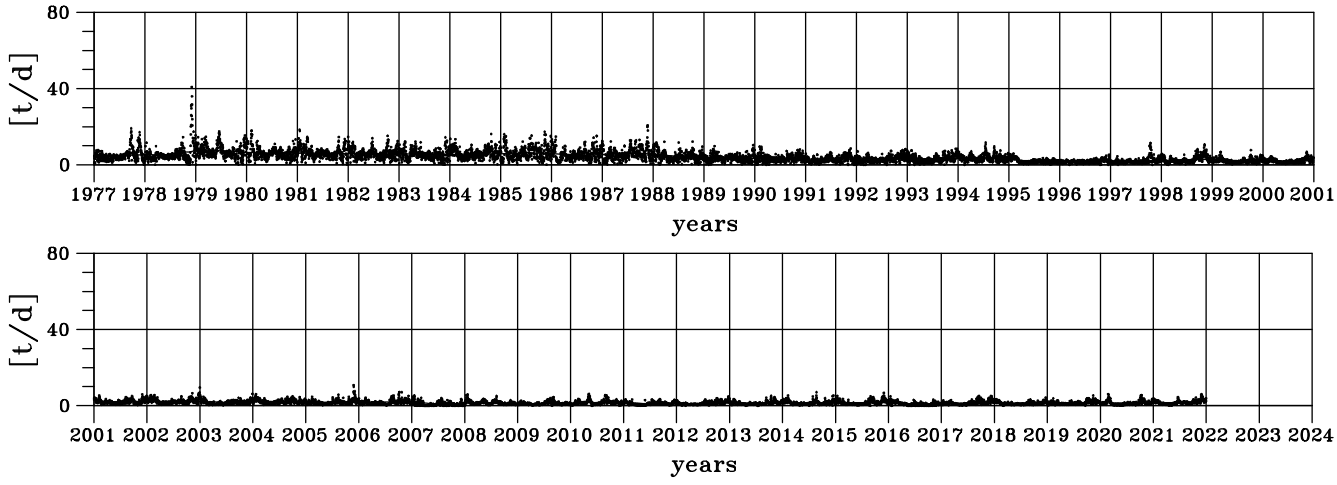
year	t/y	year	t/y	year	t/y	year	t/y	year	t/y	year	t/y
1977	1824	1985	2283	1993	1148	2001	754	2009	411	2017	522
1978	2109	1986	1947	1994	1322	2002	841	2010	589	2018	429
1979	2612	1987	2093	1995	703	2003	619	2011	406	2019	530
1980	2220	1988	1623	1996	643	2004	788	2012	469	2020	492
1981	2307	1989	1256	1997	744	2005	676	2013	476	2021	609
1982	2117	1990	1212	1998	1008	2006	647	2014	545		
1983	1917	1991	1071	1999	789	2007	282	2015	579		
1984	2153	1992	1113	2000	761	2008	551	2016	331		

TIME SERIES
mean: 3.0 t/d
relative standard deviation: 0.88
minimum: 0.0 t/d March 24, 1990
maximum: 40.8 t/d December 4, 1978

LOW PASS
minimum: 0.8 t/d November 2016
maximum: 7.8 t/d February 1979

ANNUAL CYCLE
minimum: 2.1 t/d May, rel. stdev: 0.75
maximum: 3.7 t/d December, rel. stdev: 0.72





Phosphate load for Nordzeekanaal

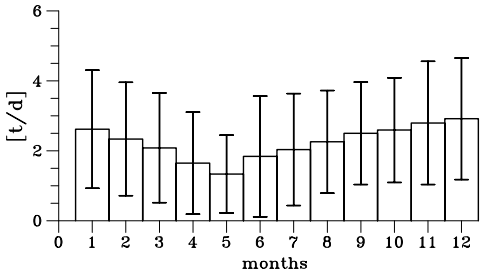
ANNUAL LOADS

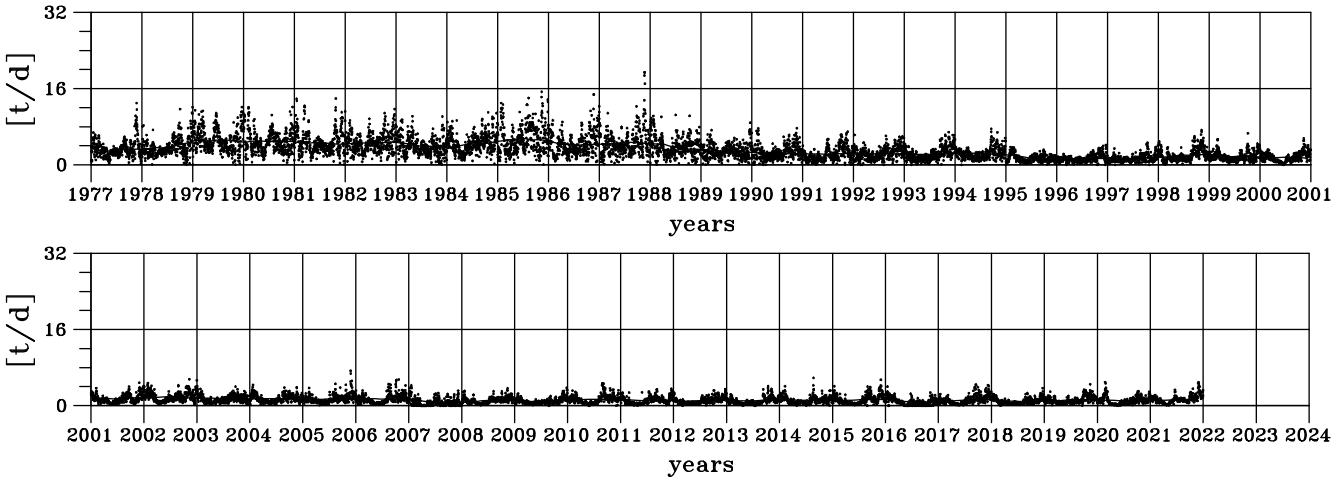
year	t/y	year	t/y	year	t/y	year	t/y	year	t/y	year	t/y
1977	1200	1985	1987	1993	804	2001	521	2009	335	2017	440
1978	1313	1986	1556	1994	854	2002	665	2010	476	2018	329
1979	1893	1987	1633	1995	507	2003	496	2011	399	2019	421
1980	1766	1988	1387	1996	495	2004	543	2012	378	2020	375
1981	1707	1989	1034	1997	492	2005	527	2013	348	2021	481
1982	1684	1990	945	1998	746	2006	504	2014	414		
1983	1405	1991	794	1999	632	2007	234	2015	453		
1984	1634	1992	868	2000	571	2008	396	2016	278		

TIME SERIES
mean: 2.2 t/d
relative standard deviation: 0.88
minimum: 0.0 t/d March 24, 1990
maximum: 19.4 t/d November 22, 1987

LOW PASS
minimum: 0.6 t/d August 2007
maximum: 5.5 t/d July 1985

ANNUAL CYCLE
minimum: 1.3 t/d May, rel. stdev: 0.83
maximum: 2.9 t/d December, rel. stdev: 0.60





Silicate load for Nordzeekanaal

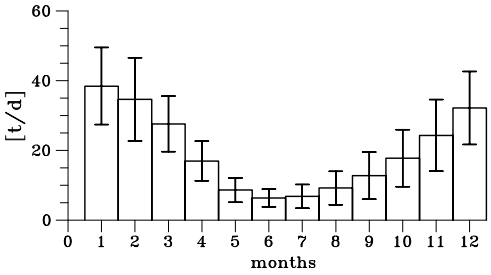
ANNUAL LOADS

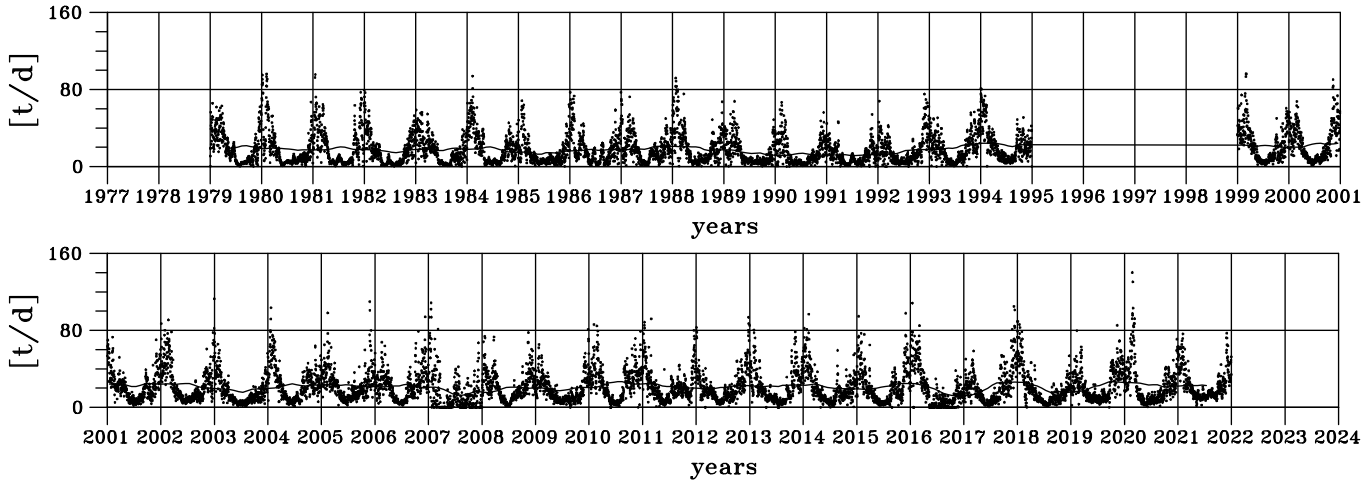
year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y
		1985	4.9	1993	6.7	2001	7.8	2009	6.4	2017	7.9
		1986	6.5	1994	8.1	2002	9.0	2010	9.3	2018	6.9
1979	7.1	1987	6.5			2003	5.6	2011	8.1	2019	8.2
1980	6.6	1988	7.7			2004	8.9	2012	7.7	2020	8.3
1981	7.4	1989	5.0			2005	8.7	2013	7.6	2021	8.6
1982	5.5	1990	4.9			2006	8.2	2014	7.5		
1983	5.9	1991	4.1	1999	8.2	2007	4.9	2015	7.9		
1984	7.4	1992	6.1	2000	8.6	2008	7.9	2016	6.5		

TIME SERIES
mean: 18.4 t/d
relative standard deviation: 0.87
minimum: 0.0 t/d March 24, 1990
maximum: 140.1 t/d February 24, 2020

LOW PASS
minimum: 11.4 t/d July 1991
maximum: 26.8 t/d August 2010

ANNUAL CYCLE
minimum: 6.3 t/d June, rel. stdev: 0.40
maximum: 38.4 t/d January, rel. stdev: 0.29





5.7 Loads of Nieuwe Waterweg

Total Nitrogen load for Nieuwe Waterweg

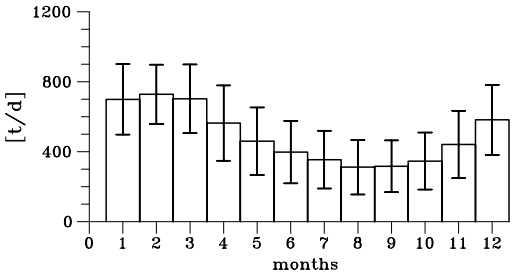
ANNUAL LOADS

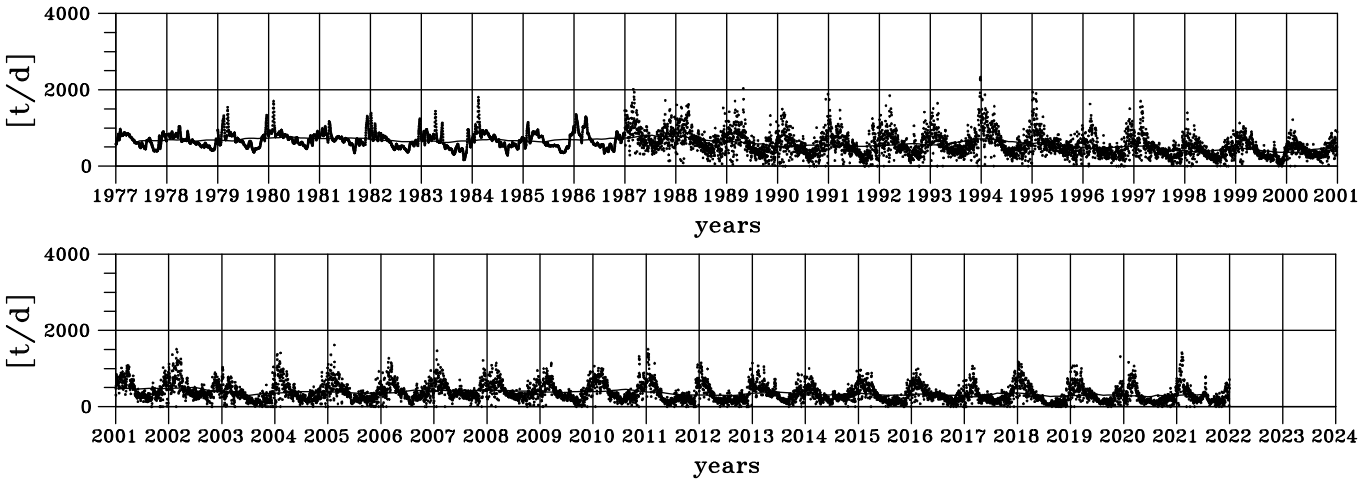
year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y
1977	241.4	1985	236.4	1993	226.5	2001	169.2	2009	135.1	2017	110.0
1978	239.3	1986	259.7	1994	234.3	2002	181.8	2010	157.0	2018	105.6
1979	260.0	1987	294.8	1995	214.2	2003	103.8	2011	120.9	2019	117.9
1980	275.0	1988	251.5	1996	180.3	2004	145.3	2012	110.2	2020	92.7
1981	267.8	1989	218.0	1997	168.9	2005	131.5	2013	137.8	2021	115.4
1982	239.4	1990	193.5	1998	144.5	2006	146.1	2014	112.7		
1983	223.6	1991	192.9	1999	148.4	2007	158.0	2015	110.6		
1984	258.1	1992	212.1	2000	157.9	2008	149.1	2016	118.3		

TIME SERIES
mean: 490.8 t/d
relative standard deviation: 0.58
minimum: 0.0 t/d February 8, 1990
maximum: 2327.9 t/d December 27, 1993

