North Sea Biogeochemical Climatology

Technical Report

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Abstract

By bringing together observations available from various data centers a biogeochemical North Sea Climatology **(NSBC)** has been constructed providing a suite of biogeochemical parameters for the wider North Sea Region. During the preparation of the climatology, a standardization of the observations was applied to the individual data sets to harmonize data formats and physical units of the parameters. Duplicates were removed and a quality control procedure eliminated erroneous observations. The final data set consists of gridded fields of climatological mean values of biogeochemical parameters that complement the hydrographical climatology of temperature and salinity for the same region ([Bersch2013], http://icdc.zmaw.de/knsc_hydrographic.html?&L=1).

The data product can be accessed https://icdc.cen.uni-hamburg.de/daten/ocean/nsbc/.

1 Introduction

Biogeochemical and hydrographic observations of the Northwest-European Shelf represent detailed information about shelf seas. This statement made by Laane [1996] still holds today, especially since the late nineties of the last century a large amount of new shelf area observations have been collected and archived in different data centers. The data stem from scientific cruises, but also from commercial ships. The observations are now freely available and were used here as basis for the newly constructed climatology. The compilation of the climatology will be done in two stages.

During this first stage of the construction of this climatology we concentrated on observations of the macro nutrients nitrate, ammonium, phosphate and silicate as well as of oxygen and chlorophyll. These six parameters describe the condition of the lower trophic marine ecosystem, which shows significant spatial and temporal variations due to global changes and direct anthropogenic impact. Observations of temperature and salinity are also considered if recorded simultaneously with the biogeochemical parameters. In a future second stage of the climatology, carbonate system species and suspended matter will be added.

The idea behind this data collection and climatology is to have a sound and quality-controlled representation of the parameters in space and time that serve many purposes, for example as initial states of ecosystem modeling. Outliers in the observational data base that may originate from faulty measurements, equipment, or from errors in data transfer are identified by an extensive quality control procedure and have been ignored to the best of knowledge. Real outliers that describe marginal phenomena or abnormal conditions are also ignored by our methods.

The sampling density of the observed parameters directly defines the temporal and spatial resolution to which mapping of the parameters seems reasonable. A trade-off between temporal resolution and spatial coverage is applied in this data product: At the moment, the climatology made available for the scientific community here consist of maps of the climatological monthly and annual mean parameter values for the period 1960-2014 and will serve e. g. as a reference data set for model validation. In future, we plan to release a time series of monthly fields of parameter averages, yet with rather incomplete spatial coverage.

2 Spatial and Temporal Extent and Parameters

Observational data from the time period 1960-2014 are used for the creation of the data set. The 3-D spatial extent of the data set is shown in Fig. 2.1. The extended North Sea region may roughly be subdivided into two areas: (1) the actual North Sea and the easternmost Baltic Sea with typical bottom depths less than 200 m (the exceptions are the Norwegian Trench and the Skagerrak); (2) the adjacent areas of the Atlantic Ocean with typical depths of several thousand meters.
The biogeochemical parameters in the NSBC are:

dissolved oxygen, nitrate, phosphate, silicate, ammonium, chlorophyll-a.

If available, observations of these biogeochemical parameters are accompanied by **temperature** and/or **salinity** observations. Observations of solely the hydrographic parameters (T, S) are not considered.

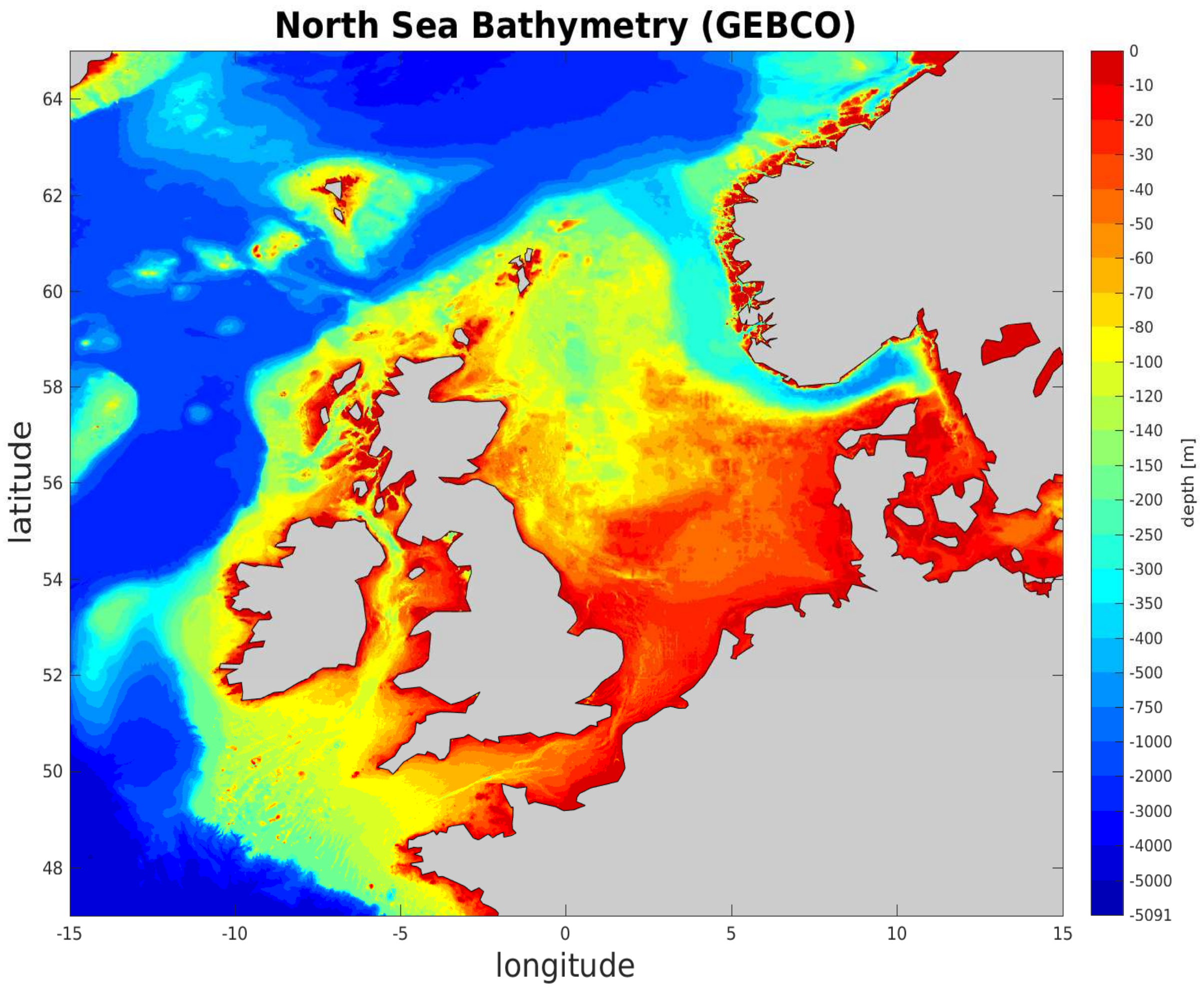


Fig. 2.1: North Sea Bathymetry and spatial extent of Biogeochemical Climatology (NSBC)

Table 2.1 gives an overview of the parameters. The parameters alkalinity, dissolved inorganic carbon, pH and suspended particulate matter are also part of the collection, but will not be processed to final data products at this stage.

Table 2.1: Overview: Parameters in the Biogeochemical North Sea Climatology with corresponding abbreviation and physical unit.

parameter	nitrate (+nitrite)	phosphate	silicate	ammonium	dissolved oxygen	chlorophyll-a	temperature	salinity
abbreviation	NO3	PO4	SiO4	NH4	O2	CHL-a	T	S
unit	µmol/l	µmol/l	µmol/l	µmol/l	µmol/l	µg/l	°C	-

The temporal data coverage is limited to rather few profiles in the first 15 year of the time period in focus, but increases considerably after 1975, as displayed in Fig. 2.2.

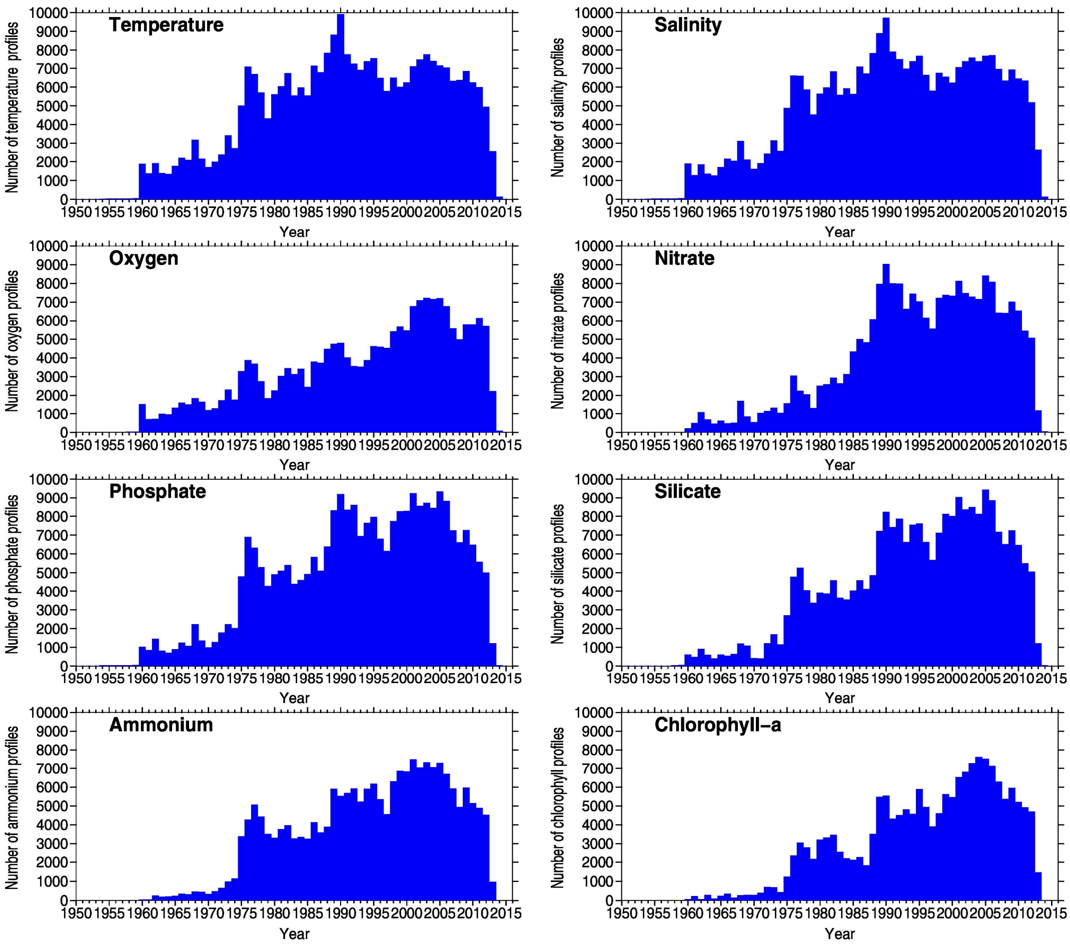


Fig. 2.2: Yearly number of profiles for different parameters.

3 Data Sources

Observational data from seven sources were collected.

The data sources are

NOWESP NOWESP Research Data Base,
https://wiki.cen.uni-hamburg.de/ifm/ECOHAM/DATA_NOWESP

WOD13 World Ocean Data Base 2013, NODC, USA
https://www.nodc.noaa.gov/OC5/WOD/pr_wod.html

DOD German Oceanographic Data Centre, BSH
http://www.bsh.de/en/Marine_data/Observations/DOD_Data_Centre/index.jsp

EMODNet European Marine Observation and Data Network
http://www.emodnet.eu/

PANGAEA PANGAEA Data Publisher for Earth & Environmental Science
Alfred Wegener Institute, Helmholtz Center for Polar and Marine Research (AWI), Bremerhaven, Germany
http://www.pangaea.de/

ICES International Council for Exploration of the Sea
www.ices.dk

BROCKMANN Monika Schütt (mon@uni-hamburg.de) and Uwe Brockmann (brockmann@uni-hamburg.de), Institute of Geology, Department of Biochemistry and Marine Chemistry, University of Hamburg, Germany,

The data source “EMODNet“ provides observational data from several European institutes. Table 3.1 gives an overview of these institutes and the data volume they provided.

Table 3.1: Overview of data centers addressed via EMODNet/SEaDataNet and the data volume they provide

Data centre	**Country**	**Profiles provided**
Finish Meteorological Institute	Finland	102
Management Unit of North Sea and Scheldt Estuary Mathematical Models, Belgian Marine Data Centre	Belgium	2,221
Rijkswaterstaat Waterdienst	Netherlands	9,523
Aarhus University, Department of Bioscience, Marine Ecology Roskilde	Denmark	54,423
All-Russia Research Institute of Hydrometeorological Information-World Data Centre (RIHMI-WDC) Nat	Russian Federation	109
Netherlands Institute of Ecology, Centre for Estuarine and Marine Ecology	Netherlands	1,939

Institute of Marine Research – Norwegian Marine Data Centre (NMD)	Norway	5,759
Swedish Meteorological and Hydrological Institute	Sweden	18,026
IFREMER/IDM/SISMER	France	1,621
Flanders Marine Institute	Belgium	653
IEO/ Spanish Oceanographic Institute	Spain	2
Institute of Meteorology and Water Management, Maritime Branch in Gdynia (IMWM MB)	Poland	439
British Oceanographic Data Centre	United Kingdom	8,330

4 Data Processing Steps

We aggregated the collection of observational data from the different data sources to one set of unified and quality controlled observations which, in turn, form the basis for data products being published and made available for users. Several different processing steps were necessary and allow classification of the data according to the processing level they completed.
The definitions of the different levels are:

Level 0: aggregation of unified and unique original observations of all data sources
Level 1: quality controlled Level 0 data
Level 2: bin-averaged gridded fields based on Level 1 data, not all bins covered
Level 3: interpolated gridded fields based on Level 2 data, all bins covered

A feature of Level 2 data fields is that only those bins with actual observations are occupied. In Level 3 data, however, bins lacking observations are filled by optimal interpolation. For an example of Level 2, respectively Level 3 data, see Fig. A2.6.

The different processing steps Level 0-3 are further described in the following sections.

4.1 Initial processing of the observed data (Level 0 data)

Three main steps in preparing the different data sets for aggregation are

1. **Pre-selection of observational profiles**
2. **reformatting data to a uniform data format and converting parameter values to standardized physical/chemical units**
3. **eliminate duplicate observations**

4.1.1 Pre-selection of observational profiles

The pool of observational data varies considerably in spatial and temporal resolution. Vertical spacing between the observations ranges from less than 1m for high resolution CTD profiles to several 100 meters for ocean station data. High-frequent stationary observations (“moorings”) contrast with single observations during research cruises. And autonomously observing systems on ships of opportunity yield observations in both high spatial (horizontal) and temporal resolution.

To avoid biasing of the data products, the data collection is limited to ocean station data and profiles observations with a mean vertical spacing of more than 0.95m. The threshold for high-frequent stationary observations is set to 11 observations per day, which means that stations with an observation frequency greater than this threshold are left aside. Autonomous on-track observations are also not taken into account for the creation of the data set. Nevertheless, future versions of the **NSBC** will include the high-resolution and high-frequent observations.

The total numbers of pre-selected profiles from the different data sources are listed in Table 4.1.

Table 4.1: Number of preselected observational profiles from the different data sources

data source	BROCKM	DOD	EMODNet	ICES	NOWESP	PANGAEA	WOD13	**total**
Σ profiles	20,167	69,171	129,952	189,885	89,698	37,157	159,477	**695,477**

4.1.2 Reformatting to uniform data format

All profiles of one data source are listed consecutively in a text file with defined structure. A profile is defined as the set of observations that are related to the same geographical and temporal coordinates. Each profile (depth values and observed parameters) is preceded by two header lines containing the metadata of this profile. The second header line is followed by the actual profile data that are organized in an array with the size (i.e., number of rows, number of columns) defined by the number of observed depth levels and the number of observed parameters. The first column represents the depth levels of the profile, the other columns contain the observations of the parameters.

The following example shows a profile observed between 11 p.m. and midnight on 8th of June 1960 (64.433°N 10.133°W) that was provided by ICES. Observations of the parameters temperature, salinity, oxygen, phosphate and silicate were recorded without indication of the method of observation. The original profile contained one or more depth levels on which solely temperature and salinity were recorded (modification ‘split’), as well as repeated depth levels by which the profile had to be reduced (modification ‘red’).

Profile example:

```
ICES        6709 xx        -9      -9  540 xx 90PE                              2558
1960 6 8 23 64.433 -10.133 5 6 1.99 2.99 8.99 10.99 11.99 2 split red
   0.0000    7.2800   35.0430   370.2400    0.0000    0.0000
  95.0000    3.6200   34.9120   334.0600    0.6400    5.3000
 290.0000    0.0900   34.9120   322.4500    0.8900    7.8000
 385.0000   -0.4400   34.9140   315.7500    0.9100    8.2000
 525.0000   -0.6300   34.9170   311.2900    0.9400   10.5000
```

Missing values are indicated by a dummy value of -9.9999 (not shown in this example).

In the following, the header lines are described in more detail.

Header line 1

consists of 9 different fields, all separated by a blank. The fields are:

1. data source (e.g. ICES)
2. station number(6709)
3. instrument type (xx, not provided)
4. profile ID (-9, not provided)
5. cruise number (-9, not provided)
6. bottom depth (540m)
7. country code (xx, not provided)
8. platform (90PE
9. internal ID (ID added to the profiles while creating text file, i.e. serial number; in this case 2558)

In case the information of the field is not available in the original data, the fields value is set to 'xx' or '-9'.

Header line 2

contains a variable number of fields, all separated by blanks. The fields of the second header line can be separated into **three blocks**. Block 1 always contains eight fields which are the following:

1. year (1960)
2. month (6)
3. day (23)
4. hour (23)
5. latitude (64.433)
6. longitude (-10.133)
7. number of recorded depth levels (i.e. number of rows in profile, in this case 5)
8. number of columns in the profile (6)

The number of fields in the **block 2** is variable and depends on the parameters recorded in the profile. It can be derived from field 8 of the first block since this is the number of columns in the profile, i.e. number of observed parameters +1 (column for depth levels). The fields of the second block consist of parameter codes (decimal numbers, separated by blanks) with the digits to the left of the decimal point referring to the parameter and to the right to the method of observation of this parameter.

List of codes of possible available parameters:
1.XX : temperature [°C]
2.XX : salinity [-]
(*3.XX : alkalinity [mmol/l])*

4.XX : ammonium [μmol/l]
5.XX : chlorophyll [μg/l]
(*6.XX : dissolved inorganic carbon [μmol/l])*
7.XX : nitrate [μmol/l]
8.XX : oxygen [μmol/l]
(*9.XX : pH*)
10.XX : phosphate [μmol/l]
11.XX : silicate [μmol/l]
(*12.XX : suspended particulate matter [mg/l]*)

The standardized units for each parameter are shown in squared brackets. (*Parameters contained in the data collection but not further processed at this stage are put in parentheses and in italics*).
XX refers to a parameter-specific code that points to the method of observation and is either set to '99' or '00' if no method of observation was indicated. Lists of XX codes and the respective methods of observation can be found in Appendix 1, for the data sources DOD, EMODNet and NOWESP. Only these data sources provide this kind of information.

Block 3 also consists of a variable number of fields and contains information about possible modifications of the original profiles. The first field of block 3 is an integer specifying the number of modifications. Profiles can be modified in two ways:

Modification 1, 'split': the original profile contained depth levels with solely temperature and/ or salinity observations. In this case, the profile is split into two profiles; one with only the hydrographic parameters and the other one with the hydrographic **and** the biogeochemical parameters. Consequently, the content of the respective field in block 3 is the string '**split**'. The purely hydrographic part of the profile is not subjected to further processing.

Modification 2 'red': the original profile showed multiple occurrences of depth levels. In this case, the lower median of the observations on the repeated depth levels is chosen, whereas the other values are discarded. The respective content of the modification field is '**red**' for 'reduced'.

Overview of the spatial and temporal distributions of observations is shown in the following for the seven data sources (Fig. 4.1, Fig. 4.2, Fig. 4.3, Fig. 4.4, Fig. 4.5, Fig. 4.6 and Fig. 4.7). They represent the preselected data.

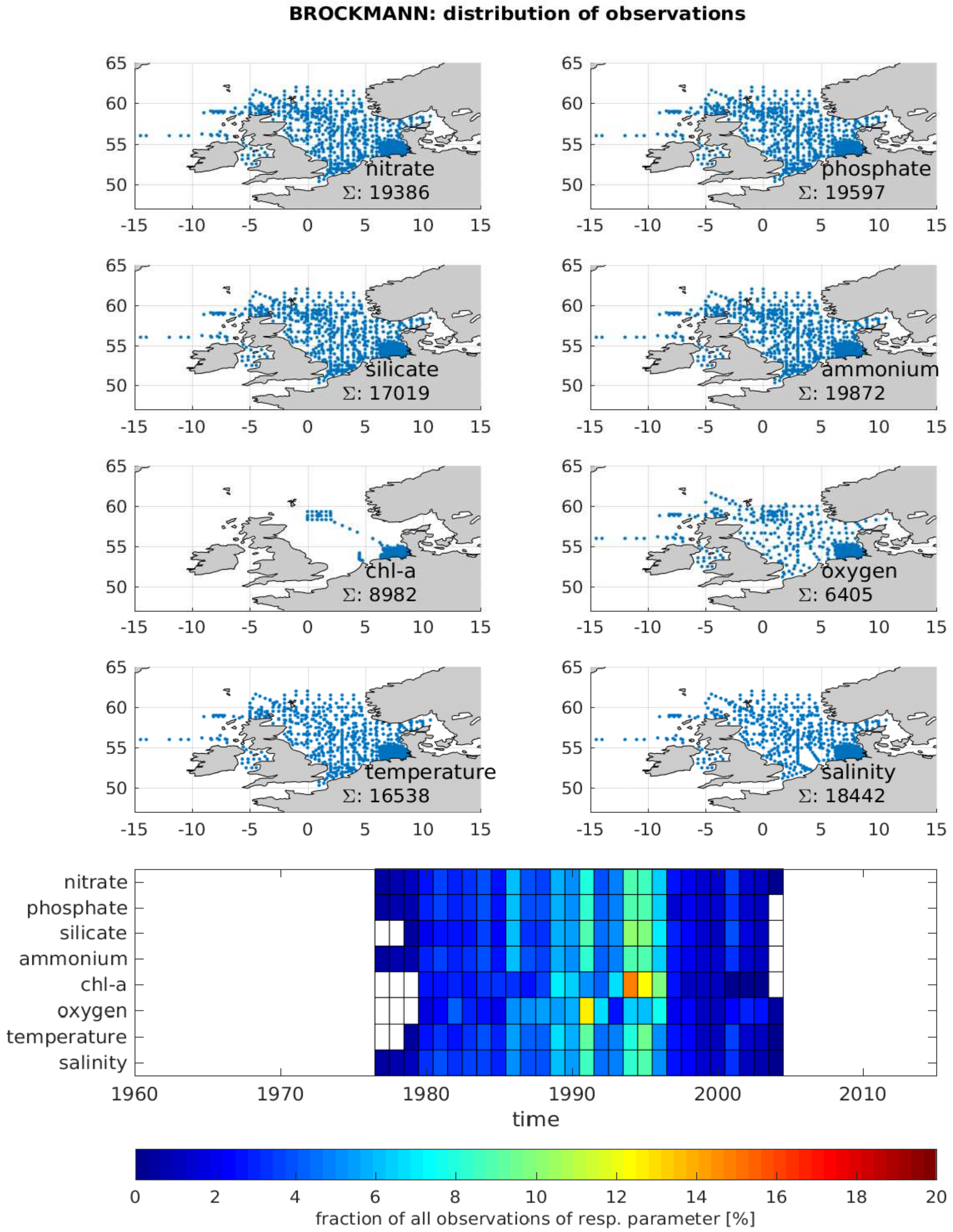


Fig. 4.1: upper panels: spatial distribution, each blue dot marks a profile position; lower panel: temporal distribution (bin width= 1 year); each line sums up to 100%