LOW PASS
minimum: 260.9 t/d March 2017
maximum: 805.7 t/d June 1987

ANNUAL CYCLE
minimum: 311.3 t/d August, rel. stdev: 0.50
maximum: 728.3 t/d February, rel. stdev: 0.23





Nitrate + Nitrite load for Nieuwe Waterweg

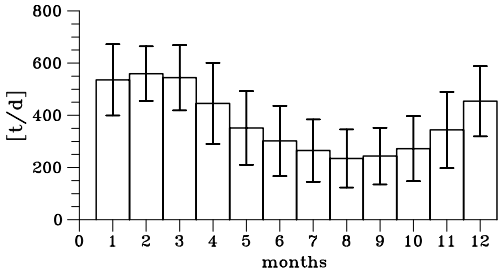
ANNUAL LOADS

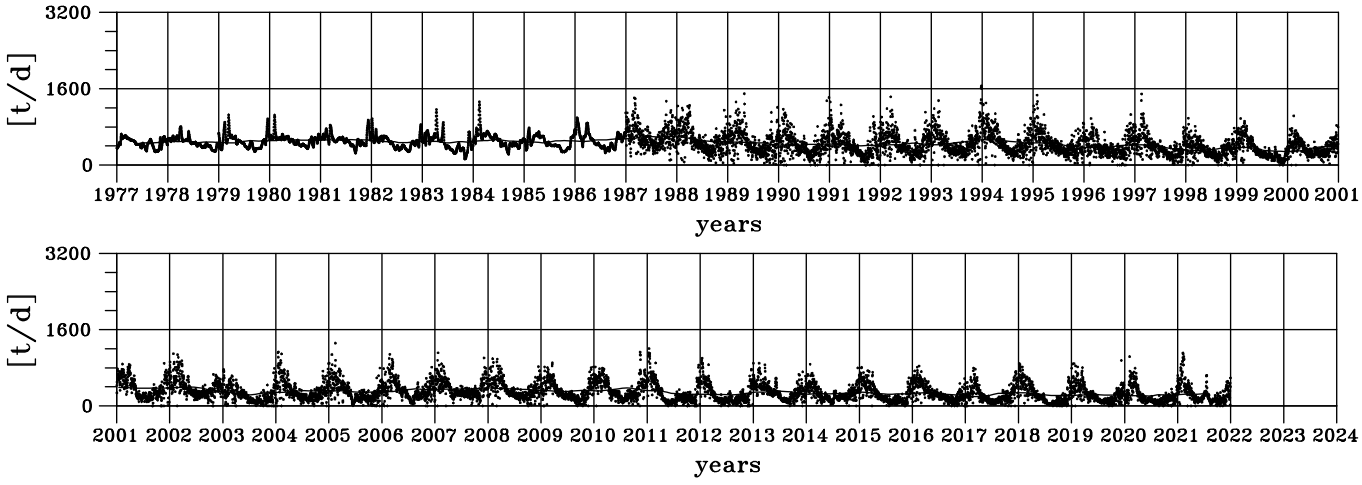
year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y
1977	167.2	1985	173.5	1993	172.2	2001	135.2	2009	111.2	2017	83.2
1978	173.5	1986	192.6	1994	179.1	2002	143.0	2010	129.6	2018	84.0
1979	181.3	1987	218.7	1995	161.0	2003	80.7	2011	95.5	2019	88.7
1980	191.7	1988	187.4	1996	140.1	2004	117.3	2012	88.2	2020	73.1
1981	194.1	1989	172.7	1997	139.2	2005	107.2	2013	112.4	2021	93.3
1982	174.7	1990	152.6	1998	117.0	2006	122.9	2014	92.3		
1983	168.5	1991	150.9	1999	115.8	2007	130.6	2015	91.1		
1984	195.0	1992	162.9	2000	130.1	2008	128.7	2016	98.2		

TIME SERIES
mean: 378.3 t/d
relative standard deviation: 0.57
minimum: 0.0 t/d February 8, 1990
maximum: 1658.1 t/d December 27, 1993

LOW PASS
minimum: 196.1 t/d February 2017
maximum: 602.0 t/d November 1987

ANNUAL CYCLE
minimum: 234.6 t/d August, rel. stdev: 0.47
maximum: 559.5 t/d February, rel. stdev: 0.19





Ammonium load for Nieuwe Waterweg

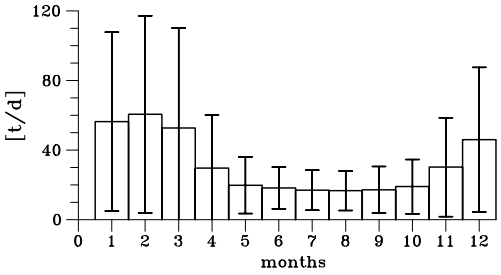
ANNUAL LOADS

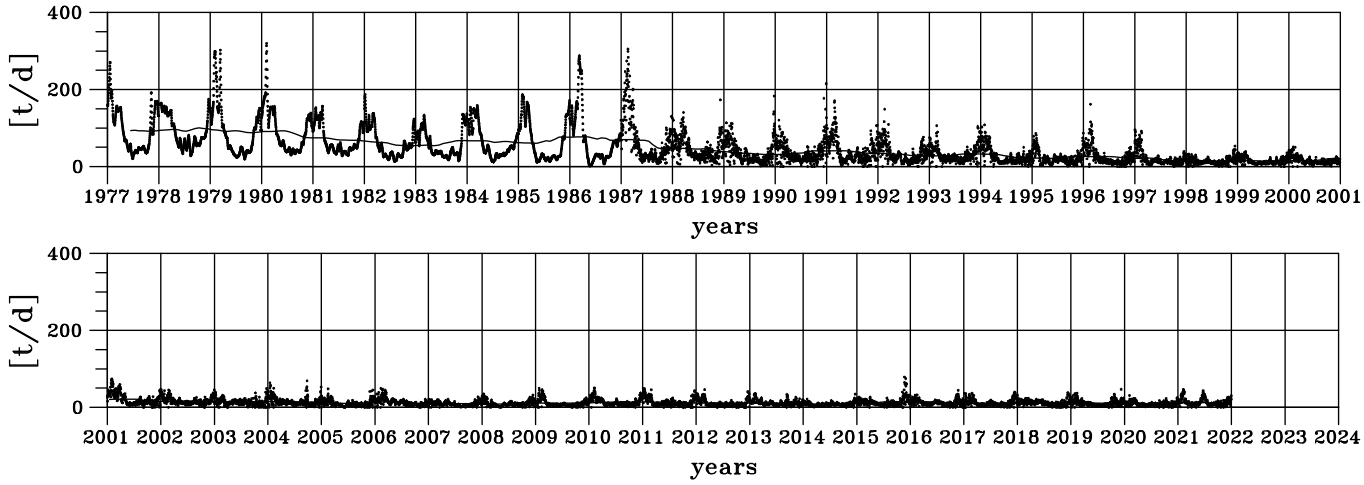
year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y
1977	35.1	1985	24.1	1993	10.9	2001	7.8	2009	3.8	2017	4.1
1978	33.2	1986	25.9	1994	9.7	2002	6.1	2010	5.1	2018	4.3
1979	33.5	1987	24.6	1995	7.8	2003	4.8	2011	4.8	2019	4.0
1980	33.7	1988	16.6	1996	9.3	2004	5.5	2012	3.8	2020	3.3
1981	25.1	1989	12.5	1997	7.3	2005	3.7	2013	4.2	2021	4.8
1982	21.9	1990	12.7	1998	5.0	2006	4.8	2014	3.0		
1983	21.0	1991	14.0	1999	5.2	2007	3.2	2015	5.1		
1984	22.9	1992	11.5	2000	5.6	2008	3.4	2016	4.4		

TIME SERIES
mean: 31.8 t/d
relative standard deviation: 1.23
minimum: 0.0 t/d February 8, 1990
maximum: 319.5 t/d February 6, 1980

LOW PASS
minimum: 7.9 t/d December 2007
maximum: 100.3 t/d October 1978

ANNUAL CYCLE
minimum: 16.7 t/d August, rel. stdev: 0.68
maximum: 60.5 t/d February, rel. stdev: 0.94





Total Phosphorus load for Nieuwe Waterweg

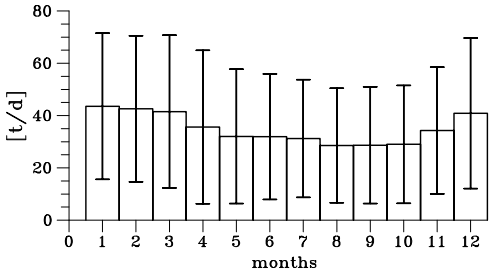
ANNUAL LOADS

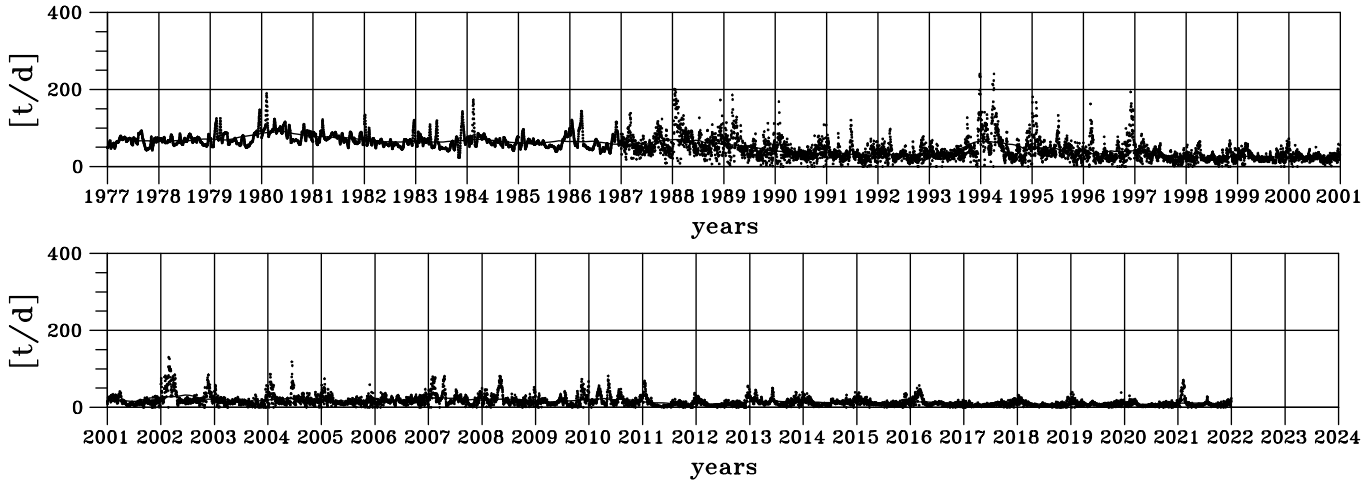
year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y
1977	23.6	1985	22.3	1993	15.0	2001	5.6	2009	6.0	2017	2.8
1978	24.5	1986	23.8	1994	21.2	2002	11.7	2010	7.1	2018	3.0
1979	27.0	1987	20.6	1995	16.8	2003	5.2	2011	3.9	2019	3.4
1980	32.5	1988	25.4	1996	14.8	2004	8.3	2012	3.7	2020	2.7
1981	27.3	1989	18.2	1997	10.5	2005	6.0	2013	5.7	2021	4.0
1982	23.7	1990	13.9	1998	8.8	2006	6.4	2014	4.6		
1983	23.2	1991	11.7	1999	9.8	2007	8.6	2015	4.4		
1984	24.7	1992	11.4	2000	8.8	2008	7.7	2016	4.7		

TIME SERIES
mean: 34.9 t/d
relative standard deviation: 0.83
minimum: 0.0 t/d February 8, 1990
maximum: 240.6 t/d December 27, 1993

LOW PASS
minimum: 6.6 t/d February 2017
maximum: 91.0 t/d May 1980

ANNUAL CYCLE
minimum: 28.5 t/d August, rel. stdev: 0.77
maximum: 43.6 t/d January, rel. stdev: 0.64





Phosphate load for Nieuwe Waterweg

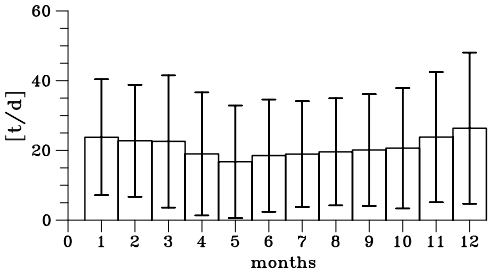
ANNUAL LOADS

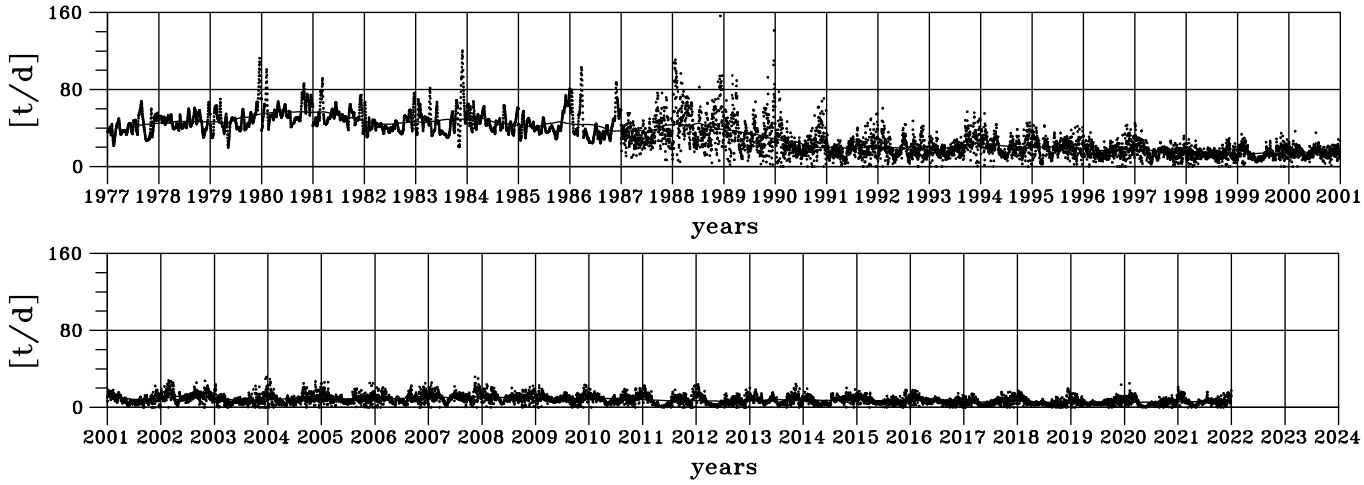
year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y
1977	14.9	1985	15.9	1993	7.7	2001	3.0	2009	3.3	2017	2.2
1978	17.1	1986	15.7	1994	7.7	2002	4.4	2010	3.3	2018	2.0
1979	17.9	1987	12.5	1995	7.2	2003	2.7	2011	2.5	2019	2.0
1980	21.0	1988	16.8	1996	6.0	2004	3.3	2012	2.3	2020	1.9
1981	19.5	1989	12.6	1997	5.7	2005	3.2	2013	2.9	2021	2.3
1982	16.0	1990	8.7	1998	4.6	2006	3.3	2014	2.7		
1983	17.6	1991	6.6	1999	5.1	2007	4.0	2015	2.5		
1984	17.1	1992	6.8	2000	5.3	2008	3.7	2016	2.5		