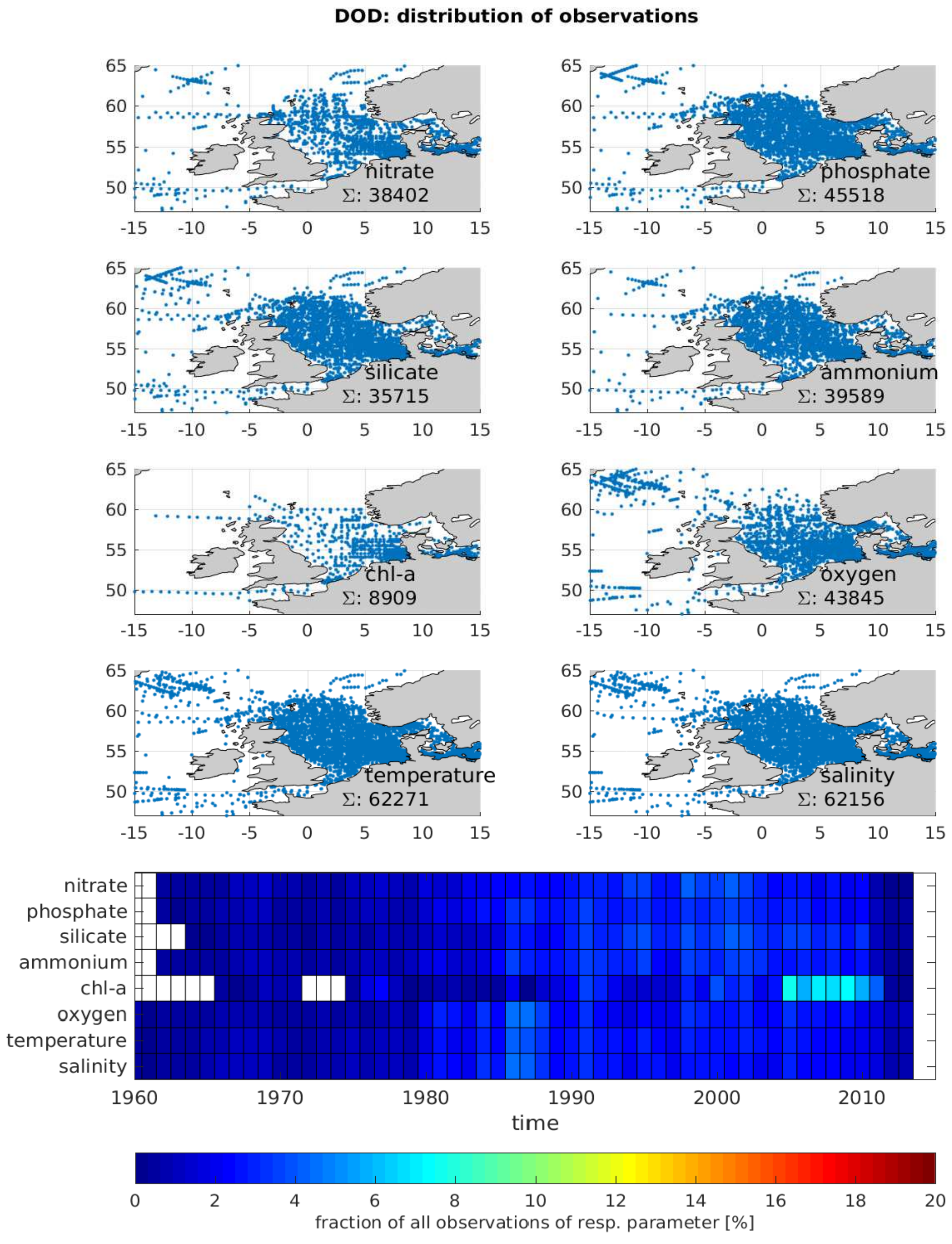


Fig. 4.2: upper panels: spatial distribution, each blue dot marks a profile position; lower panel: temporal distribution (bin width= 1 year); each line sums up to 100%

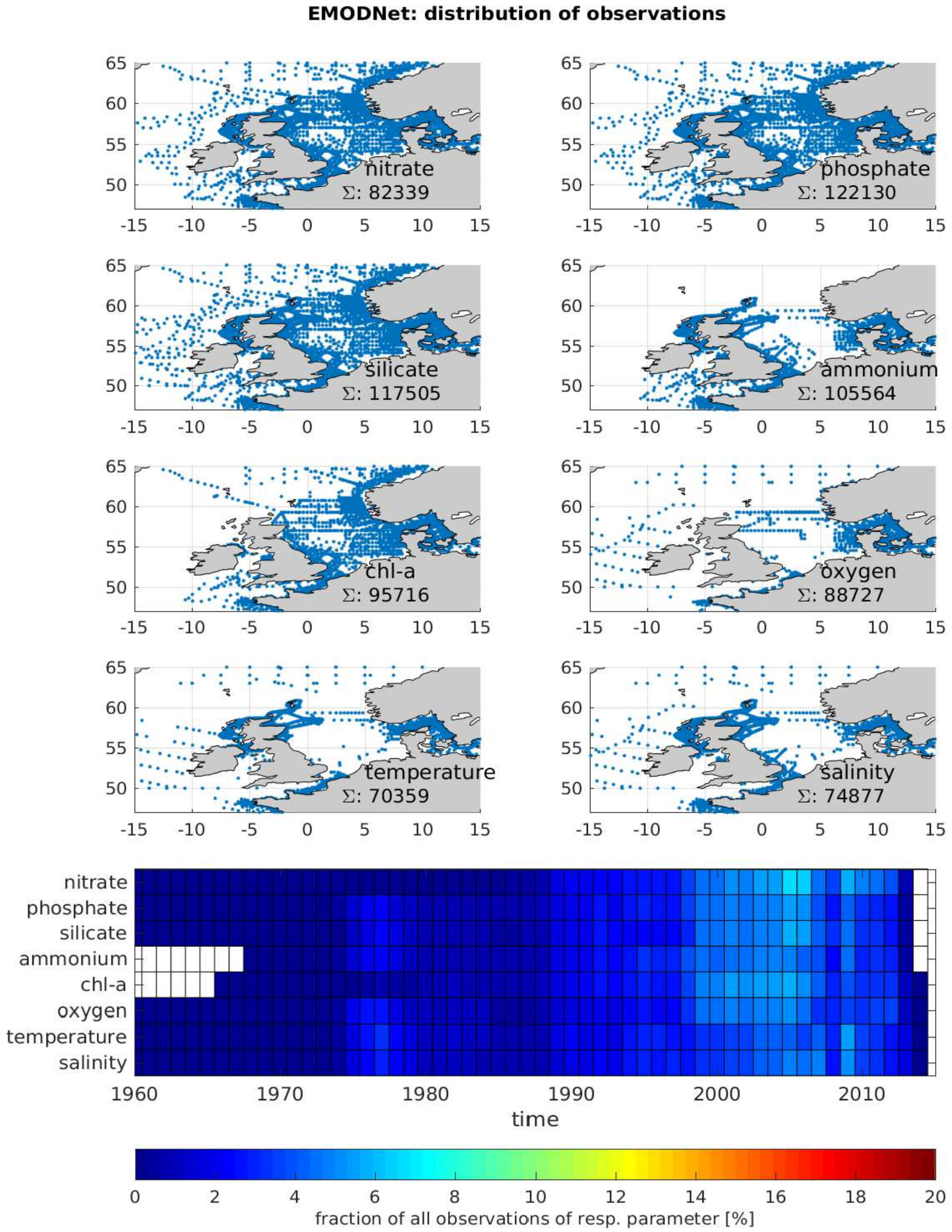


Fig. 4.3: upper panels: spatial distribution, each blue dot marks a profile position; lower panel: temporal distribution (bin width= 1 year); each line sums up to 100%

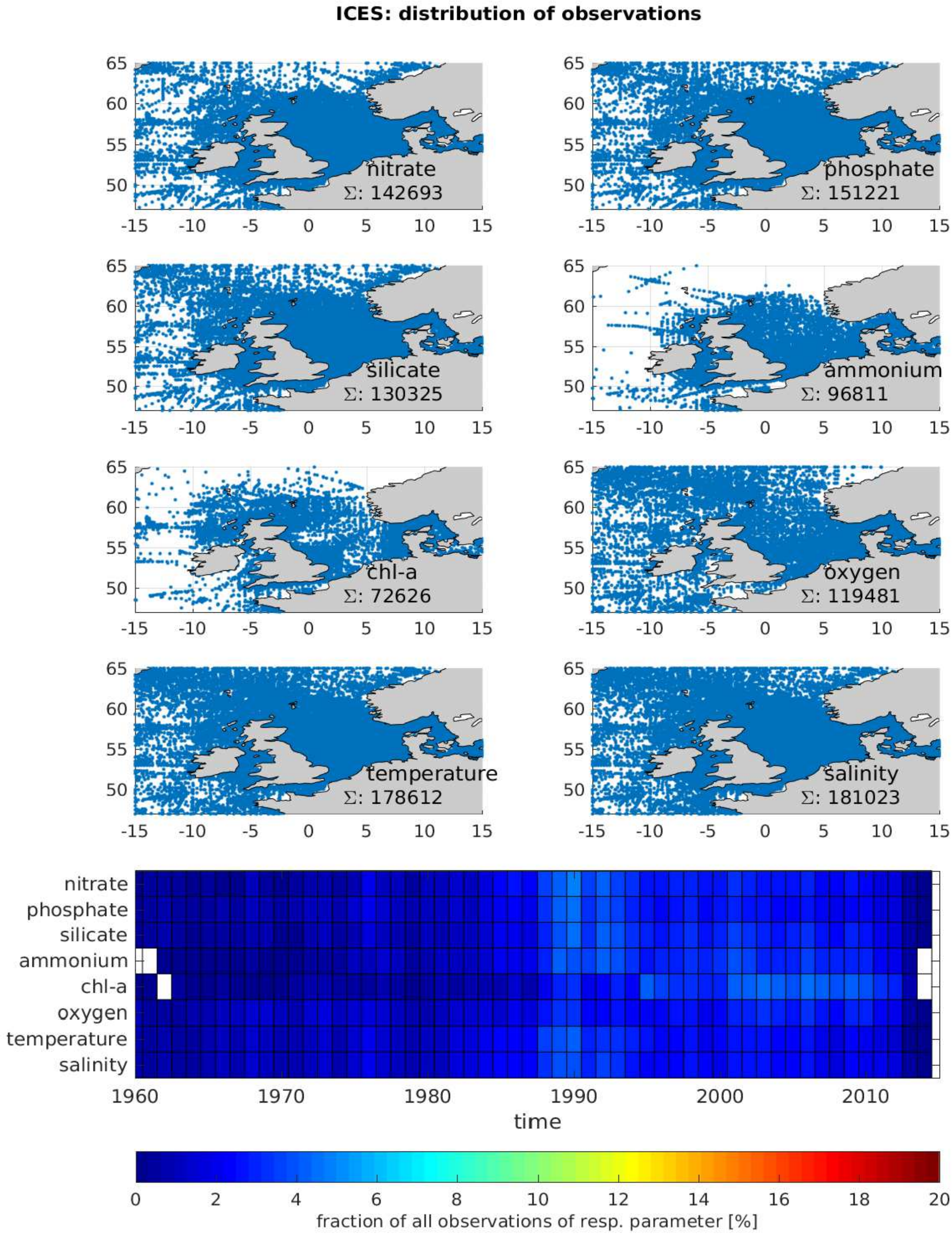


Fig. 4.4: upper panels: spatial distribution, each blue dot marks a profile position; lower panel: temporal distribution (bin width= 1 year); each line sums up to 100%

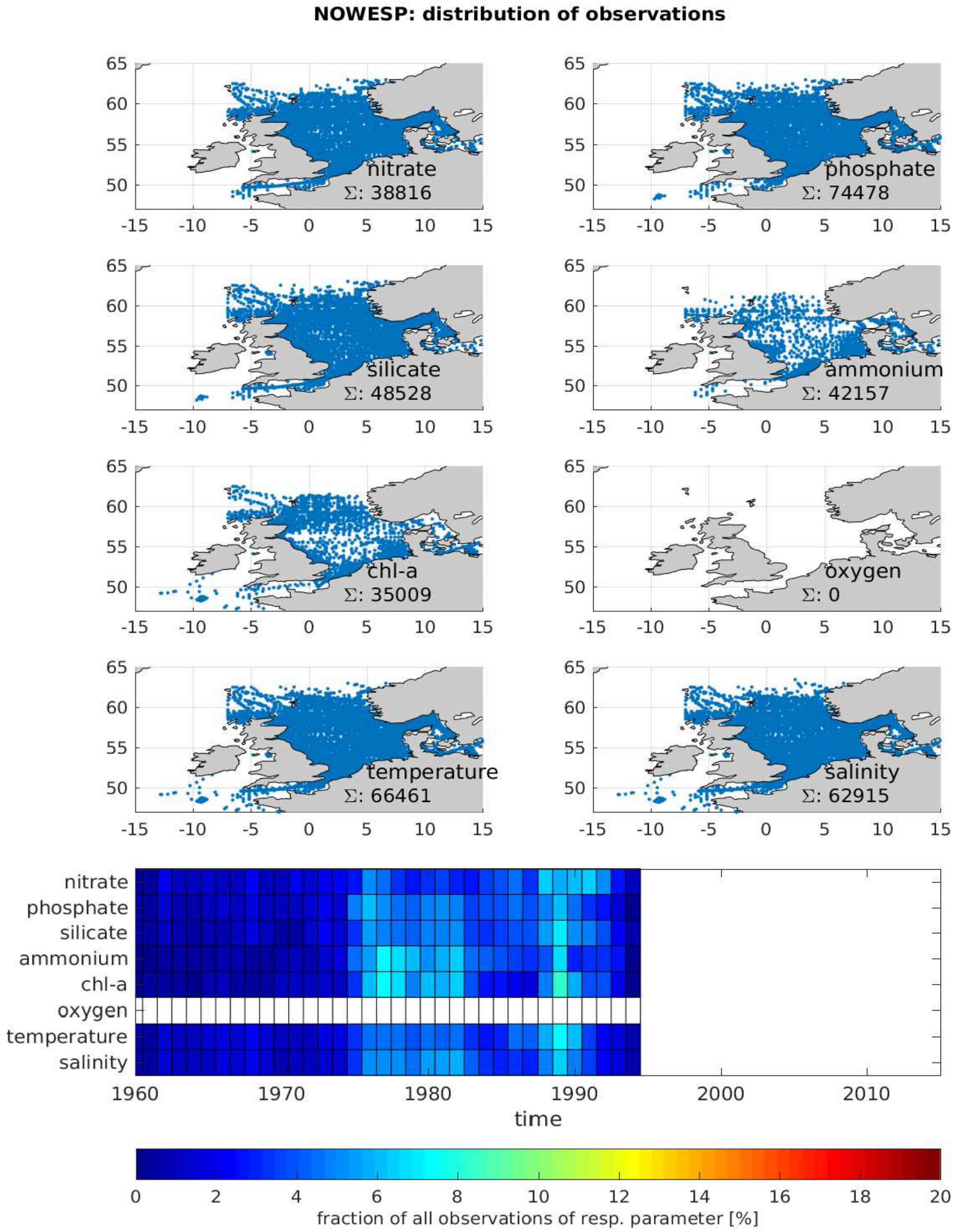


Fig. 4.5: upper panels: spatial distribution, each blue dot marks a profile position; lower panel: temporal distribution (bin width= 1 year); each line sums up to 100%. The parameter oxygen is not available from NOWESP.

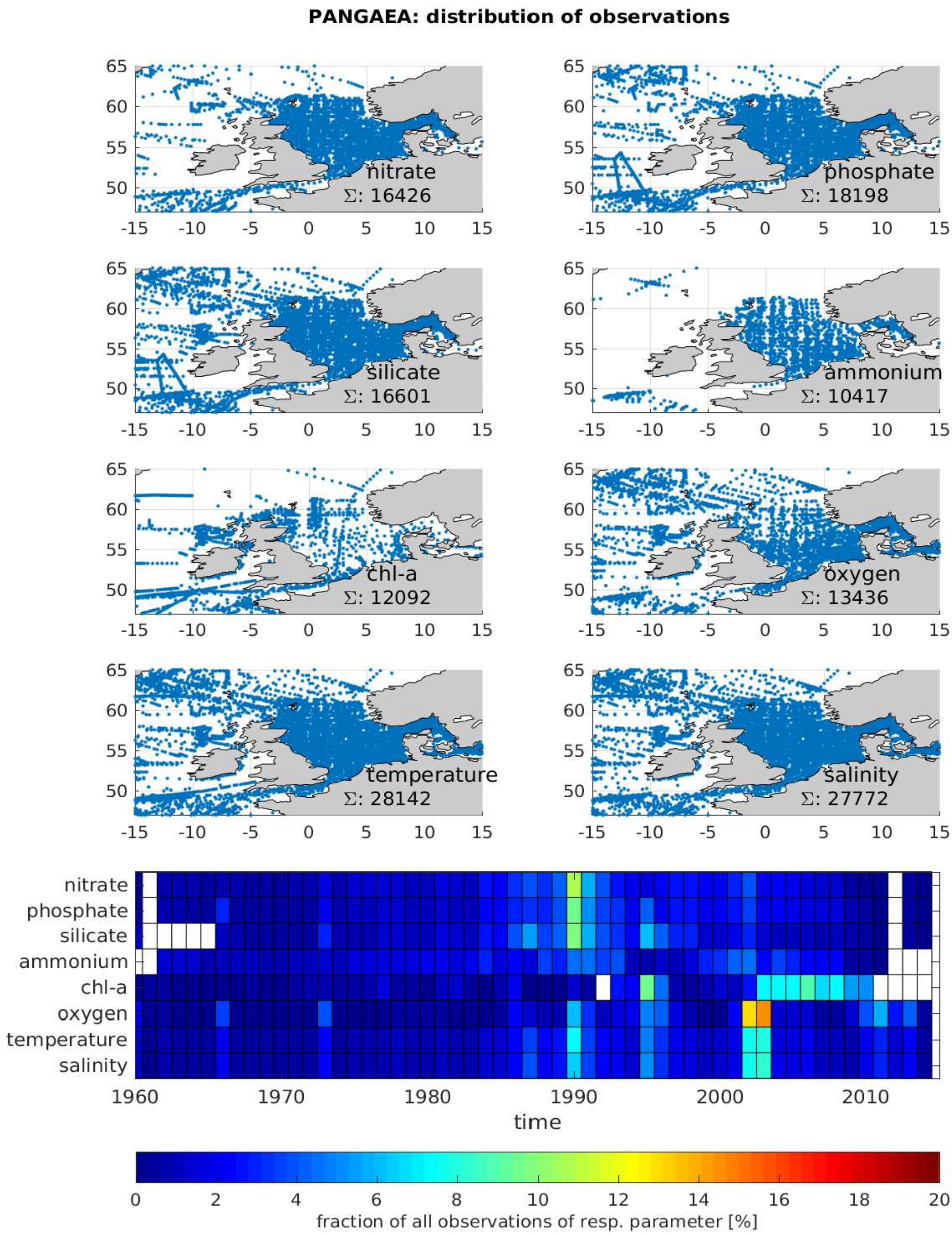


Fig. 4.6: upper panels: spatial distribution, each blue dot marks a profile position; lower panel: temporal distribution (bin width= 1 year); each line sums up to 100%

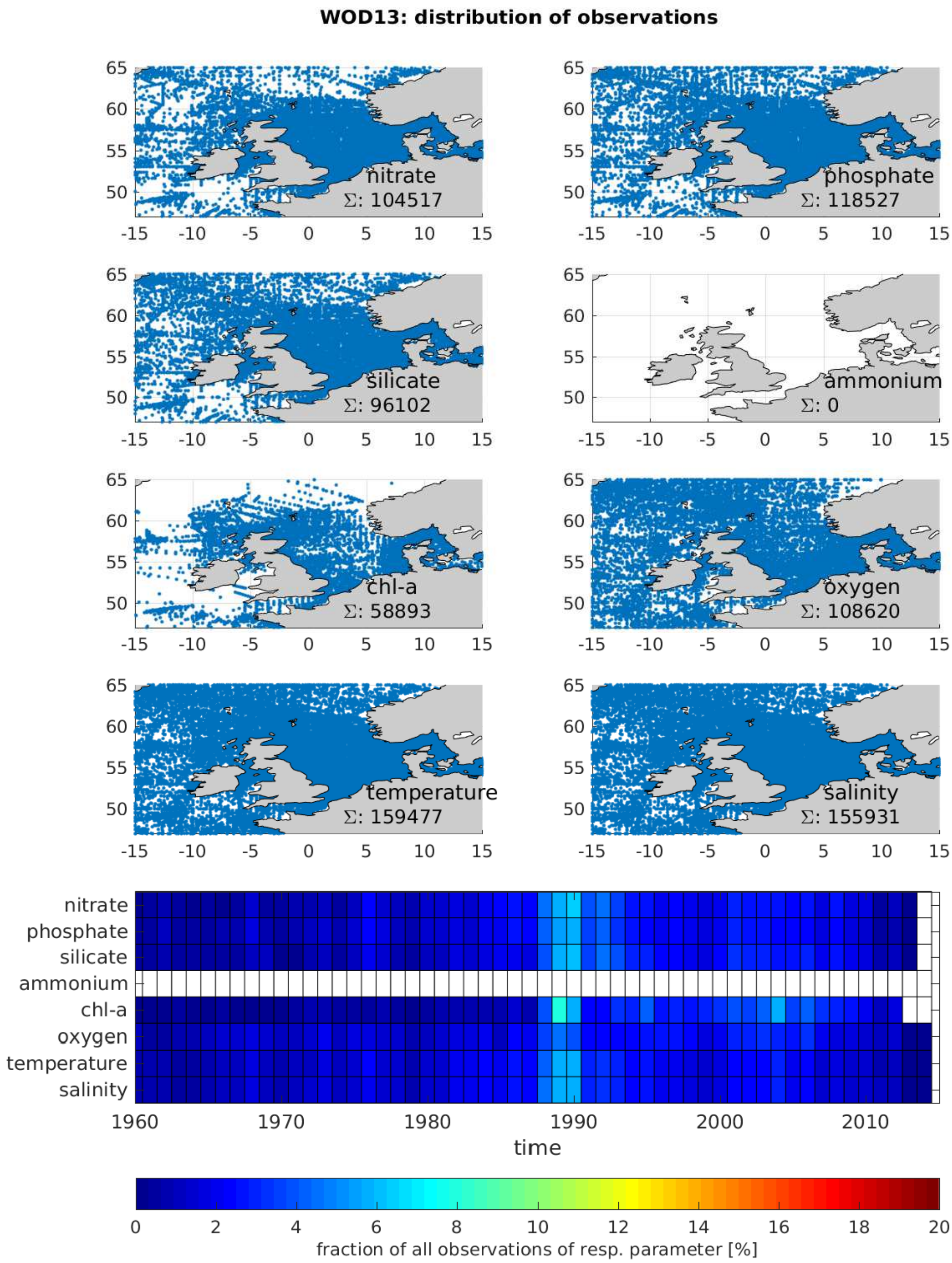


Fig. 4.7: upper panels: spatial distribution, each blue dot marks a profile position; lower panel: temporal distribution (bin width= 1 year); each line sums up to 100%. The parameter ammonium is not available from WOD13.