TIME SERIES
mean: 21.1 t/d
relative standard deviation: 0.88
minimum: 0.0 t/d February 8, 1990
maximum: 156.4 t/d December 7, 1988

LOW PASS
minimum: 5.0 t/d February 2017
maximum: 58.3 t/d May 1980

ANNUAL CYCLE
minimum: 16.8 t/d May, rel. stdev: 0.96
maximum: 26.3 t/d December, rel. stdev: 0.82





Silicate load for Nieuwe Waterweg

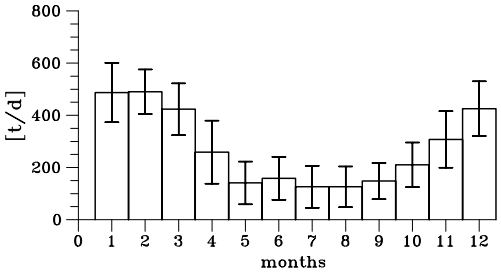
ANNUAL LOADS

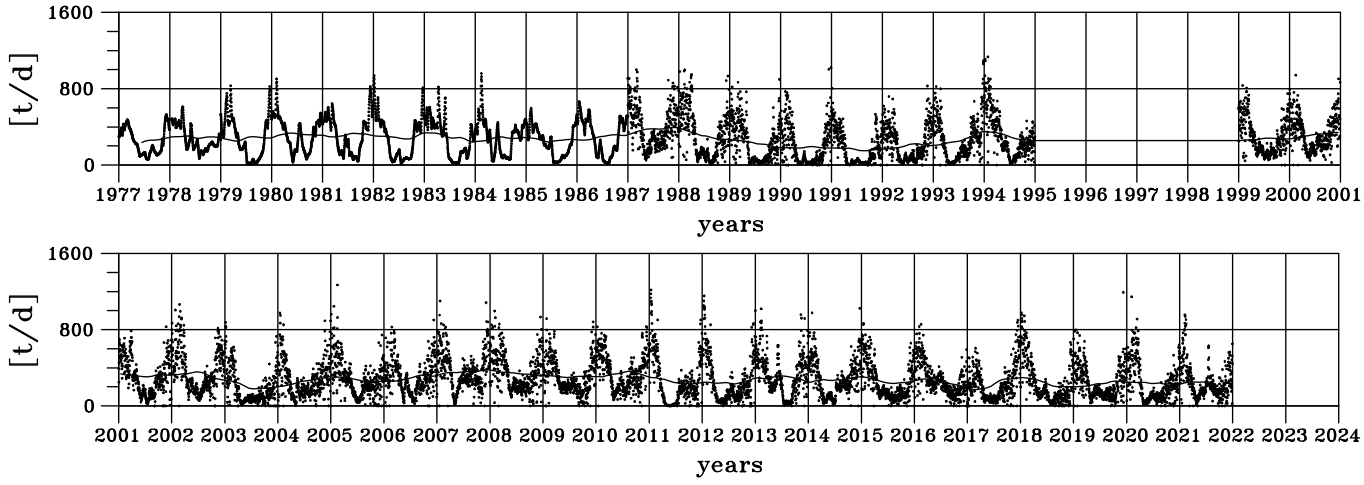
year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y
1977	90.2	1985	88.0	1993	90.1	2001	111.1	2009	107.7	2017	80.4
1978	102.6	1986	108.8	1994	107.2	2002	130.8	2010	125.3	2018	85.5
1979	103.3	1987	139.9			2003	63.9	2011	88.6	2019	85.7
1980	120.1	1988	112.2			2004	95.8	2012	89.2	2020	84.8
1981	116.7	1989	84.2			2005	100.5	2013	113.9	2021	91.3
1982	103.8	1990	67.3			2006	106.0	2014	98.6		
1983	103.5	1991	57.3	1999	103.4	2007	132.2	2015	87.8		
1984	108.7	1992	77.2	2000	117.0	2008	125.3	2016	99.7		

TIME SERIES
mean: 273.9 t/d
relative standard deviation: 0.69
minimum: 0.0 t/d February 8, 1990
maximum: 1268.8 t/d February 15, 2005

LOW PASS
minimum: 151.9 t/d August 1991
maximum: 395.5 t/d November 1987

ANNUAL CYCLE
minimum: 126.0 t/d July, rel. stdev: 0.64
maximum: 490.2 t/d February, rel. stdev: 0.17





Total Alkalinity load for Nieuwe Waterweg

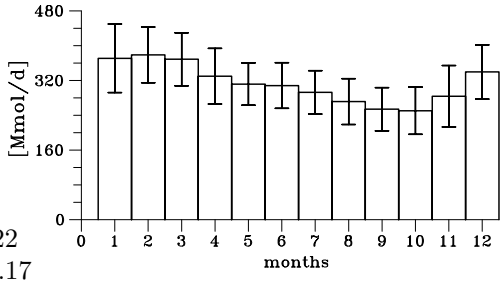
ANNUAL LOADS

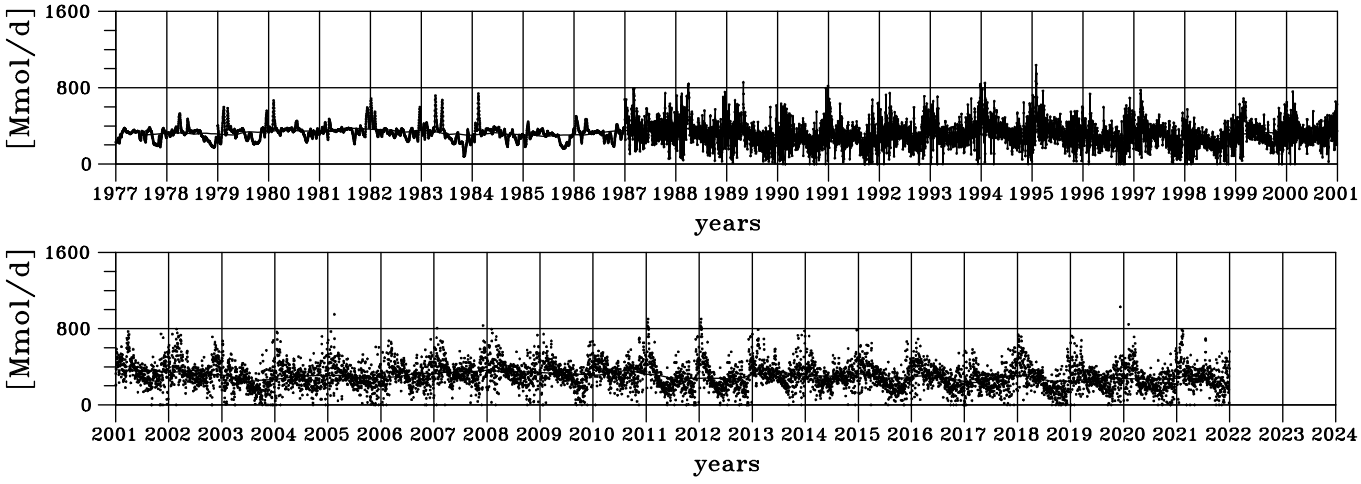
year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y
1977	110.3	1985	105.8	1993	121.7	2001	129.9	2009	115.3	2017	96.1
1978	115.1	1986	119.8	1994	129.9	2002	132.4	2010	126.4	2018	97.0
1979	120.1	1987	137.6	1995	128.3	2003	89.6	2011	102.6	2019	103.3
1980	128.7	1988	131.0	1996	103.9	2004	110.7	2012	102.9	2020	96.1
1981	131.8	1989	107.1	1997	109.5	2005	107.3	2013	124.7	2021	111.0
1982	126.9	1990	102.7	1998	86.9	2006	114.1	2014	110.0		
1983	113.3	1991	102.6	1999	120.7	2007	127.9	2015	103.4		
1984	120.1	1992	115.0	2000	121.2	2008	128.4	2016	107.6		

TIME SERIES
mean: 313.1 Mmol/d
relative standard deviation: 0.39
minimum: 0.0 Mmol/d February 8, 1990
maximum: 1036.3 Mmol/d January 31, 1995

LOW PASS
minimum: 231.2 Mmol/d April 1998
maximum: 387.5 Mmol/d November 1987

ANNUAL CYCLE
minimum: 250.6 Mmol/d October, rel. stdev: 0.22
maximum: 379.0 Mmol/d February, rel. stdev: 0.17





Dissolved Inorganic Carbon load for Nieuwe Waterweg

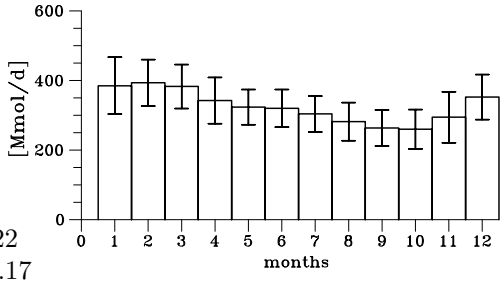
ANNUAL LOADS

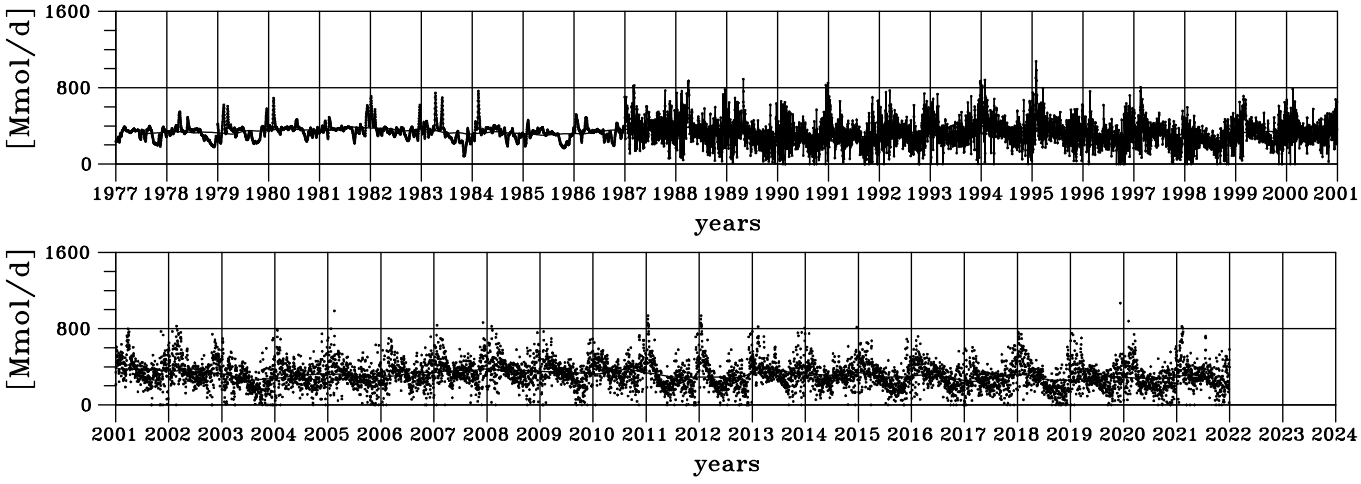
year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y
1977	114.5	1985	109.8	1993	126.3	2001	134.9	2009	119.7	2017	99.7
1978	119.4	1986	124.3	1994	134.8	2002	137.5	2010	131.2	2018	100.7
1979	124.6	1987	142.8	1995	133.2	2003	93.0	2011	106.4	2019	107.2
1980	133.6	1988	136.0	1996	107.8	2004	114.9	2012	106.8	2020	99.7
1981	136.8	1989	111.2	1997	113.7	2005	111.4	2013	129.4	2021	115.2
1982	131.7	1990	106.6	1998	90.2	2006	118.4	2014	114.2		
1983	117.6	1991	106.5	1999	125.3	2007	132.8	2015	107.3		
1984	124.6	1992	119.3	2000	125.8	2008	133.2	2016	111.7		

TIME SERIES
mean: 325.0 Mmol/d
relative standard deviation: 0.39
minimum: 0.0 Mmol/d February 8, 1990
maximum: 1075.7 Mmol/d January 31, 1995

LOW PASS
minimum: 240.0 Mmol/d April 1998
maximum: 402.2 Mmol/d November 1987

ANNUAL CYCLE
minimum: 260.1 Mmol/d October, rel. stdev: 0.22
maximum: 393.4 Mmol/d February, rel. stdev: 0.17