4.2 Elimination of duplicate observations

In the following, two steps of elimination of duplicates are shown:

4.2.1 First step: Profiles with all observed parameters

There can be duplicate profiles in one data source as well as duplicate observational data between the different data sources. Duplicate profiles in each individual data source and between the data sources are identified and omitted. Two profiles are considered as identical, if all of the following criteria are met:

1. the time of observation is the same (**day-exact**)

2. the spatial difference is not greater than a certain spatial **tolerance limit Δ (2 km)**

3. the same parameters are observed, or all parameters of one profile are a **subset** of the other profile

4. the number of depth levels is equal to or all depth levels of one profile are represented in the other profile (**tolerance for depth level identity is set to 0.5 m**)

5. the difference between the last depth levels is not greater than 1m

In cases were all five criteria are met, one of the two profiles is regarded as a duplicate and is ignored in the further processing. See Fig. 4.8 for a schematic overview of the identification of duplicate profiles.

The test for duplicate observations progresses data source by data source. In the first step, profiles from the source “WOD13” are compared to profiles from “BROCKMANN“. The WOD13 profiles are preferred to the BROCKMANN profiles, so in case of a duplicate profile, the WOD13 profile is kept. All unique profiles from this first comparison are then checked against the profiles from the next data source and so on, always with preference on the profiles from the previous step. This implies a defined order and thus a ranking between the data sources which is listed in Table 4.2. The ranking directly influences the fraction of original profiles of one data source that proceed into the merged data set.

The first step of elimination of duplicate profiles yielded in total 382,565 profiles, i.e. 312,912 of the preselected profiles (see Table 4.1) were identified as duplicates, which corresponds to 45%.

Table 4.2: Ranking and order of data sources in the elimination of duplicates.

Progression step	data source
1.	WOD13
2.	BROCKMANN
3.	NOWESP
4.	ICES
5.	DOD
6.	EMODNet
7.	PANGAEA

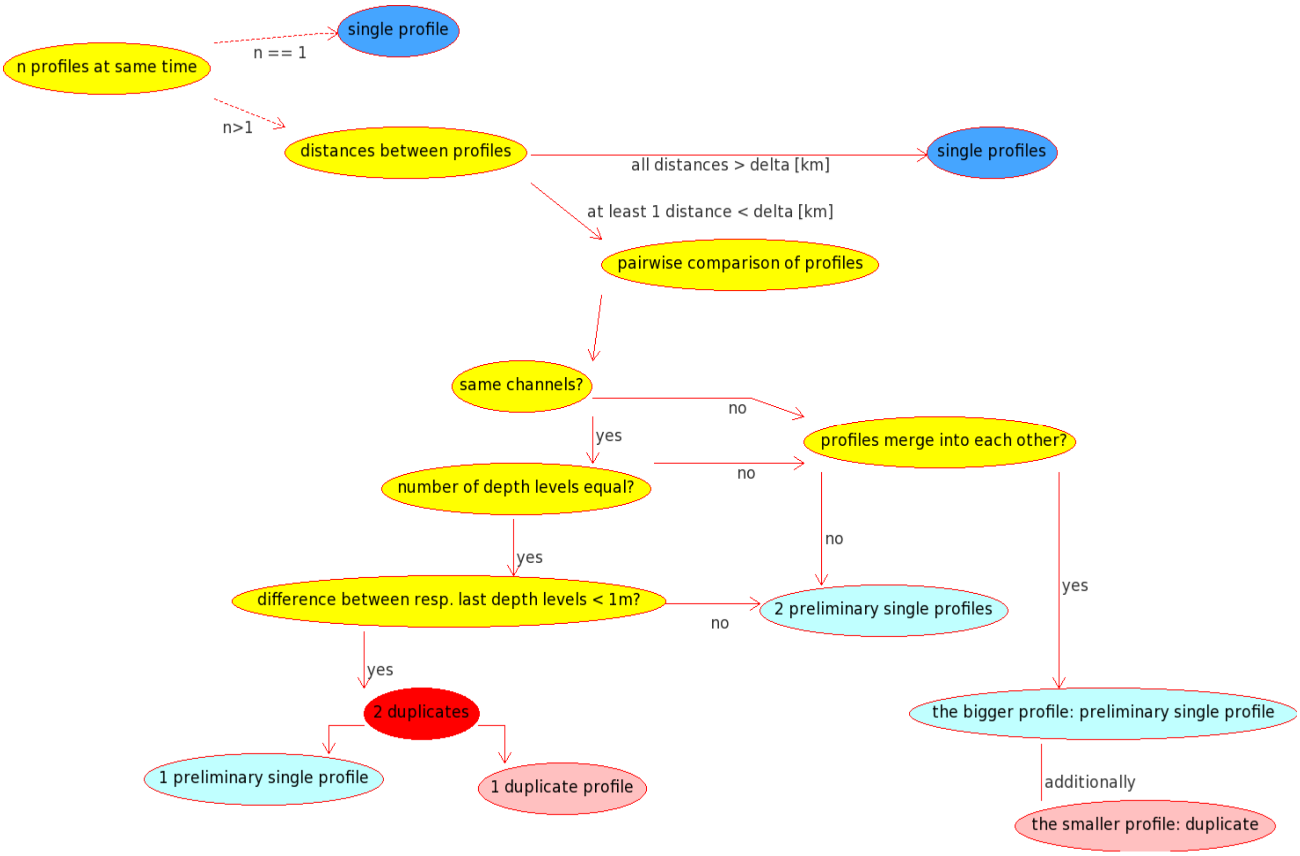


Fig. 4.8: Schematic diagram to explain the elimination of duplicate observational data. A profile classified as "preliminary single profile" in one pairwise comparison may be identified as a duplicate profile in a later pairwise comparison.

4.2.2 Second step: Profiles with single parameters

After the first step of elimination of duplicate profiles, duplicate observations still exist because two profiles are kept as single profiles in case neither of the profiles is a subset of or identical with the other profile in terms of observed parameters.

We therefore decided to split the profiles into the single parameters recorded and to perform a second check for duplicate profiles for each parameter separately. The criteria for two profiles being identical are the following:

1. the time of observation is the same (**day-exact**)

2. the spatial difference is not greater than a certain spatial **tolerance limit Δ (2 km)**

3. all depth levels are identical OR all depth levels of one profile are a subset of the depth levels of the other profile

Again a tolerance values is applied:

Depth levels are regarded as identical if the absolute difference is not more then 0.5 m OR if the relative difference of the depth levels (|depth1-depth2|/depth1*100%) is not more than 2 %. Example: depth1 == 100 m, depth2 is then considered as identical to depth1 if it ranges from 98 -102 m.

If two identical profiles with congruent depth levels are detected, the same data source ranking as in the first step (see Table 4.2) is applied to decide which profile is kept as a preliminary single profile.

If the depth levels of a shorter profile are an identical subset of the longer profile, the longer profile is kept as a preliminary single profile. The shorter one is discarded.

In the second step, another 4-8 % of duplicate profiles were eliminated for each parameter, see Table 4.3.

Table 4.3: Second step of elimination of duplicate profiles

Parameter	**No. of profiles before 2nd step**	**duplicates**	**No. of profiles after 2nd step**
ammonium	217,145	12,329 (5.68 %)	204,816
chlorophyll-a	190,447	13,425 (7.05 %)	177,022
nitrate	238,502	10,513 (4.41 %)	227,989
oxygen	214,539	14,625 (6.82 %)	199,914
phosphate	300,551	18,954 (6.31 %)	281,597
silicate	263,999	14,637 (5.54 %)	249,362
temperature	310,935	23,671 (7.61 %)	287,264
salinity	314,149	24,744 (7.88 %)	289,405

4.2.3 Spatial tolerance limit Δ

Concerning the spatial tolerance limit **Δ** applied in the elimination of duplicate observations, different values were tested. This resulted in different amounts of profiles recognized as duplicates and hence in amounts of profiles regarded as unique. An overview of the amount of unique profiles as a function of **Δ** is given in Table 4.4.

Table 4.4: Number of profiles after first step of duplicate elimination as a function of spatial tolerance limit Δ

spatial tolerance limit **Δ**	5 km	2 km	1 km
number of profiles	360,135	382,565	397,272

4.2.4 Reliability of time information

Fig. 4.9 gives an overview of the values recorded for the hour in the metadata sorted by data source. Five out of seven data sources show a significantly higher fraction of '0'-values. This leads to the assumption that '0' was used as a dummy-value in case the hour of observation was not recorded. Only WOD13 uses the dummy-value -9.

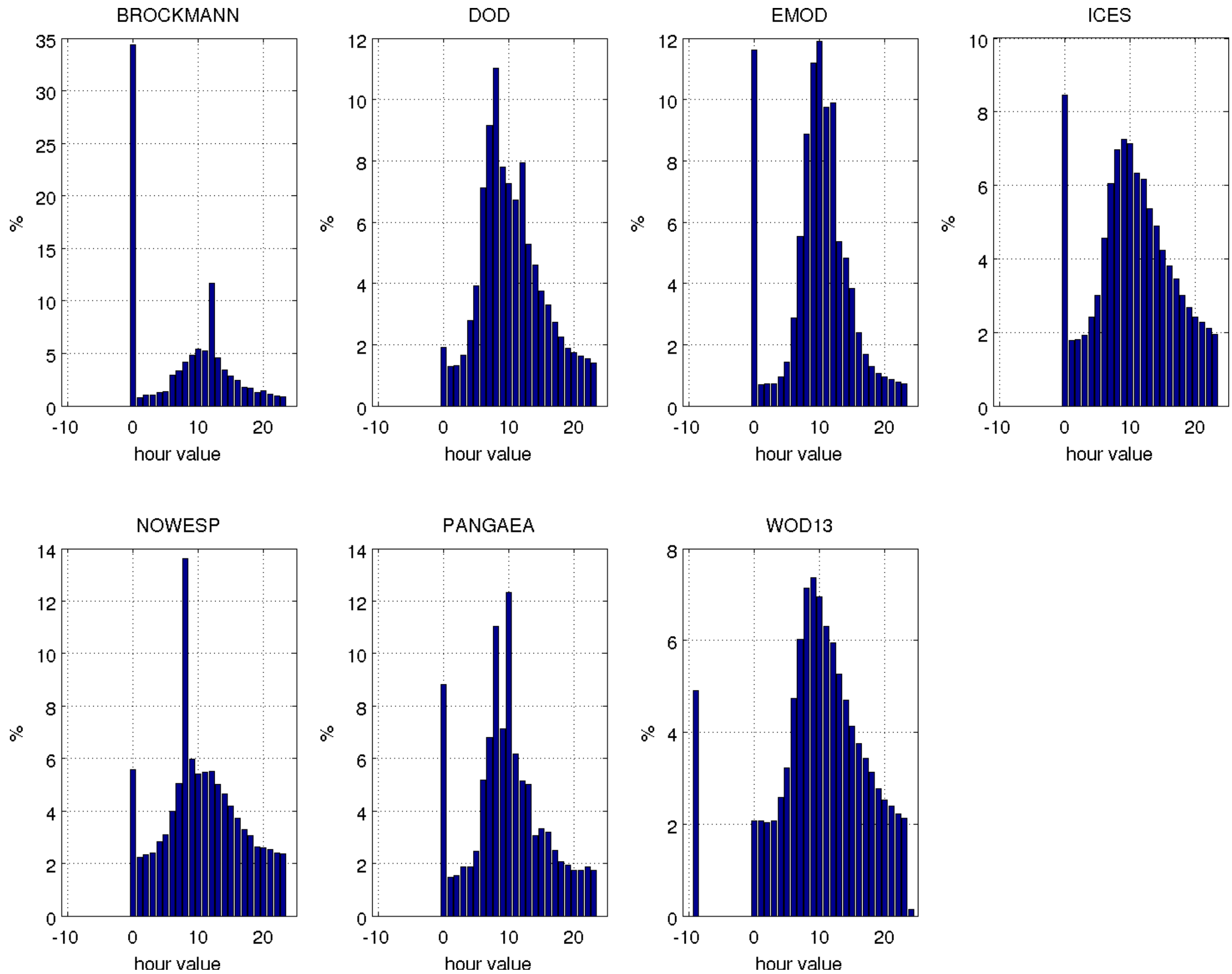


Fig. 4.9: Frequency of "hour of observation"-value provided in the metadata

Furthermore, it is questionable whether the time scale (UTC, CET, CEST, etc.) was used uniformly in the recording of the hour values. Thus, the same profile might be listed in different data sources, but with different hour values. This, of course, leads to erroneous interpretation concerning duplicate profiles when comparing hour-exact. To estimate the occurrence of mismatch between the hour values, the following test is applied:

Duplicate profiles are identified in a day-exact comparison. The difference between the recorded hour values of these profiles is then further investigated in those cases where both hour values are different from 0, i.e., the dummy value. Fig. 4.10 shows the frequency of the difference in hour values for the single progression steps (see Table 4.2). For all data sources, the difference in hour values accumulates on 0, 1 and 2, meaning that the identical profiles either show the same recorded hour value or that a difference of 1 or 2 hours is detected, which points to different time scales. We therefore decided to do a day-exact comparison in the elimination of duplicate profiles.