Dissolved Organic Carbon load for Nieuwe Waterweg

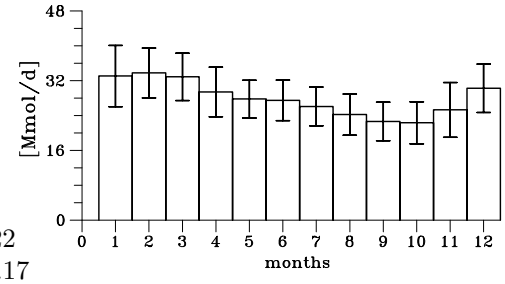
ANNUAL LOADS

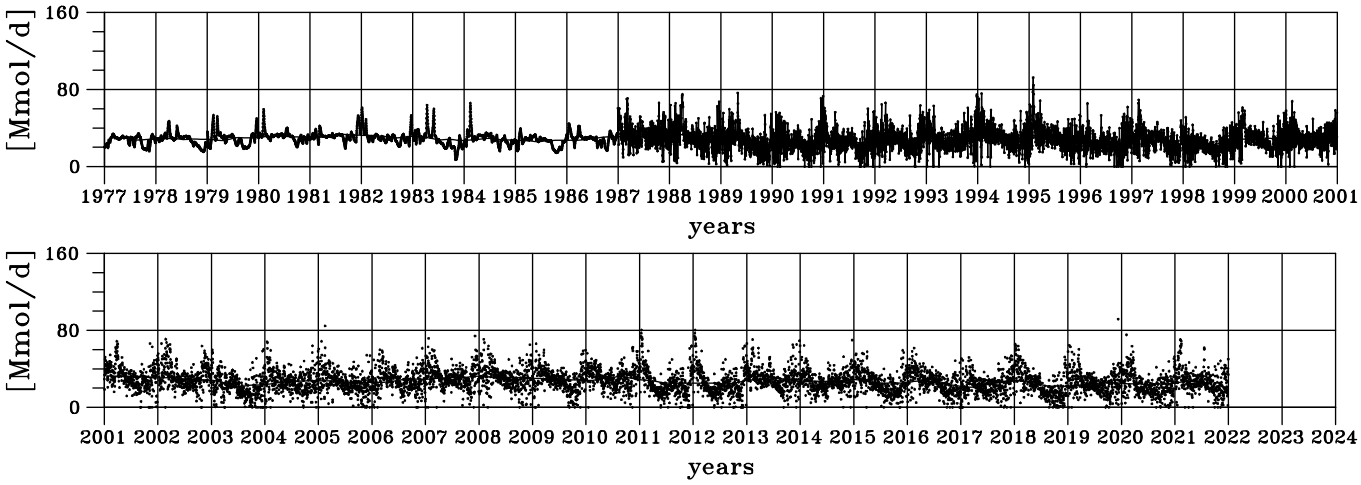
year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y
1977	9.8	1985	9.4	1993	10.8	2001	11.6	2009	10.3	2017	8.6
1978	10.3	1986	10.7	1994	11.6	2002	11.8	2010	11.3	2018	8.7
1979	10.7	1987	12.3	1995	11.4	2003	8.0	2011	9.1	2019	9.2
1980	11.5	1988	11.7	1996	9.3	2004	9.9	2012	9.2	2020	8.6
1981	11.8	1989	9.5	1997	9.8	2005	9.6	2013	11.1	2021	9.9
1982	11.3	1990	9.2	1998	7.7	2006	10.2	2014	9.8		
1983	10.1	1991	9.1	1999	10.8	2007	11.4	2015	9.2		
1984	10.7	1992	10.2	2000	10.8	2008	11.4	2016	9.6		

TIME SERIES
mean: 27.9 Mmol/d
relative standard deviation: 0.39
minimum: 0.0 Mmol/d February 8, 1990
maximum: 92.4 Mmol/d January 31, 1995

LOW PASS
minimum: 20.6 Mmol/d April 1998
maximum: 34.5 Mmol/d November 1987

ANNUAL CYCLE
minimum: 22.3 Mmol/d October, rel. stdev: 0.22
maximum: 33.8 Mmol/d February, rel. stdev: 0.17





5.8 Loads of Haringvliet

Total Nitrogen load for Haringvliet

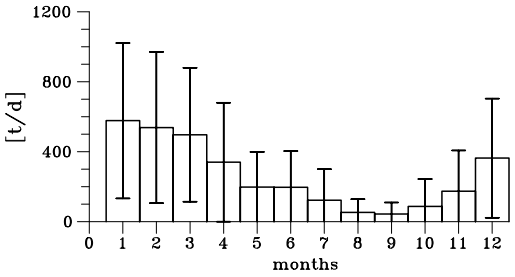
ANNUAL LOADS

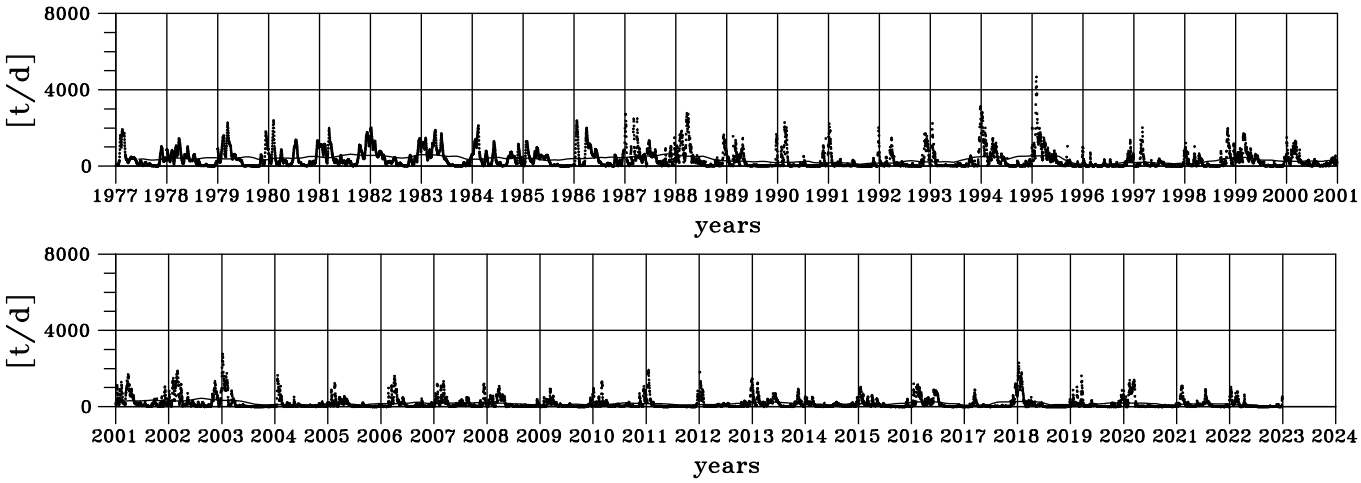
year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y
1977	129.5	1985	103.9	1993	77.9	2001	113.1	2009	37.2	2017	39.2
1978	128.1	1986	169.1	1994	146.7	2002	128.5	2010	56.2	2018	74.2
1979	173.3	1987	191.9	1995	197.4	2003	81.2	2011	44.7	2019	48.7
1980	146.8	1988	192.6	1996	44.6	2004	42.3	2012	54.1	2020	56.7
1981	213.6	1989	78.9	1997	49.4	2005	44.7	2013	81.8	2021	49.6
1982	164.5	1990	74.8	1998	97.8	2006	60.9	2014	34.2	2022	34.6
1983	181.9	1991	62.8	1999	114.1	2007	81.0	2015	45.5		
1984	168.8	1992	89.9	2000	99.9	2008	53.6	2016	87.6		

TIME SERIES
mean: 264.7 t/d
relative standard deviation: 1.55
minimum: 0.0 t/d August 28, 1990
maximum: 4672.3 t/d February 2, 1995

LOW PASS
minimum: 48.1 t/d March 2017
maximum: 641.4 t/d November 1987

ANNUAL CYCLE
minimum: 43.6 t/d September, rel. stdev: 1.52
maximum: 577.0 t/d January, rel. stdev: 0.77





Nitrate + Nitrite load for Haringvliet

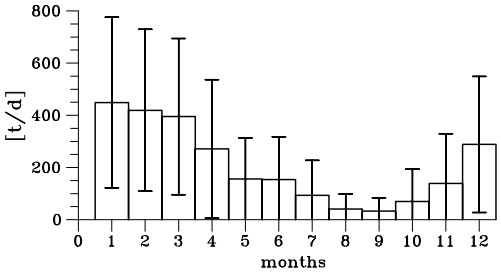
ANNUAL LOADS

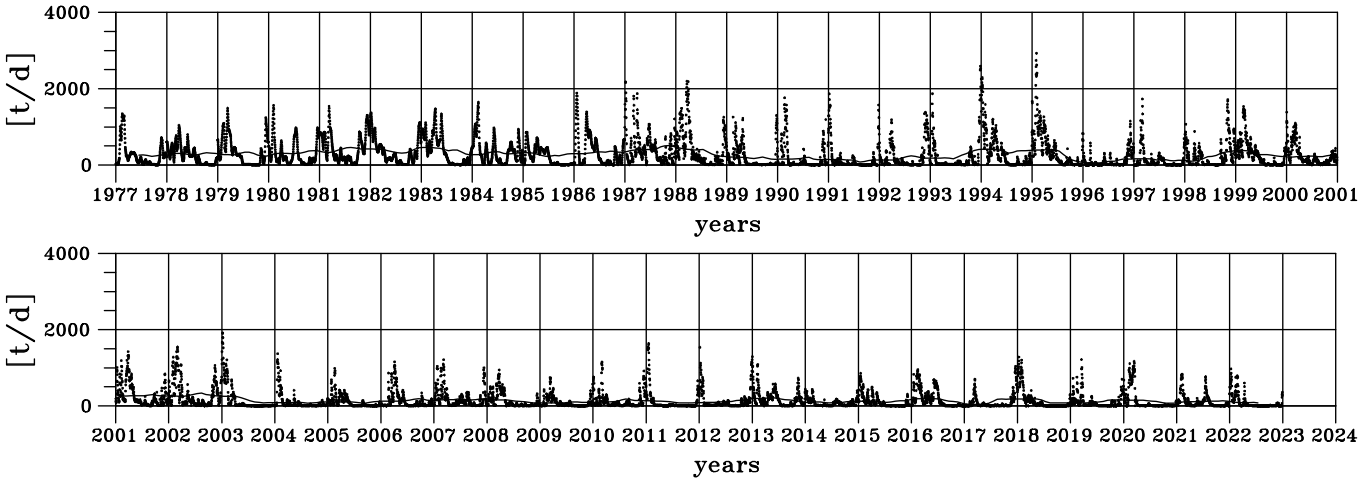
year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y
1977	92.0	1985	75.9	1993	65.0	2001	97.0	2009	30.7	2017	32.2
1978	94.3	1986	130.5	1994	120.0	2002	106.0	2010	47.5	2018	49.4
1979	122.3	1987	150.0	1995	142.3	2003	58.3	2011	37.4	2019	37.7
1980	107.0	1988	152.4	1996	38.0	2004	34.3	2012	44.6	2020	46.3
1981	162.5	1989	62.6	1997	42.4	2005	35.5	2013	69.0	2021	39.7
1982	120.6	1990	59.3	1998	84.3	2006	48.4	2014	28.1	2022	32.8
1983	139.7	1991	51.4	1999	97.8	2007	70.1	2015	37.4		
1984	131.6	1992	73.7	2000	84.6	2008	46.9	2016	68.0		

TIME SERIES
mean: 208.2 t/d
relative standard deviation: 1.52
minimum: 0.0 t/d August 28, 1990
maximum: 2927.3 t/d February 2, 1995

LOW PASS
minimum: 37.1 t/d March 2017
maximum: 513.0 t/d November 1987

ANNUAL CYCLE
minimum: 32.9 t/d September, rel. stdev: 1.55
maximum: 448.9 t/d January, rel. stdev: 0.73





Ammonium load for Haringvliet

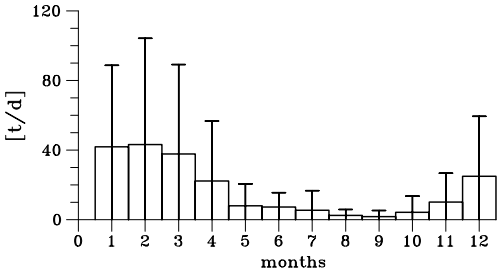
ANNUAL LOADS

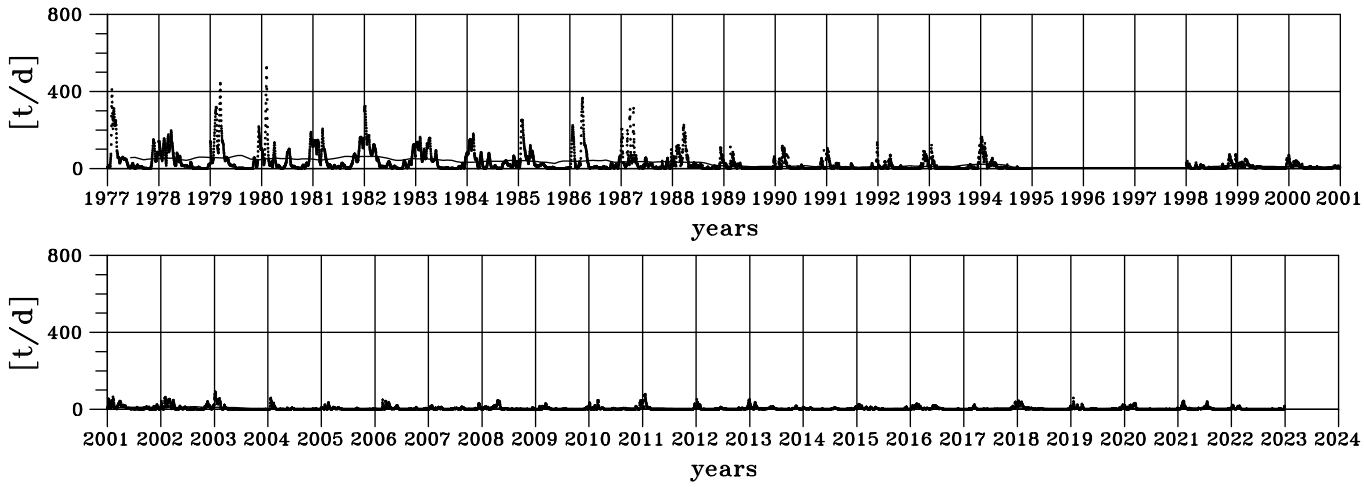
year	t/y	year	t/y	year	t/y	year	t/y	year	t/y	year	t/y
1977	19944	1985	11813	1993	3332	2001	3663	2009	992	2017	1152
1978	15312	1986	15603	1994	6158	2002	4207	2010	2013	2018	1645
1979	24225	1987	12901			2003	2575	2011	1731	2019	1401
1980	18596	1988	12466			2004	1291	2012	1656	2020	1260
1981	19828	1989	3256			2005	1045	2013	1825	2021	1908
1982	18746	1990	4473	1998	3824	2006	1674	2014	737	2022	760
1983	15377	1991	3693	1999	3669	2007	1358	2015	1214		
1984	13617	1992	4311	2000	3072	2008	1921	2016	1940		

TIME SERIES
mean: 18.4 t/d
relative standard deviation: 2.10
minimum: 0.0 t/d August 28, 1990
maximum: 523.7 t/d February 6, 1980

LOW PASS
minimum: 1.4 t/d March 2017
maximum: 67.7 t/d August 1979

ANNUAL CYCLE
minimum: 1.7 t/d September, rel. stdev: 2.04
maximum: 43.2 t/d February, rel. stdev: 1.41