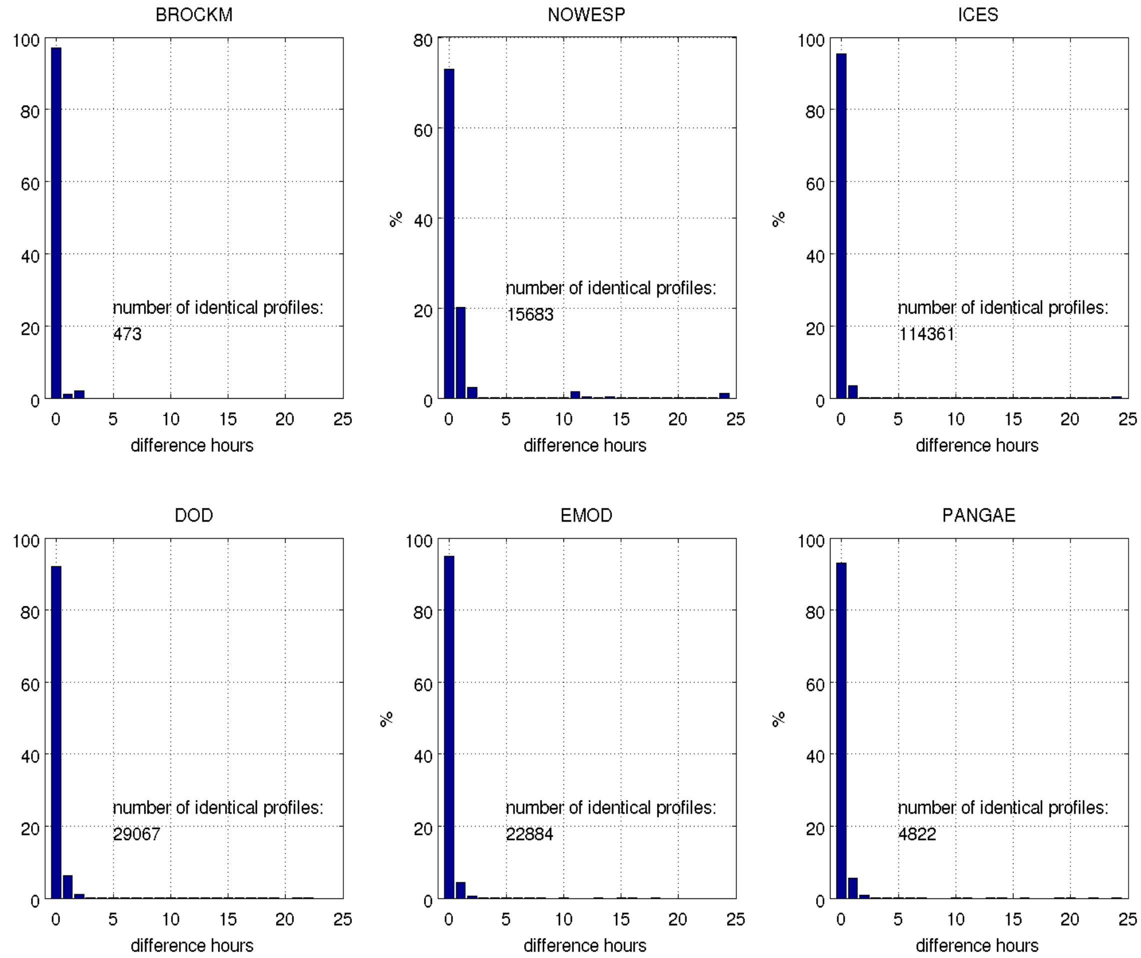


Fig. 4.10: Frequency of differences in hour values of day-exact identical profiles. Profiles of the data sources listed here are compared to the unique profiles from the previous progression step in the process of eliminating duplicate profiles (see Table 4.2)

4.3 Aggregated observational data

After the second step of duplicate elimination, an aggregated data set for each parameter remains. Fig. 4.11 quantifies the amount of profiles per data source of the single parameters. The spatial and temporal coverage is shown in Fig. 4.12 and Fig. 4.13, respectively.

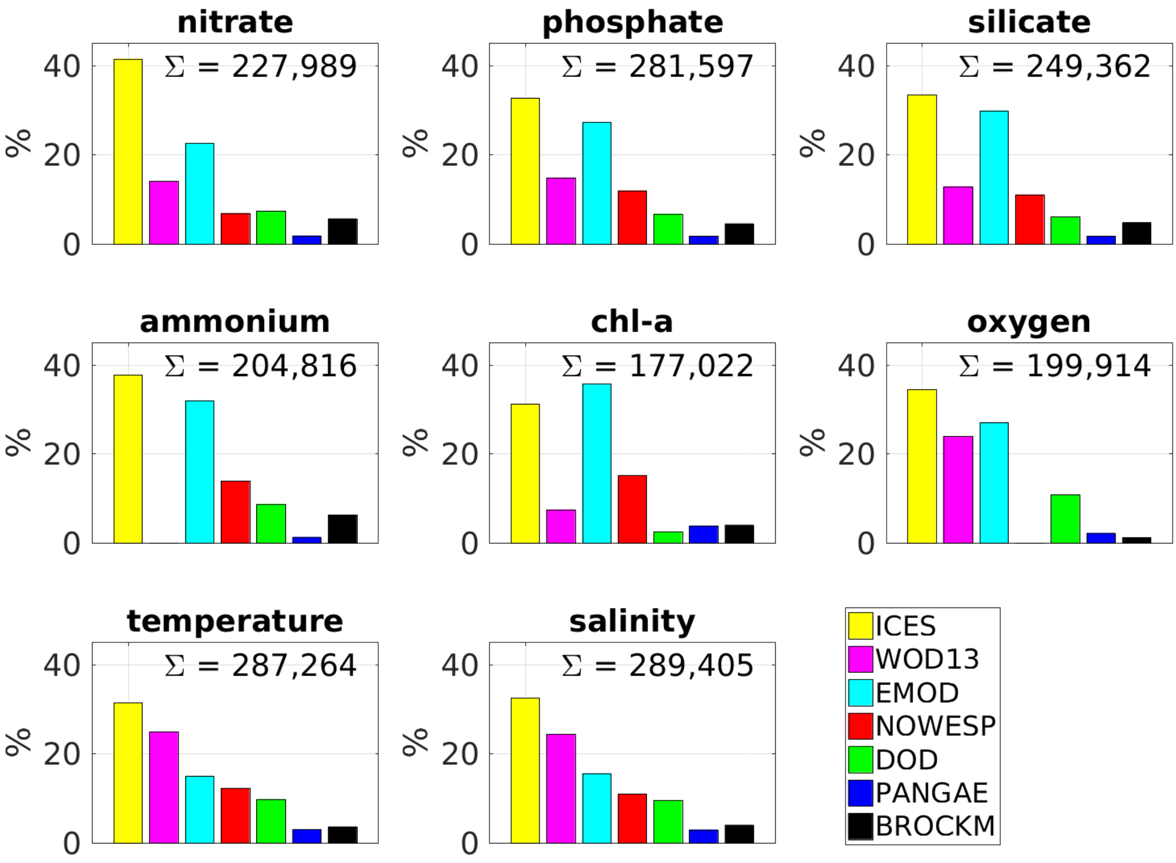


Fig. 4.11: Level 0, merged data set: frequency of parameters per data source

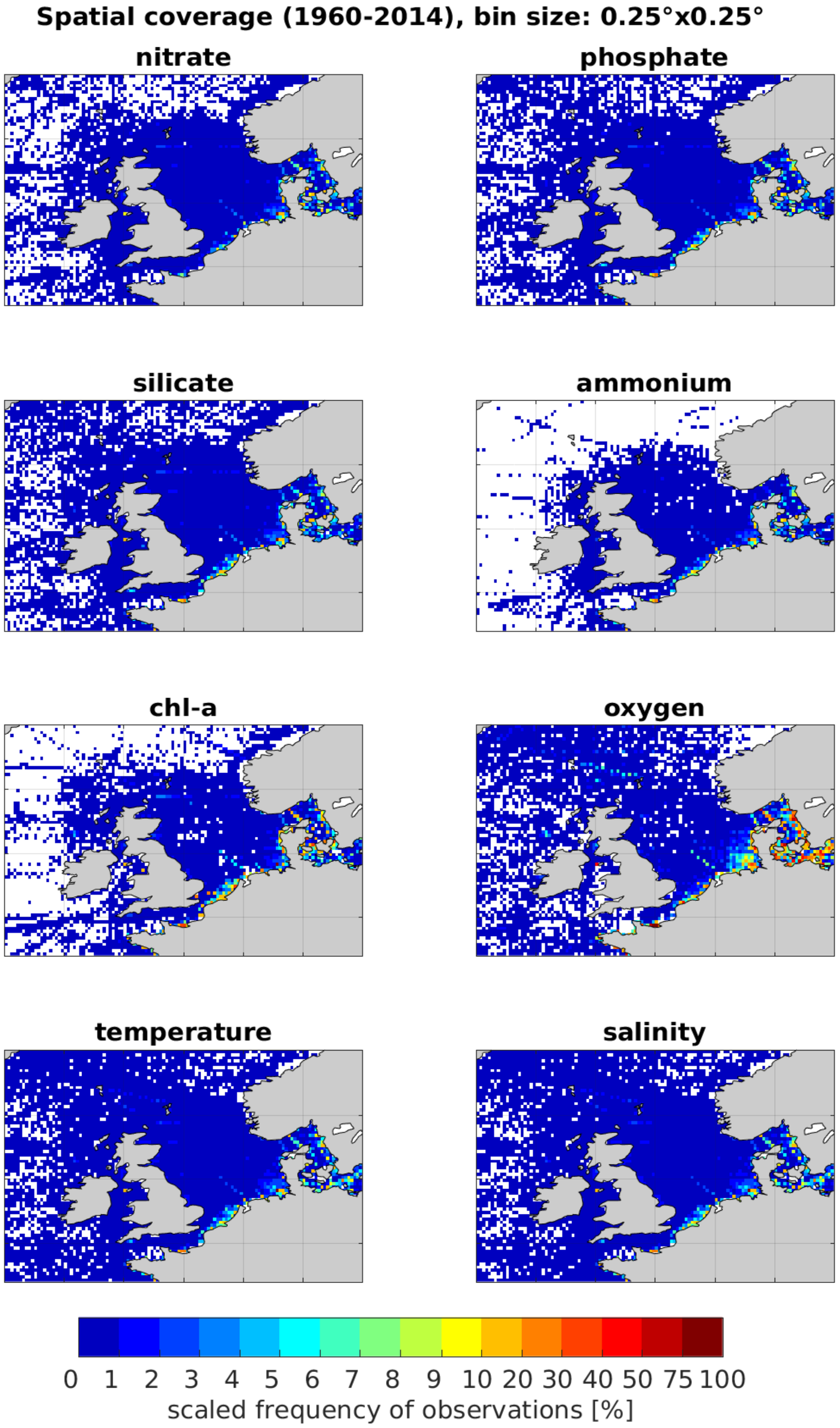


Fig. 4.12: Merged data set: surface data density of single parameters in the horizontal plane. Frequencies are scaled to the grid box value of maximum number of observations for each parameter. Note the nonlinear color bar.