Total Phosphorus load for Haringvliet

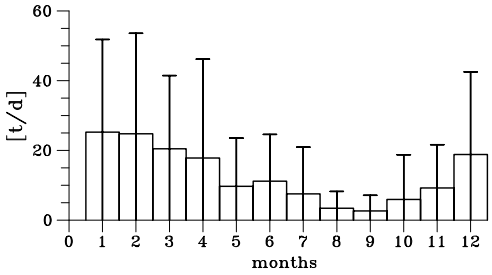
ANNUAL LOADS

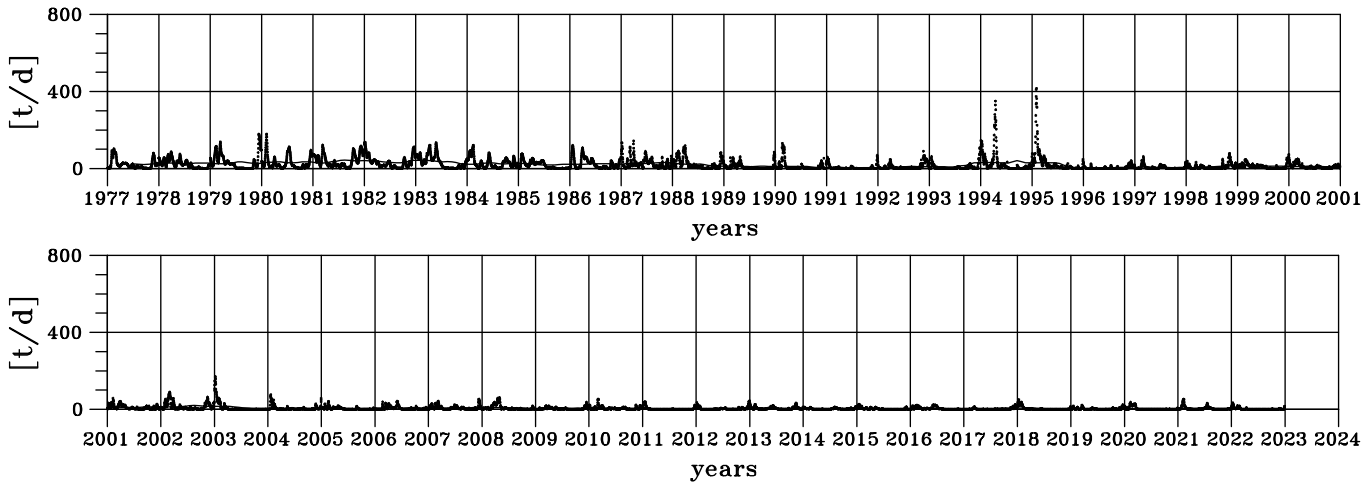
year	t/y	year	t/y	year	t/y	year	t/y	year	t/y	year	t/y
1977	7874	1985	6396	1993	2738	2001	3536	2009	1365	2017	828
1978	8596	1986	9462	1994	10231	2002	5455	2010	2105	2018	1483
1979	12509	1987	9992	1995	10741	2003	3794	2011	983	2019	1015
1980	10857	1988	8618	1996	1553	2004	2307	2012	1446	2020	1348
1981	14626	1989	3362	1997	1910	2005	1549	2013	2064	2021	1759
1982	11726	1990	3635	1998	3545	2006	2196	2014	1004	2022	957
1983	12388	1991	1890	1999	4208	2007	2889	2015	1136		
1984	10655	1992	3392	2000	3927	2008	2819	2016	1813		

TIME SERIES
mean: 13.0 t/d
relative standard deviation: 1.86
minimum: 0.0 t/d August 28, 1990
maximum: 416.2 t/d February 2, 1995

LOW PASS
minimum: 0.9 t/d February 2017
maximum: 42.9 t/d August 1981

ANNUAL CYCLE
minimum: 2.7 t/d September, rel. stdev: 1.66
maximum: 25.2 t/d January, rel. stdev: 1.05





Phosphate load for Haringvliet

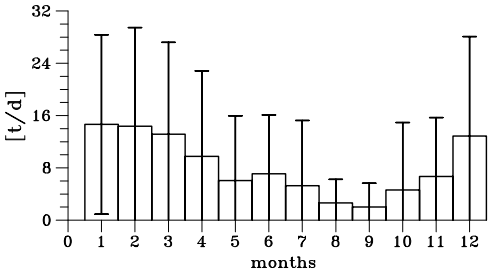
ANNUAL LOADS

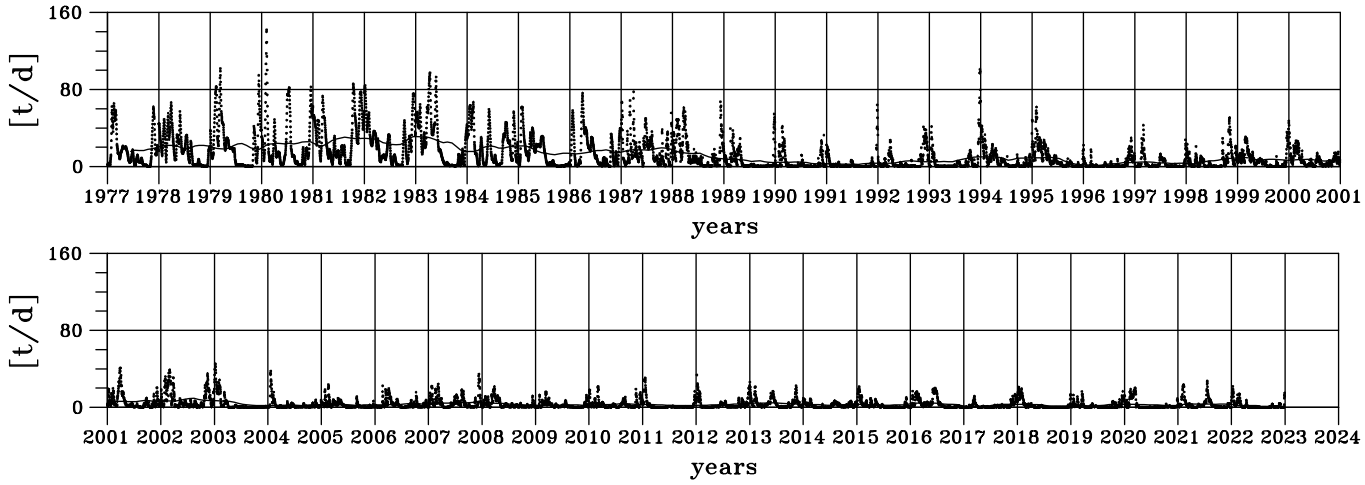
year	t/y	year	t/y	year	t/y	year	t/y	year	t/y	year	t/y
1977	5734	1985	4966	1993	2125	2001	2137	2009	816	2017	592
1978	6850	1986	6156	1994	2519	2002	3021	2010	1140	2018	796
1979	8430	1987	6252	1995	3183	2003	1385	2011	765	2019	725
1980	8631	1988	5213	1996	1035	2004	884	2012	1122	2020	875
1981	10579	1989	2025	1997	1241	2005	953	2013	1607	2021	1190
1982	8597	1990	1487	1998	2252	2006	1088	2014	736	2022	702
1983	9077	1991	1052	1999	2511	2007	1986	2015	881		
1984	7824	1992	1893	2000	2537	2008	1193	2016	1534		

TIME SERIES
mean: 8.2 t/d
relative standard deviation: 1.69
minimum: 0.0 t/d August 28, 1990
maximum: 141.9 t/d February 6, 1980

LOW PASS
minimum: 0.8 t/d February 2017
maximum: 31.1 t/d December 1982

ANNUAL CYCLE
minimum: 2.0 t/d September, rel. stdev: 1.79
maximum: 14.6 t/d January, rel. stdev: 0.94





Silicate load for Haringvliet

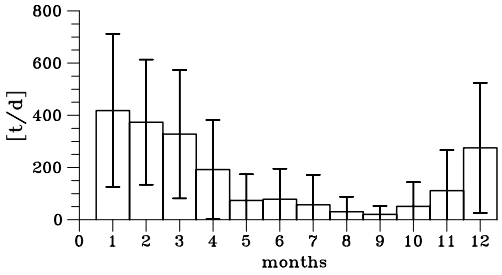
ANNUAL LOADS

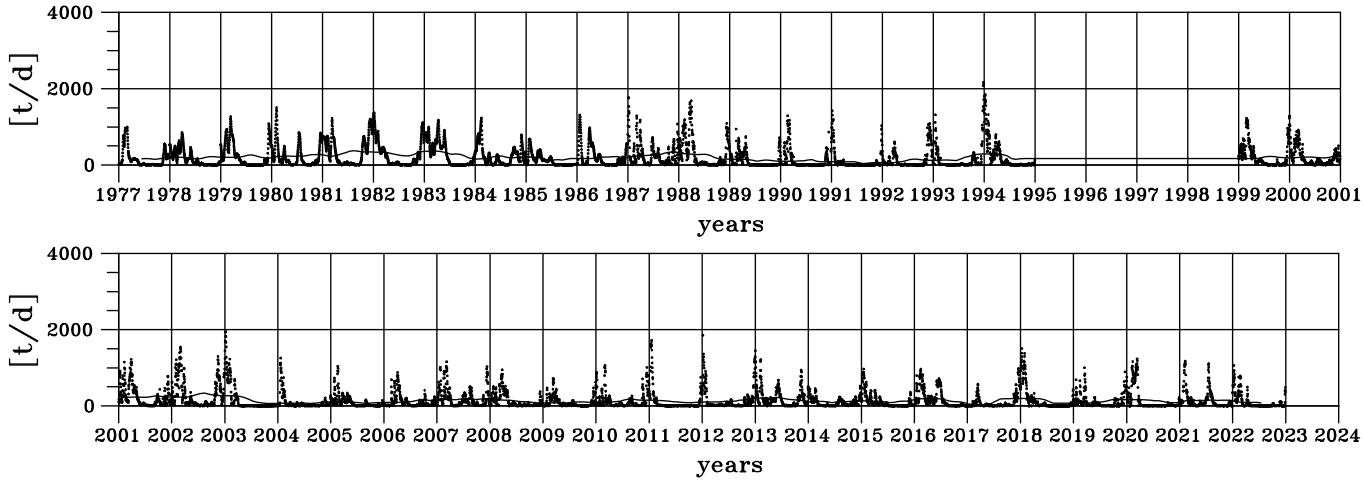
year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y
1977	59.1	1985	42.2	1993	47.4	2001	82.2	2009	30.7	2017	31.0
1978	60.7	1986	77.1	1994	76.8	2002	104.6	2010	49.8	2018	53.4
1979	92.0	1987	94.0			2003	56.9	2011	38.8	2019	37.8
1980	81.7	1988	107.7			2004	28.5	2012	49.7	2020	49.3
1981	127.0	1989	38.6			2005	33.5	2013	73.4	2021	51.1
1982	94.4	1990	39.2			2006	37.6	2014	32.5	2022	34.0
1983	105.1	1991	32.4	1999	78.5	2007	71.8	2015	37.1		
1984	88.2	1992	46.3	2000	72.1	2008	45.9	2016	66.7		

TIME SERIES
mean: 169.5 t/d
relative standard deviation: 1.54
minimum: 0.0 t/d August 28, 1990
maximum: 2168.6 t/d December 27, 1993

LOW PASS
minimum: 32.8 t/d March 2017
maximum: 374.8 t/d August 1981

ANNUAL CYCLE
minimum: 19.9 t/d September, rel. stdev: 1.70
maximum: 418.5 t/d January, rel. stdev: 0.70





Total Alkalinity load for Haringvliet

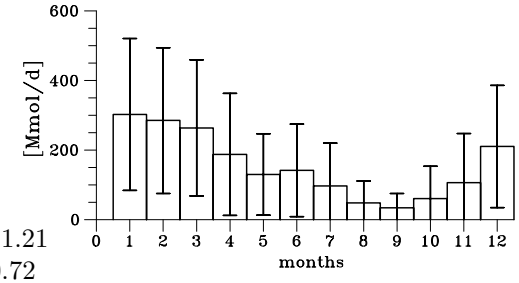
ANNUAL LOADS

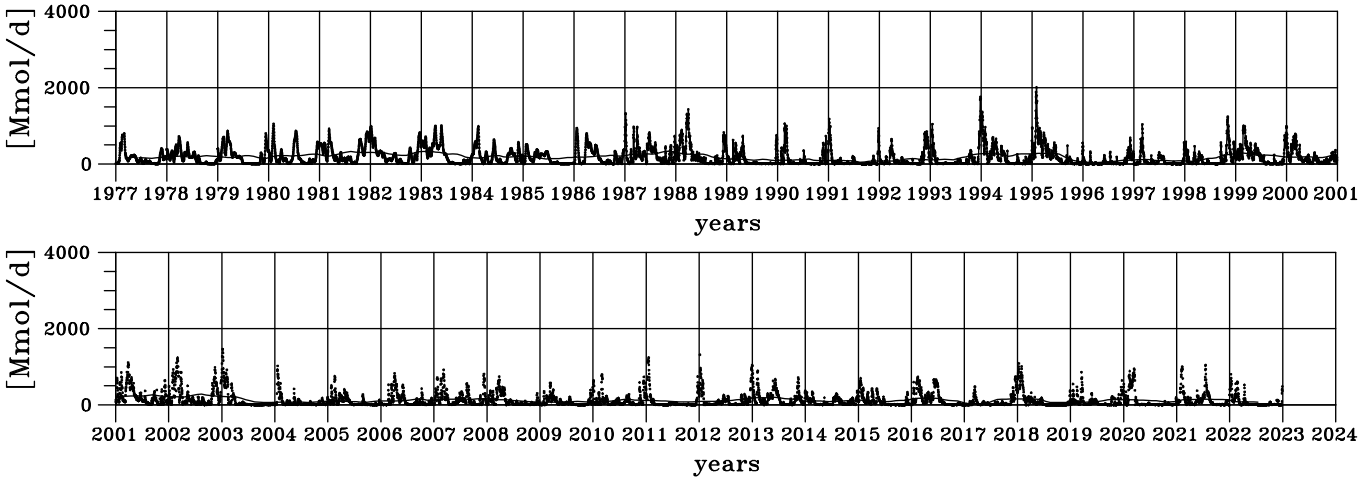
year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y
1977	58.2	1985	46.7	1993	43.6	2001	85.4	2009	28.5	2017	26.8
1978	65.2	1986	78.8	1994	78.5	2002	90.8	2010	43.2	2018	43.7
1979	79.1	1987	98.1	1995	101.3	2003	46.2	2011	32.1	2019	33.6
1980	75.8	1988	97.5	1996	25.0	2004	27.8	2012	44.6	2020	39.1
1981	111.6	1989	36.5	1997	30.8	2005	31.9	2013	66.8	2021	51.5
1982	88.3	1990	38.4	1998	55.7	2006	41.3	2014	30.4	2022	28.6
1983	96.2	1991	32.9	1999	82.6	2007	61.9	2015	35.3		
1984	81.2	1992	45.7	2000	66.1	2008	40.5	2016	61.1		