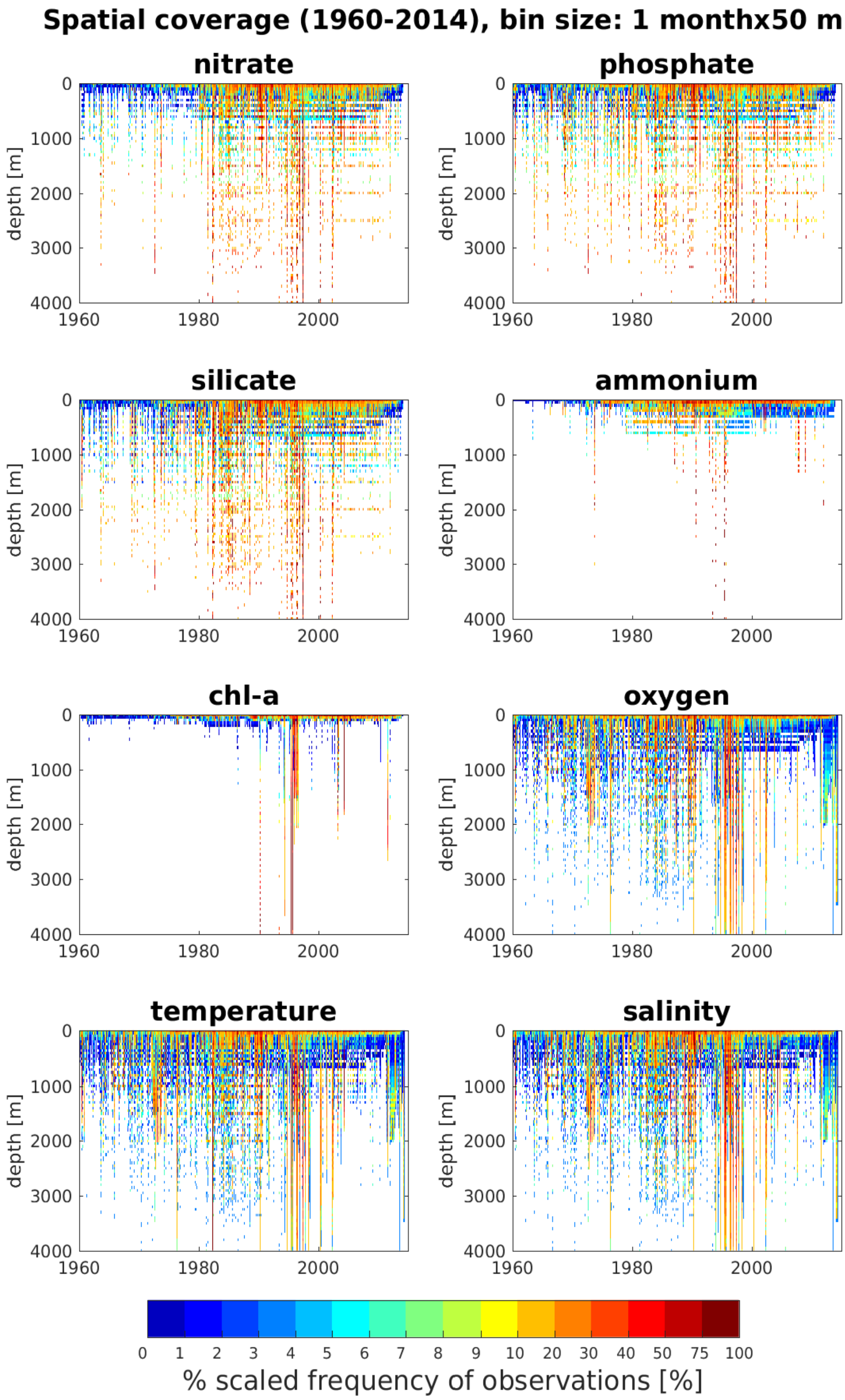


Fig. 4.13: Merged data set: data density of single parameters in depth and time. Frequencies on every depth level are scaled to the bin value of maximum number of observations on that level. Note the nonlinear color bar.

4.4 Quality control of original aggregated profiles (Level 1 data)

The quality control of the observed data represents an essential and important step for the subsequent construction of the North Sea Biogeochemical Climatology. Here we follow the data quality control strategy intended for the implementation during the international initiative **„International Quality Controlled Ocean Database (IquOD)“(http://www.iquod.org/)**.

The whole QC control procedure consists of two essentially independent steps:
the automatic quality control (AQC)
the expert quality control (EQC)

The advantages of the **AQC** are:

- it is fast as soon as the tuning of the AQC procedure is completed
- it is repeatable
- it provides quantification and statistics of the rejected data.

The disadvantage of the procedure is that some good data may still be flagged as erroneous.

The expert quality control is based on the experience of the scientist who is to decide (subjectively) about the quality of the respective data. The advantage of the EQC lies in the ability of the experienced person to decide on the data quality in cases where the AQC procedure fails. However, this kind of quality control is expensive and requires involvement of experienced oceanographers or trained persons (technicians, students).

Taking into account the large amount of data underlying the quality control (~300,000 profiles) the AQC was used for the data quality assessment, followed by a rather limited EQC procedure. The decision on which data, parameter or regions should be finally put through the EQC step will be made at later stage and will be based on the respective data quality indices provided by the AQC.

It should be kept in mind that each quality control procedure is goal-oriented. In our case the goal is a North Sea climatology, e.g. a validated database and the resulting products, that describe the mean states of temperature, salinity and biogeochemical parameters. These mean states should not be strongly dependent on true, but extremely untypical, values of the analyzed parameters. Part of the observations identified as erroneous by the AQC procedure will correspond to data which are true, but which are not representative for the goal mentioned above.

Even the automated part of the QC procedure depends on subjectively imposed thresholds which define „the boundary“ between „good“ and „bad“ data. However, the decision on thresholds for specific quality checks for each parameter is based on the analysis of the sample statistics. The overriding criteria for building the quality control system were the traceability of the decisions and the ability to monitor the performance of the AQC procedure.

The AQC procedure consists of several independent quality checks. There are two kinds of quality checks:

- Overall checks with the respective threshold values being valid for the whole region or specific instrument type. The threshold values are based on the statistical information gained from the entire North Sea Data set. Depending on the data density, it might also be more appropriate to define the tests described in the following regionally and/or seasonally for all or some of the parameters.

- **Local checks** with the respective threshold values being locally valid.

Observations failing either of the different checks are subject to rejection.

4.4.1 Overall Checks

The overall checks include:

- **Sample depth order check**
- **Crude range check**
- **Maximum observed depth for the specific data type**
- **Constant value check**
- **Spike check**
- **Vertical gradient check**
- **Number of extrema check**

Sample depth order check

This check does not require any statistical information.
Purpose: Check whether the depth levels for the profile are placed in increasing order.
Action: all original levels of the profiles are 1) re-ordered (placed in increasing order) and 2) flagged. Re-order flags do not contribute to the final quality assessment.

Crude range check

Purpose: screen the data for extreme parameter values and flag the data which are grossly in error. Global parameter-depth histograms (exemplarily for the parameter temperature, see Fig. 4.14) are used to define the parameter-depth mask for gross errors. The threshold frequency is set to 1%. Values beyond this mask fail the test. It is assumed that observations which failed this test give no information on the true parameter value.
Action: values beyond the mask are flagged and are assumed to be definitely bad.
Flag = 1, if the parameter value lies outside the overall parameter limits (see Table 4.5)
Flag = 2, if the parameter value lies outside the parameter mask
The overall parameter limits in Table 4.3 are accepted outside the coastal or estuarial areas where higher values of the geochemical parameters may occur.

Table 4.5: Overall parameter limits

Parameter	**Minimum Value**	**Maximum Value**
ammonium	0	10
chlorophyll-a	0	35
nitrate	0	60
oxygen	0	500
phosphate	0	5
silicate	0	50
temperature	-2	25
salinity	0	38

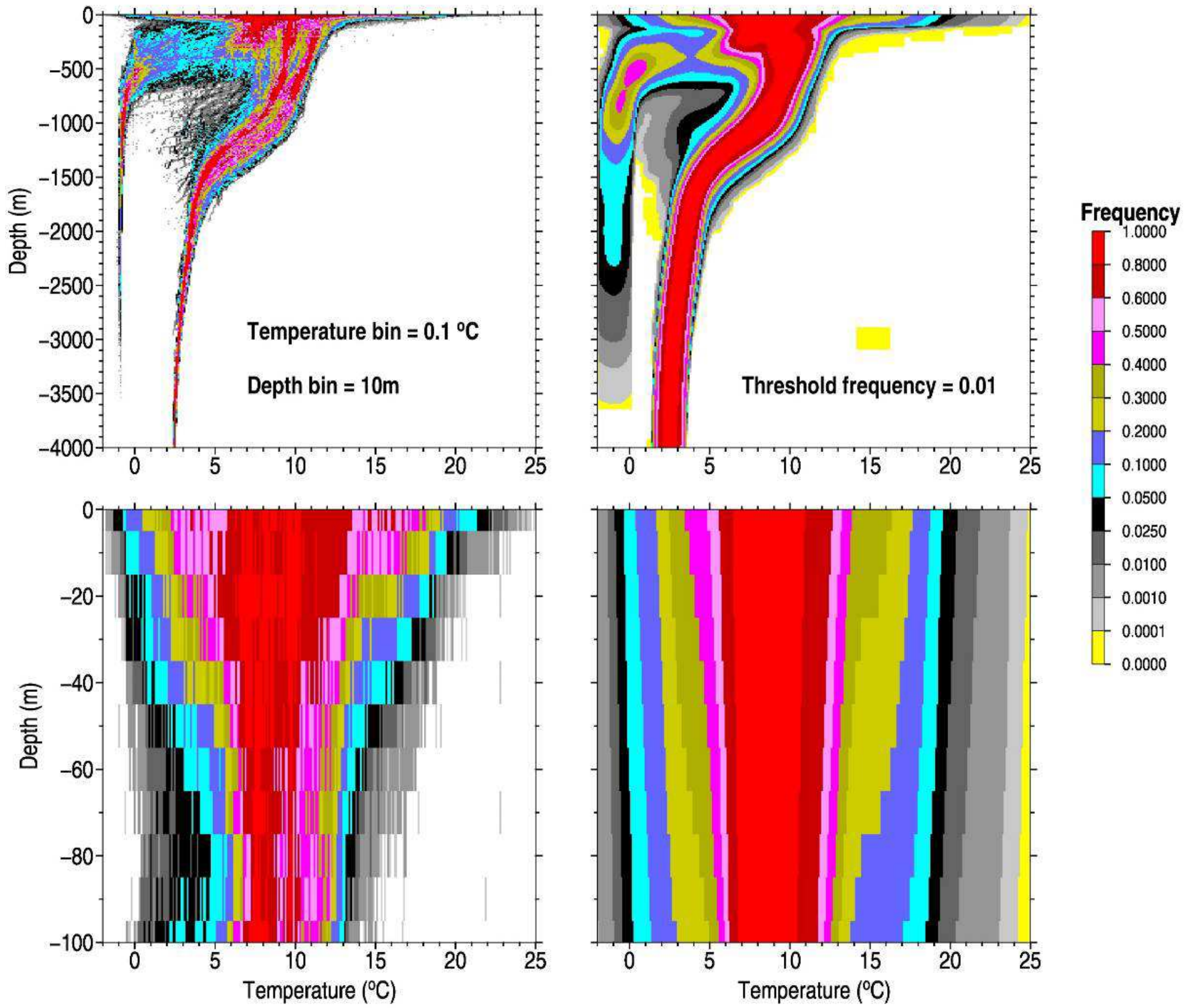


Fig. 4.14: Normalized temperature-depth histogram. For each level the number of observations in each bin is divided by the number of observations for the most populated bin of the same level. Left: unsmoothed histograms; right –histograms smoothed with 11x11 point kernel

Maximum observed depth for the specific data type

The North Sea dataset is represented by the profiles obtained by the CTD devices and by means of Nansen bottles. Following maximum sample depth is accepted for these profile types:

1. Nansen casts 7000 m
2. CTD 9000 m

Purpose: check if the depth of the profile is in agreement with the instrumentation type
Action: all levels of the profile are flagged. Failing the test may indicate a wrong data-type attribution or probably bad data.
No outliers have been identified by this check for the extended North Sea region, because the maximum water depth everywhere is less then the check thresholds.