TIME SERIES
mean: 155.1 Mmol/d
relative standard deviation: 1.39
minimum: 0.0 Mmol/d August 28, 1990
maximum: 2009.6 Mmol/d February 2, 1995

LOW PASS
minimum: 32.8 Mmol/d February 2017
maximum: 336.5 Mmol/d November 1987

ANNUAL CYCLE
minimum: 34.1 Mmol/d September, rel. stdev: 1.21
maximum: 302.5 Mmol/d January, rel. stdev: 0.72





Dissolved Inorganic Carbon load for Haringvliet

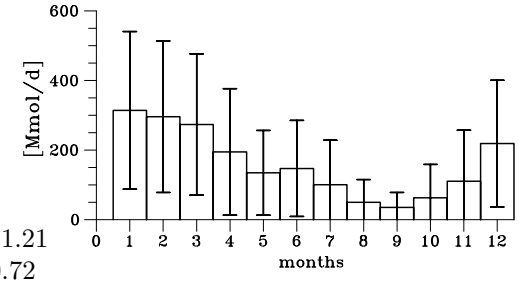
ANNUAL LOADS

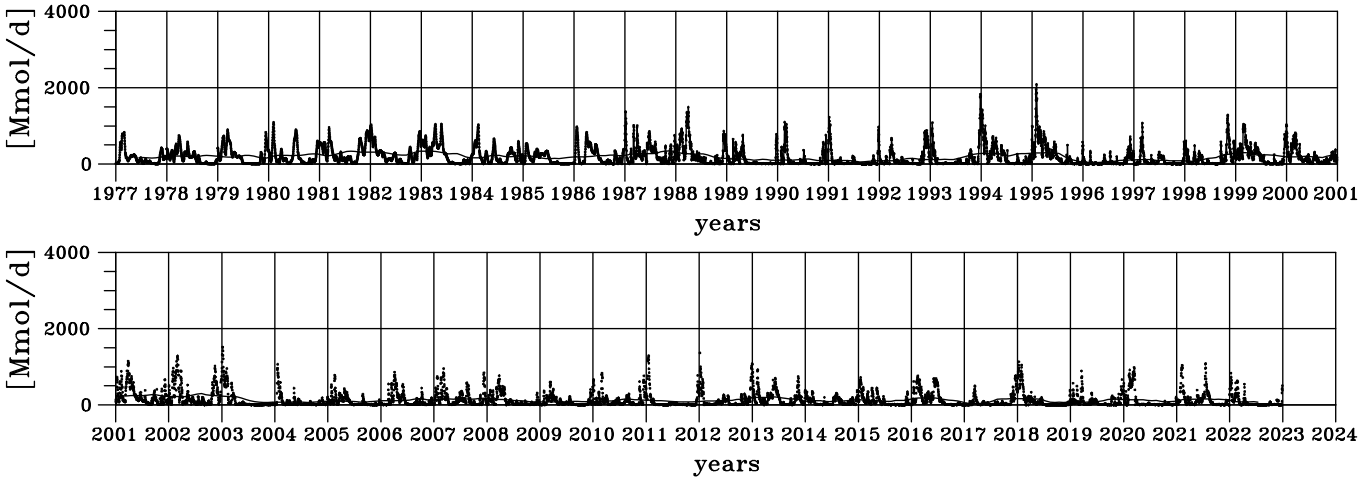
year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y
1977	60.4	1985	48.5	1993	45.3	2001	88.6	2009	29.6	2017	27.8
1978	67.7	1986	81.8	1994	81.5	2002	94.2	2010	44.8	2018	45.3
1979	82.1	1987	101.9	1995	105.2	2003	48.0	2011	33.3	2019	34.9
1980	78.6	1988	101.2	1996	26.0	2004	28.8	2012	46.3	2020	40.6
1981	115.8	1989	37.9	1997	32.0	2005	33.1	2013	69.4	2021	53.5
1982	91.7	1990	39.8	1998	57.8	2006	42.9	2014	31.6	2022	29.7
1983	99.9	1991	34.2	1999	85.7	2007	64.3	2015	36.7		
1984	84.2	1992	47.4	2000	68.6	2008	42.0	2016	63.4		

TIME SERIES
mean: 160.9 Mmol/d
relative standard deviation: 1.39
minimum: 0.0 Mmol/d August 28, 1990
maximum: 2085.9 Mmol/d February 2, 1995

LOW PASS
minimum: 34.1 Mmol/d February 2017
maximum: 349.3 Mmol/d November 1987

ANNUAL CYCLE
minimum: 35.4 Mmol/d September, rel. stdev: 1.21
maximum: 314.0 Mmol/d January, rel. stdev: 0.72





Dissolved Organic Carbon load for Haringvliet

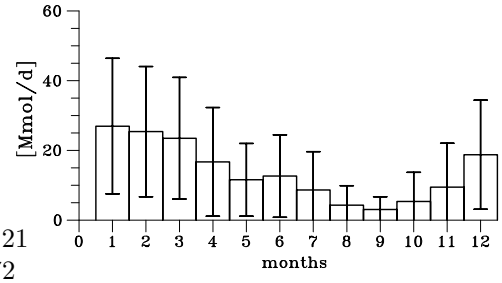
ANNUAL LOADS

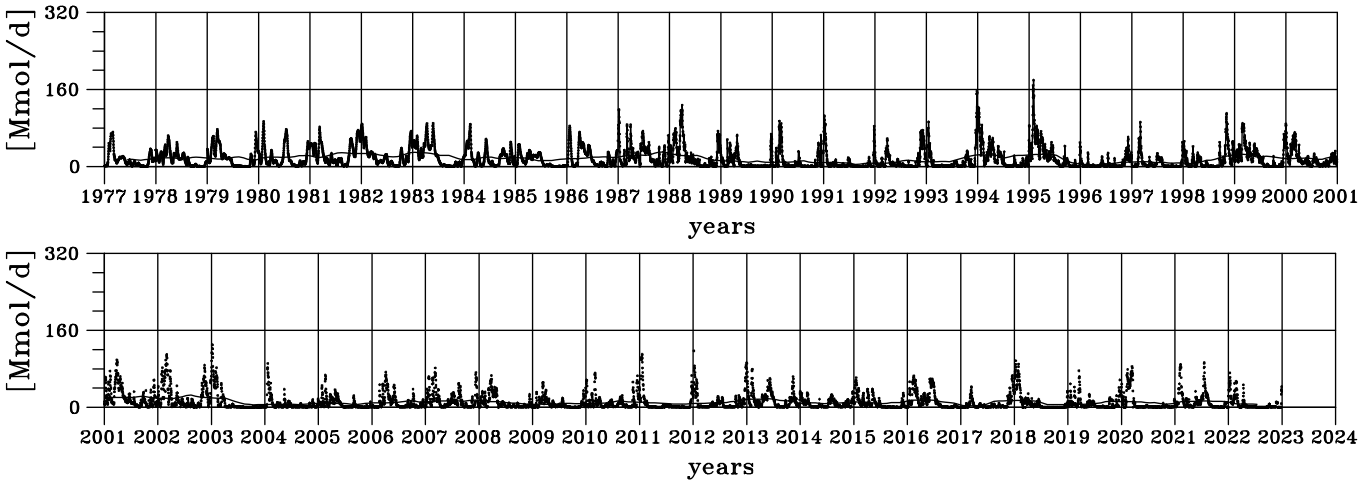
year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y
1977	5.2	1985	4.2	1993	3.9	2001	7.6	2009	2.5	2017	2.4
1978	5.8	1986	7.0	1994	7.0	2002	8.1	2010	3.8	2018	3.9
1979	7.0	1987	8.7	1995	9.0	2003	4.1	2011	2.9	2019	3.0
1980	6.8	1988	8.7	1996	2.2	2004	2.5	2012	4.0	2020	3.5
1981	9.9	1989	3.3	1997	2.7	2005	2.8	2013	6.0	2021	4.6
1982	7.9	1990	3.4	1998	5.0	2006	3.7	2014	2.7	2022	2.6
1983	8.6	1991	2.9	1999	7.4	2007	5.5	2015	3.1		
1984	7.2	1992	4.1	2000	5.9	2008	3.6	2016	5.4		

TIME SERIES
mean: 13.8 Mmol/d
relative standard deviation: 1.39
minimum: 0.0 Mmol/d August 28, 1990
maximum: 179.1 Mmol/d February 2, 1995

LOW PASS
minimum: 2.9 Mmol/d February 2017
maximum: 30.0 Mmol/d November 1987

ANNUAL CYCLE
minimum: 3.0 Mmol/d September, rel. stdev: 1.21
maximum: 27.0 Mmol/d January, rel. stdev: 0.72





5.9 Loads of River Schelde

Total Nitrogen load for River Schelde

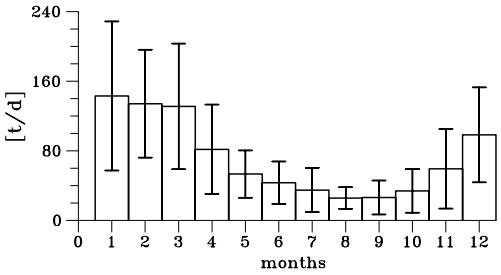
ANNUAL LOADS

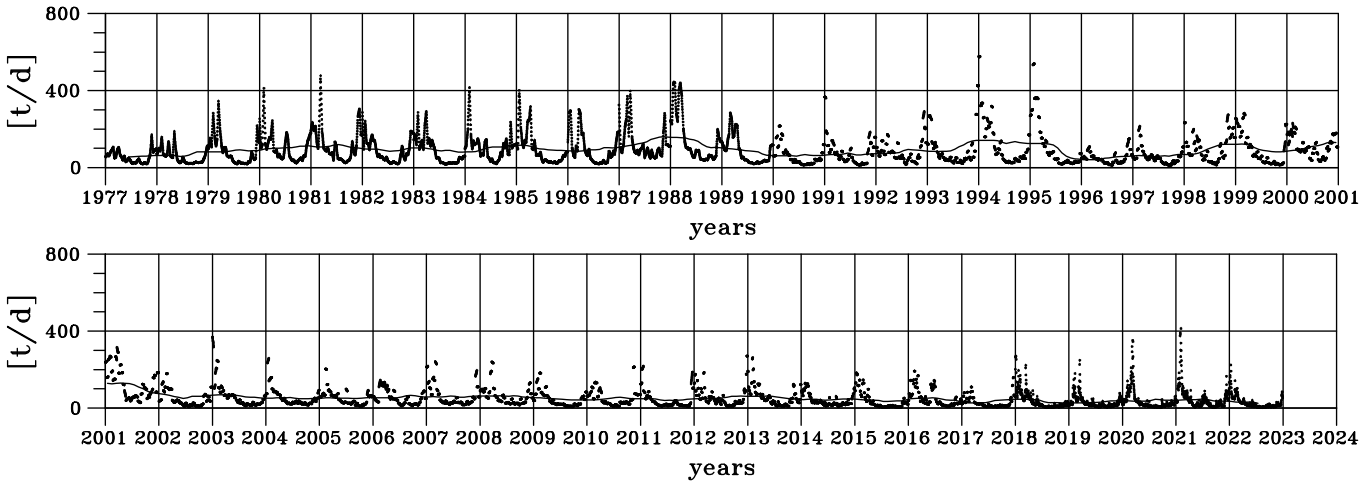
year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y
1977	20.2	1985	34.5	1993	32.2	2001	45.8	2009	16.4	2017	10.9
1978	20.9	1986	35.1	1994	45.8	2002	17.1	2010	18.9	2018	13.9
1979	32.1	1987	45.5	1995	41.5	2003	23.5	2011	14.8	2019	10.8
1980	37.5	1988	53.6	1996	18.3	2004	20.0	2012	19.5	2020	13.1
1981	44.1	1989	31.1	1997	20.1	2005	19.0	2013	21.1	2021	17.0
1982	31.2	1990	21.4	1998	36.4	2006	19.6	2014	14.8	2022	10.0
1983	30.8	1991	27.9	1999	33.3	2007	23.2	2015	13.7		
1984	38.7	1992	30.0	2000	39.9	2008	22.7	2016	19.3		

TIME SERIES
mean: 71.9 t/d
relative standard deviation: 0.98
minimum: 3.3 t/d August 16, 2022
maximum: 576.1 t/d January 1, 1994

LOW PASS
minimum: 25.0 t/d July 2022
maximum: 160.1 t/d November 1987

ANNUAL CYCLE
minimum: 25.7 t/d August, rel. stdev: 0.48
maximum: 143.0 t/d January, rel. stdev: 0.60





Nitrate + Nitrite load for River Schelde

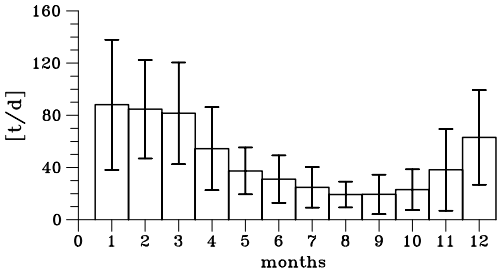
ANNUAL LOADS

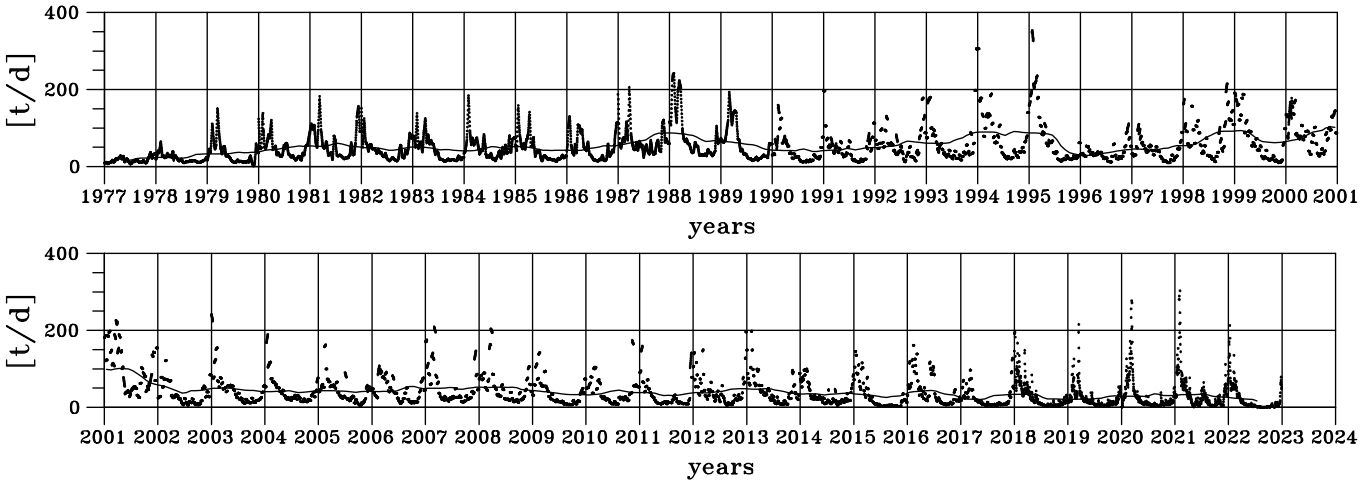
year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y
1977	6.1	1985	15.5	1993	23.5	2001	36.3	2009	13.0	2017	8.6
1978	7.7	1986	18.1	1994	29.1	2002	12.4	2010	14.9	2018	10.6
1979	12.4	1987	23.8	1995	28.5	2003	17.3	2011	11.6	2019	8.1
1980	17.6	1988	29.4	1996	13.2	2004	15.7	2012	15.3	2020	10.3
1981	22.2	1989	21.2	1997	14.8	2005	15.3	2013	16.5	2021	12.7
1982	15.6	1990	14.7	1998	28.6	2006	15.7	2014	11.7	2022	7.0
1983	15.6	1991	17.5	1999	24.5	2007	19.2	2015	10.2		
1984	18.5	1992	21.1	2000	31.9	2008	19.0	2016	15.8		

TIME SERIES
mean: 46.9 t/d
relative standard deviation: 0.91
minimum: 0.1 t/d September 3, 2022
maximum: 353.1 t/d January 23, 1995

LOW PASS
minimum: 16.2 t/d June 1977
maximum: 102.7 t/d November 2000

ANNUAL CYCLE
minimum: 19.3 t/d August, rel. stdev: 0.51
maximum: 88.1 t/d January, rel. stdev: 0.57





Ammonium load for River Schelde

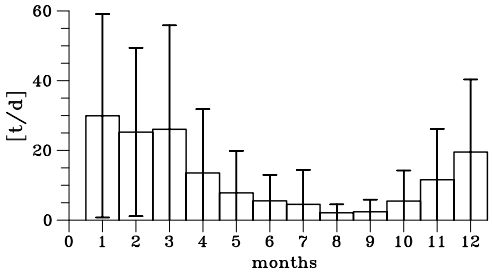
ANNUAL LOADS

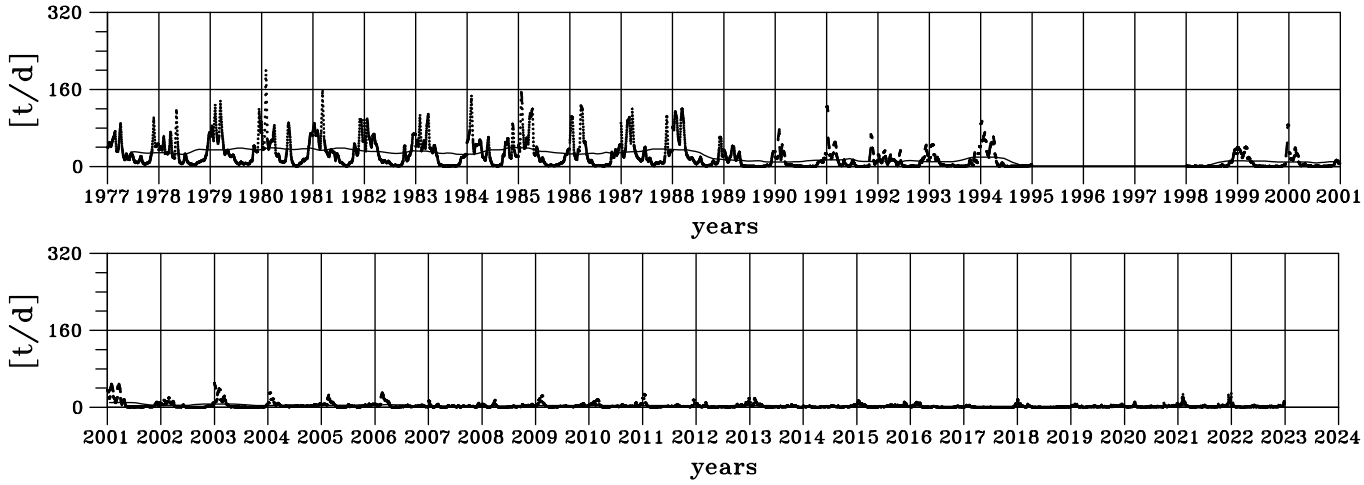
year	t/y	year	t/y	year	t/y	year	t/y	year	t/y	year	t/y
1977	11211	1985	11601	1993	3581	2001	3693	2009	1408	2017	296
1978	9258	1986	10358	1994	5783	2002	1330	2010	1455	2018	488
1979	13925	1987	11590			2003	2293	2011	1346	2019	700
1980	13142	1988	11634			2004	1860	2012	1012	2020	658
1981	14071	1989	3833			2005	1577	2013	1023	2021	1279
1982	10316	1990	3462	1998	1477	2006	1742	2014	569	2022	629
1983	9397	1991	5735	1999	4335	2007	876	2015	1184		
1984	12481	1992	3945	2000	2480	2008	902	2016	591		

TIME SERIES
mean: 13.6 t/d
relative standard deviation: 1.56
minimum: 0.0 t/d August 26, 2017
maximum: 199.4 t/d February 1, 1980

LOW PASS
minimum: 0.7 t/d May 2017
maximum: 39.6 t/d November 1984

ANNUAL CYCLE
minimum: 2.1 t/d August, rel. stdev: 1.17
maximum: 29.9 t/d January, rel. stdev: 0.97





Total Phosphorus load for River Schelde

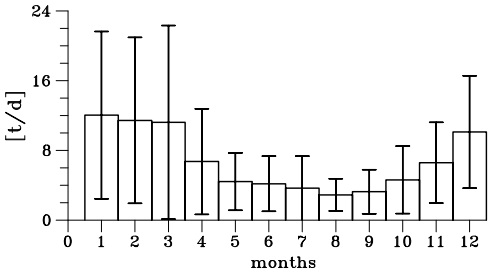
ANNUAL LOADS

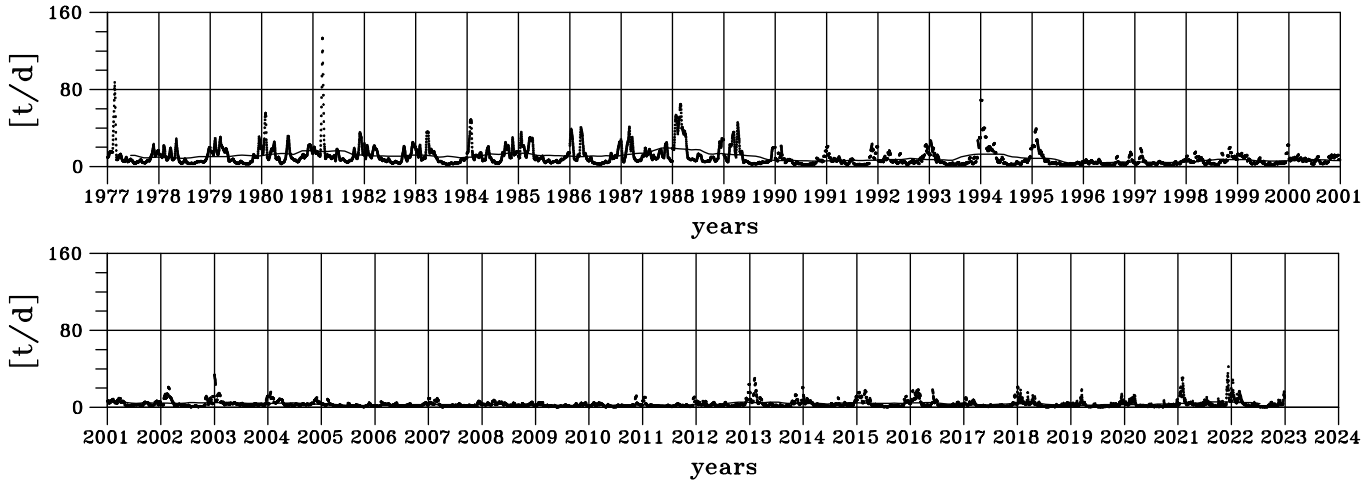
year	t/y	year	t/y	year	t/y	year	t/y	year	t/y	year	t/y
1977	4179	1985	4070	1993	2519	2001	1517	2009	723	2017	975
1978	3082	1986	4183	1994	4375	2002	1626	2010	812	2018	1265
1979	4047	1987	4808	1995	2650	2003	1715	2011	888	2019	936
1980	4984	1988	6699	1996	1570	2004	1706	2012	1246	2020	898
1981	5952	1989	3953	1997	1471	2005	771	2013	1907	2021	2091
1982	3911	1990	2094	1998	2517	2006	850	2014	1261	2022	1467
1983	3387	1991	2497	1999	2212	2007	1020	2015	1529		
1984	4883	1992	2670	2000	2627	2008	1147	2016	1660		

TIME SERIES
mean: 6.7 t/d
relative standard deviation: 1.18
minimum: 0.3 t/d May 25, 2009
maximum: 133.3 t/d March 11, 1981

LOW PASS
minimum: 1.9 t/d August 2009
maximum: 19.4 t/d November 1987

ANNUAL CYCLE
minimum: 2.9 t/d August, rel. stdev: 0.64
maximum: 12.0 t/d January, rel. stdev: 0.80





Phosphate load for River Schelde

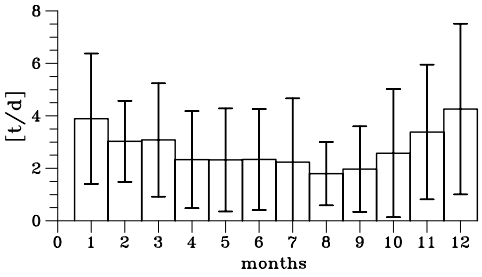
ANNUAL LOADS

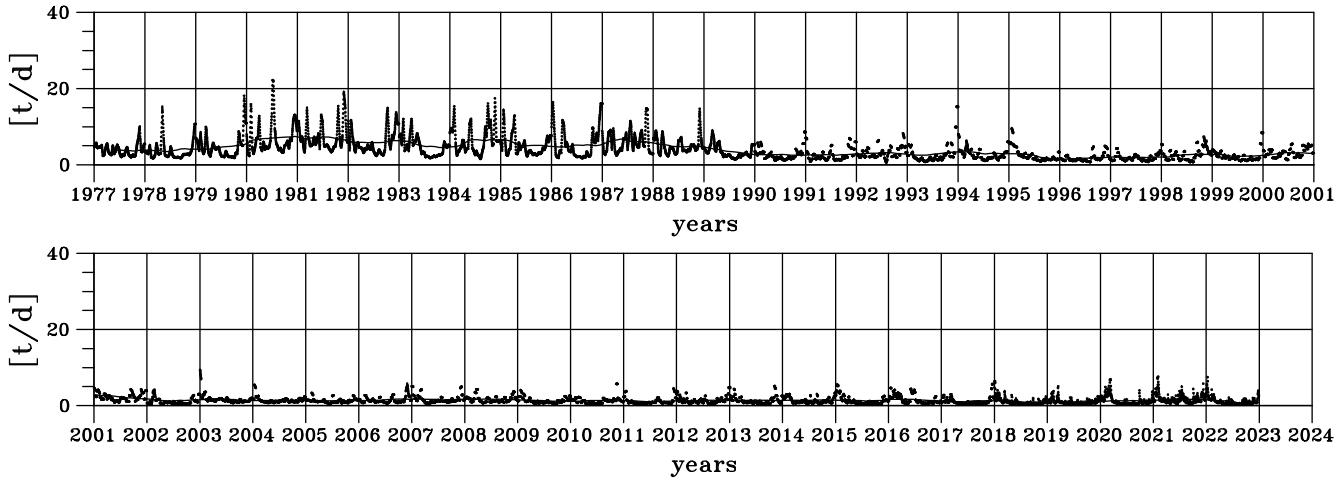
year	t/y	year	t/y	year	t/y	year	t/y	year	t/y	year	t/y
1977	1438	1985	1808	1993	1033	2001	835	2009	472	2017	406
1978	1320	1986	2003	1994	1010	2002	395	2010	478	2018	380
1979	1733	1987	2210	1995	925	2003	613	2011	394	2019	353
1980	2543	1988	1825	1996	652	2004	520	2012	497	2020	450
1981	2674	1989	1249	1997	670	2005	460	2013	503	2021	632
1982	2131	1990	996	1998	980	2006	553	2014	485	2022	405
1983	1696	1991	949	1999	821	2007	605	2015	474		
1984	2426	1992	1132	2000	1152	2008	615	2016	602		

TIME SERIES
mean: 2.8 t/d
relative standard deviation: 0.92
minimum: 0.3 t/d September 11, 2014
maximum: 22.2 t/d July 7, 1980

LOW PASS
minimum: 0.9 t/d August 2018
maximum: 7.5 t/d December 1980

ANNUAL CYCLE
minimum: 1.8 t/d August, rel. stdev: 0.67
maximum: 4.3 t/d December, rel. stdev: 0.76





Silicate load for River Schelde

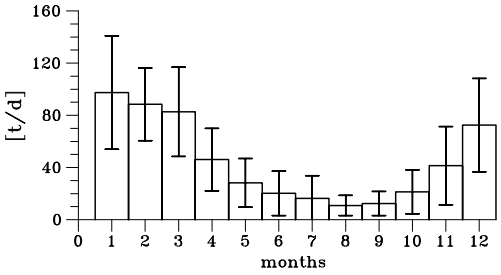
ANNUAL LOADS

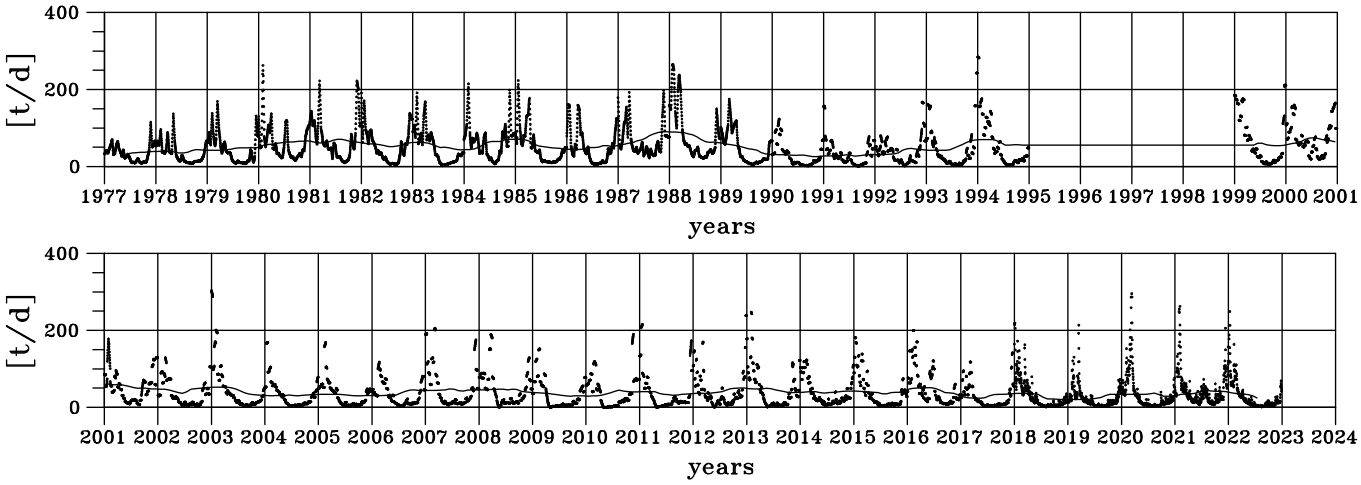
year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y	year	kt/y
1977	12.4	1985	18.9	1993	16.4	2001	19.5	2009	11.5	2017	9.8
1978	12.7	1986	18.9	1994	20.6	2002	12.5	2010	13.9	2018	11.0
1979	16.7	1987	24.7			2003	17.0	2011	12.7	2019	8.3
1980	22.8	1988	30.3			2004	12.0	2012	14.9	2020	12.1
1981	25.9	1989	17.2			2005	11.8	2013	16.4	2021	15.4
1982	19.2	1990	10.3			2006	12.0	2014	13.5	2022	9.8
1983	18.0	1991	11.2	1999	23.2	2007	17.8	2015	13.6		
1984	23.6	1992	14.0	2000	27.2	2008	16.8	2016	18.1		

TIME SERIES
mean: 45.2 t/d
relative standard deviation: 0.95
minimum: 0.3 t/d April 26, 2011
maximum: 303.4 t/d January 1, 2003

LOW PASS
minimum: 20.0 t/d March 2019
maximum: 90.1 t/d November 1987

ANNUAL CYCLE
minimum: 10.9 t/d August, rel. stdev: 0.71
maximum: 97.4 t/d January, rel. stdev: 0.45





Total Alkalinity load for River Schelde

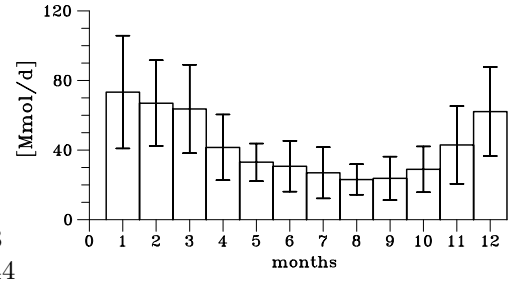
ANNUAL LOADS

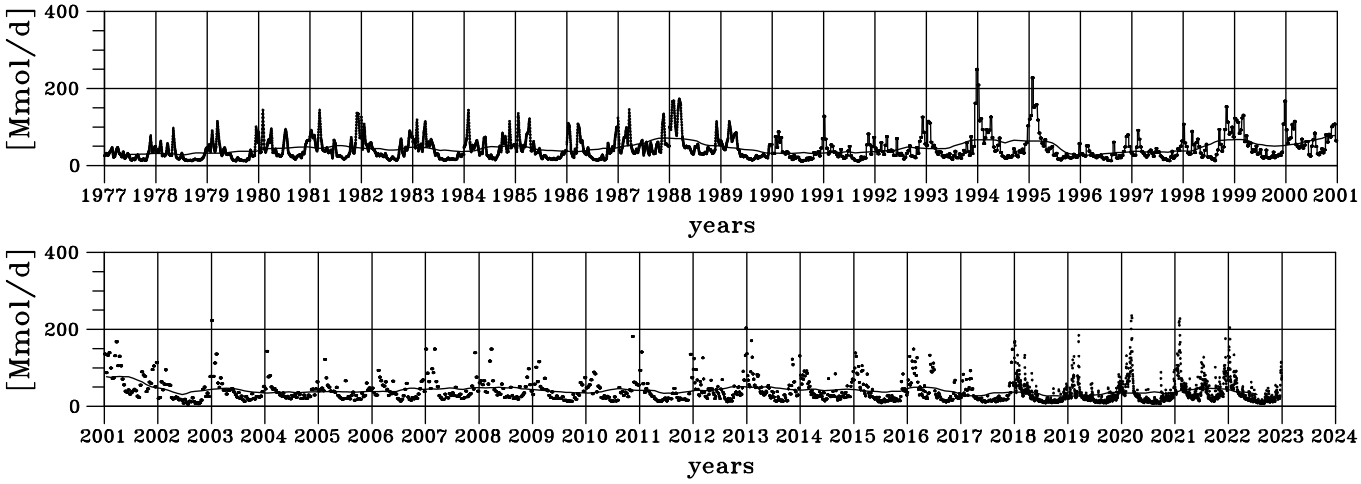
year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y
1977	10.4	1985	14.5	1993	17.9	2001	27.9	2009	13.9	2017	11.4
1978	10.0	1986	15.6	1994	21.3	2002	10.5	2010	15.6	2018	11.4
1979	13.0	1987	20.3	1995	20.9	2003	16.5	2011	12.9	2019	10.7
1980	16.4	1988	24.3	1996	11.4	2004	13.9	2012	16.6	2020	12.4
1981	19.0	1989	14.7	1997	12.2	2005	13.8	2013	17.3	2021	17.7
1982	14.8	1990	11.6	1998	19.8	2006	14.3	2014	14.8	2022	11.8
1983	14.2	1991	13.2	1999	20.3	2007	17.7	2015	13.9		
1984	17.9	1992	15.6	2000	23.2	2008	17.5	2016	17.4		

TIME SERIES
mean: 43.0 Mmol/d
relative standard deviation: 0.72
minimum: 5.6 Mmol/d July 21, 2002
maximum: 249.3 Mmol/d December 21, 1993

LOW PASS
minimum: 26.0 Mmol/d January 1996
maximum: 78.0 Mmol/d April 2001

ANNUAL CYCLE
minimum: 23.1 Mmol/d August, rel. stdev: 0.38
maximum: 73.3 Mmol/d January, rel. stdev: 0.44





Dissolved Inorganic Carbon load for River Schelde

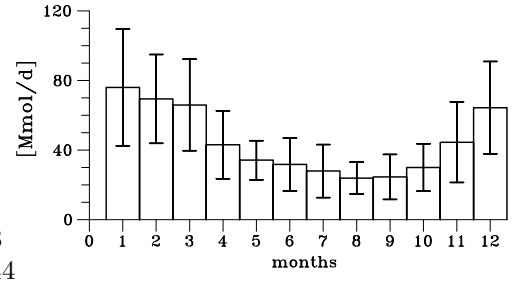
ANNUAL LOADS

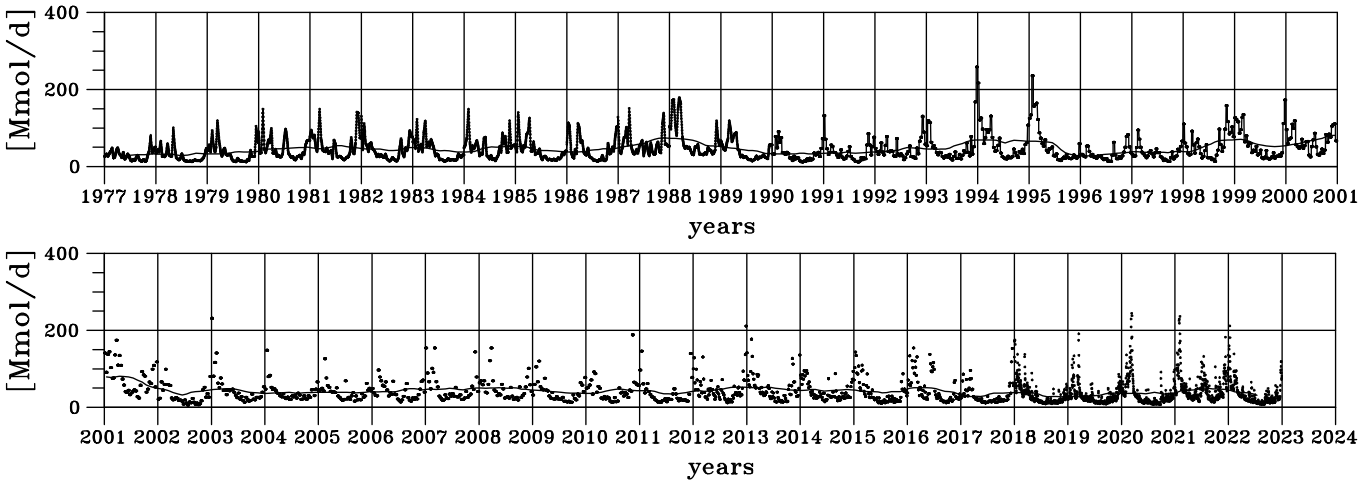
year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y
1977	10.7	1985	15.0	1993	18.6	2001	28.9	2009	14.4	2017	11.8
1978	10.4	1986	16.2	1994	22.0	2002	10.9	2010	16.2	2018	11.8
1979	13.5	1987	21.1	1995	21.6	2003	17.1	2011	13.3	2019	11.1
1980	17.0	1988	25.2	1996	11.8	2004	14.4	2012	17.2	2020	12.8
1981	19.7	1989	15.3	1997	12.6	2005	14.3	2013	18.0	2021	18.3
1982	15.4	1990	12.0	1998	20.5	2006	14.9	2014	15.3	2022	12.2
1983	14.7	1991	13.7	1999	21.1	2007	18.4	2015	14.4		
1984	18.6	1992	16.1	2000	24.0	2008	18.2	2016	18.0		

TIME SERIES
mean: 44.6 Mmol/d
relative standard deviation: 0.72
minimum: 5.8 Mmol/d July 21, 2002
maximum: 258.4 Mmol/d December 21, 1993

LOW PASS
minimum: 26.9 Mmol/d January 1996
maximum: 80.9 Mmol/d April 2001

ANNUAL CYCLE
minimum: 23.9 Mmol/d August, rel. stdev: 0.38
maximum: 76.0 Mmol/d January, rel. stdev: 0.44





Dissolved Organic Carbon load for River Schelde

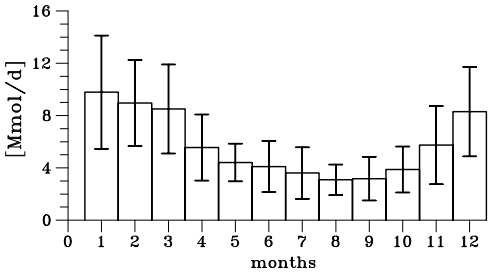
ANNUAL LOADS

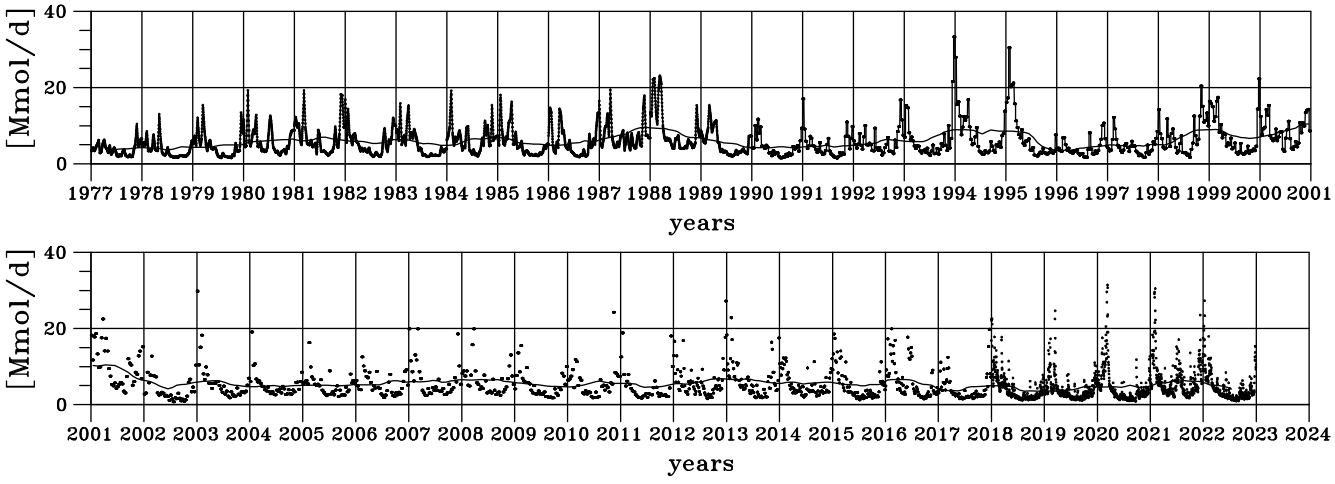
year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y	year	Gmol/y
1977	1.4	1985	1.9	1993	2.4	2001	3.7	2009	1.9	2017	1.5
1978	1.3	1986	2.1	1994	2.8	2002	1.4	2010	2.1	2018	1.5
1979	1.7	1987	2.7	1995	2.8	2003	2.2	2011	1.7	2019	1.4
1980	2.2	1988	3.3	1996	1.5	2004	1.9	2012	2.2	2020	1.7
1981	2.5	1989	2.0	1997	1.6	2005	1.8	2013	2.3	2021	2.4
1982	2.0	1990	1.5	1998	2.6	2006	1.9	2014	2.0	2022	1.6
1983	1.9	1991	1.8	1999	2.7	2007	2.4	2015	1.9		
1984	2.4	1992	2.1	2000	3.1	2008	2.3	2016	2.3		

TIME SERIES
mean: 5.7 Mmol/d
relative standard deviation: 0.72
minimum: 0.8 Mmol/d July 21, 2002
maximum: 33.3 Mmol/d December 21, 1993

LOW PASS
minimum: 3.5 Mmol/d January 1996
maximum: 10.4 Mmol/d April 2001

ANNUAL CYCLE
minimum: 3.1 Mmol/d August, rel. stdev: 0.38
maximum: 9.8 Mmol/d January, rel. stdev: 0.44





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