Constant value check

Purpose: check how many consecutive parameter values of the observed vertical profile are identical.

The test includes two parameters:

H – the minimal thickness of the layer within which all measurements show exactly the same value,
N – the number of levels with the same value within the layer H.

The tuning parameter N is assumed to be data-type dependent:

- Nansen casts 5
- CTD 50

H is set to be 300 meters

Action: All levels within the layer H are flagged and are assumed to be in error. Fig. 4.15 gives an example of an oxygen profile affected by the constant value check

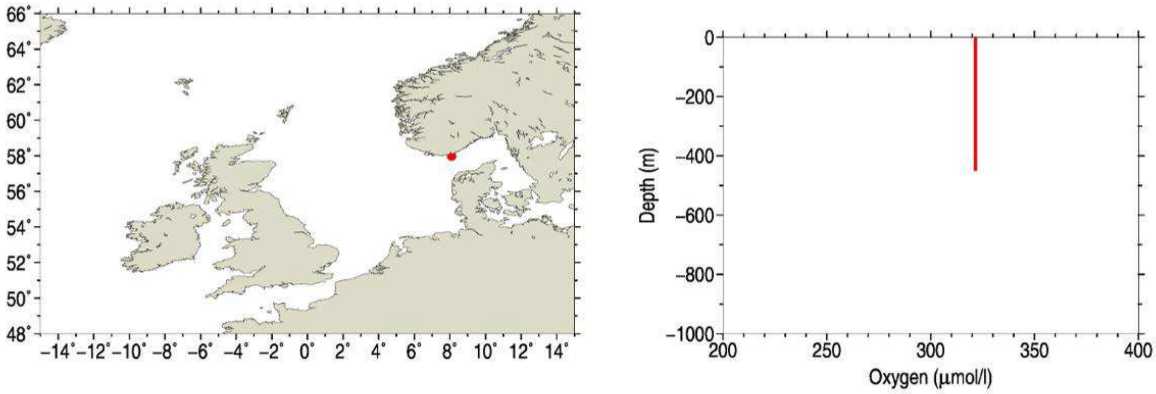


Fig. 4.15: Example of the oxygen profile with the constant value check failed

Spike check

Purpose: To identify spikes on parameter profiles.
For each triple of sampled values **p** on neighboring depth levels k-1, k, k+1 the following test values are calculated (see Fig. 4.16):

$q1=|p_k-(p_{k-1}+p_{k+1})*0.5|$
$q2=|(p_{k+1}-p_{k-1})*0.5|$
$spike=q1-q2$

The value "spike" is compared to a tunable depth dependent threshold value s_{max} (see Table 4.6). The spike test is not performed for the profiles with too big gaps between the observed levels. The following thresholds for the gap size between the depth levels are applied:

$z_{k+1}-z_{k-1} > d_{max}$,
$z_{k+1}-z_k > e_{max}$,
$z_k-z_{k-1} > e_{max}$,
$d_{max} = 50 + z_k/10$,

$e_{max} = d_{max}*0.5$.

Table 4.6: Spike threshold values

Parameter	**Spike threshold value s_{max}**	
Ammonium	3.0 µmol/l	
Chlorophyll-a	3.0 µg/l	
Nitrate	10.0 µmol/l	
Oxygen	30.0 µmol/l	
Phosphate	1.0 µmol/l	
Silicate	15.0 µmol/l	
Temperature	4.0 °C	
Salinity	3.0	

Action: If the distances between the depth levels are lower than the thresholds d_{max} and e_{max}, respectively, and if spike > s_{max} the parameter value is flagged at level k+1 and is considered to be in error.

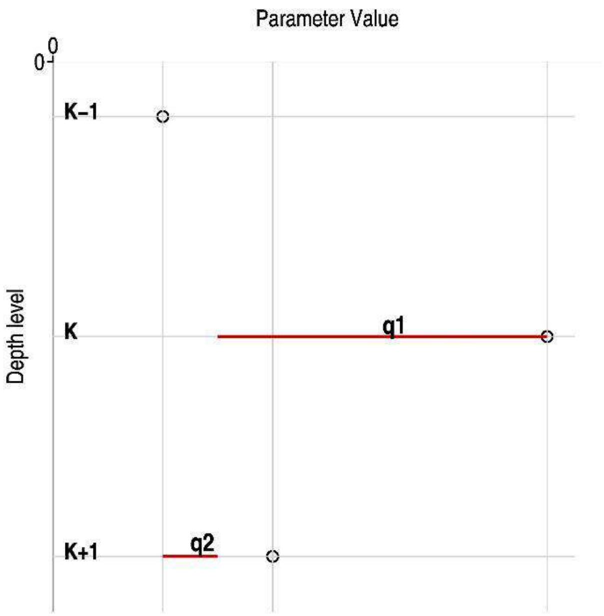


Fig. 4.16: Explanation to the spike-check

Example of a salinity profile affected by the spike test is given in the Fig. 4.17.

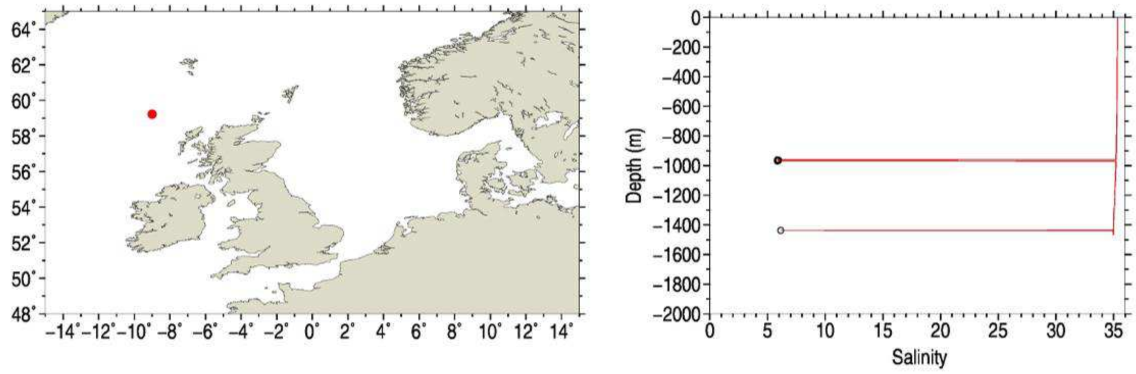


Fig. 4.17: Example of a salinity profile affected by the spike check (levels failed the check are marked with black circles).

Vertical gradient check

Purpose: identify pairs of levels for parameter P for which the vertical gradient dP/dZ exceeds an overall threshold depending on depth. The overall limits of dP/dZ are based on the respective histograms (Fig. 4.18) and are defined by the reciprocal function of depth which is taken to crudely approximate the position of bins with the probability less than 0.001. The subjective adjustment of the analytical function to the frequency histogram is performed.

Action: both observations at levels k and k+1 are flagged and are considered to be in error.

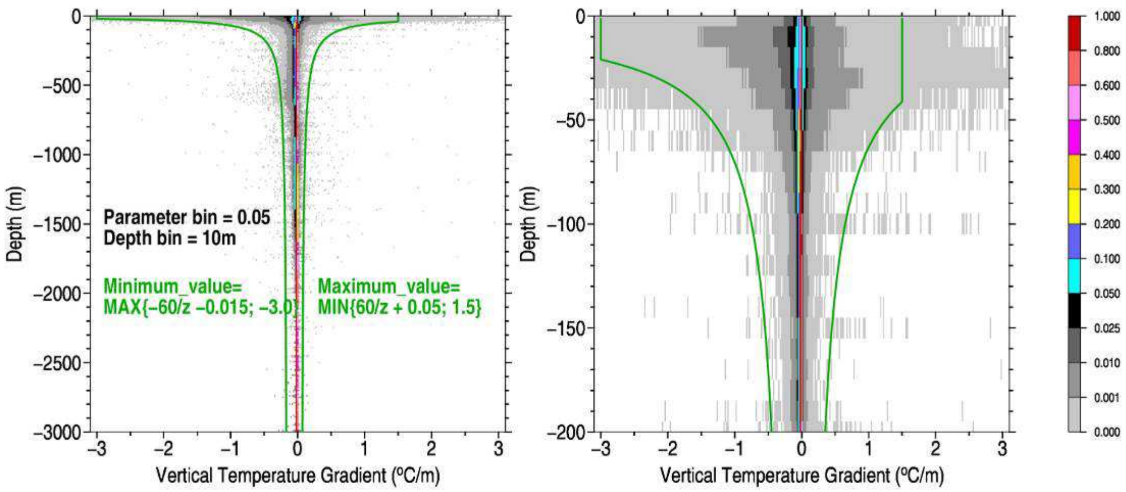


Fig. 4.18: Normalized temperature vertical gradient histogram. For each level the number of the data in each bin is divided by the number of data for the most populated bin. The min-max vertical gradient limits shown in green are subjectively approximated by the reciprocal function of depth

An example of a phosphate profile with failed gradient check is shown in Fig. 4.19.

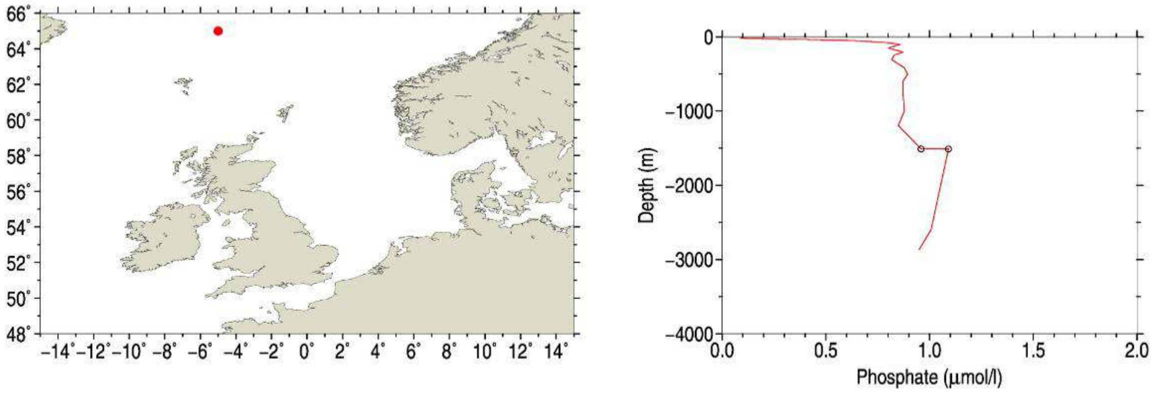


Fig. 4.19: Example of the phosphate profile affected by the vertical gradient check. The pair of levels which failed the check is marked with black circles

Number of extrema check

Purpose: Identify profiles with unrealistic number of local parameter extrema.
A local extremum is detected when:

$p_k > p_{k+1}$ and $p_k > p_{k-1}$

or

$p_k < p_{k+1}$ and $p_k < p_{k-1}$, where p denotes parameter values at levels k,k-1,k+1.

An extremum is considered to be a significant one if $|p_k - p_{k+1}| < d$ and $|p_k - p_{k-1}| < d$, where the threshold amplitude d is **chosen to be larger than both the parameter measurement precision and the typical size of the micro-scale parameter inversions.** The histograms for the number of extrema for each parameter are shown in Fig. 4.20.

Action: Profiles with more than 3 extrema (defined as outlined above) are considered to be in error and respective parameter values at all levels are rejected.

This check is applied to profiles with at least 7 observed levels.

An example of a salinity profile which failed the number of extrema check is shown in the Fig. 4.21.

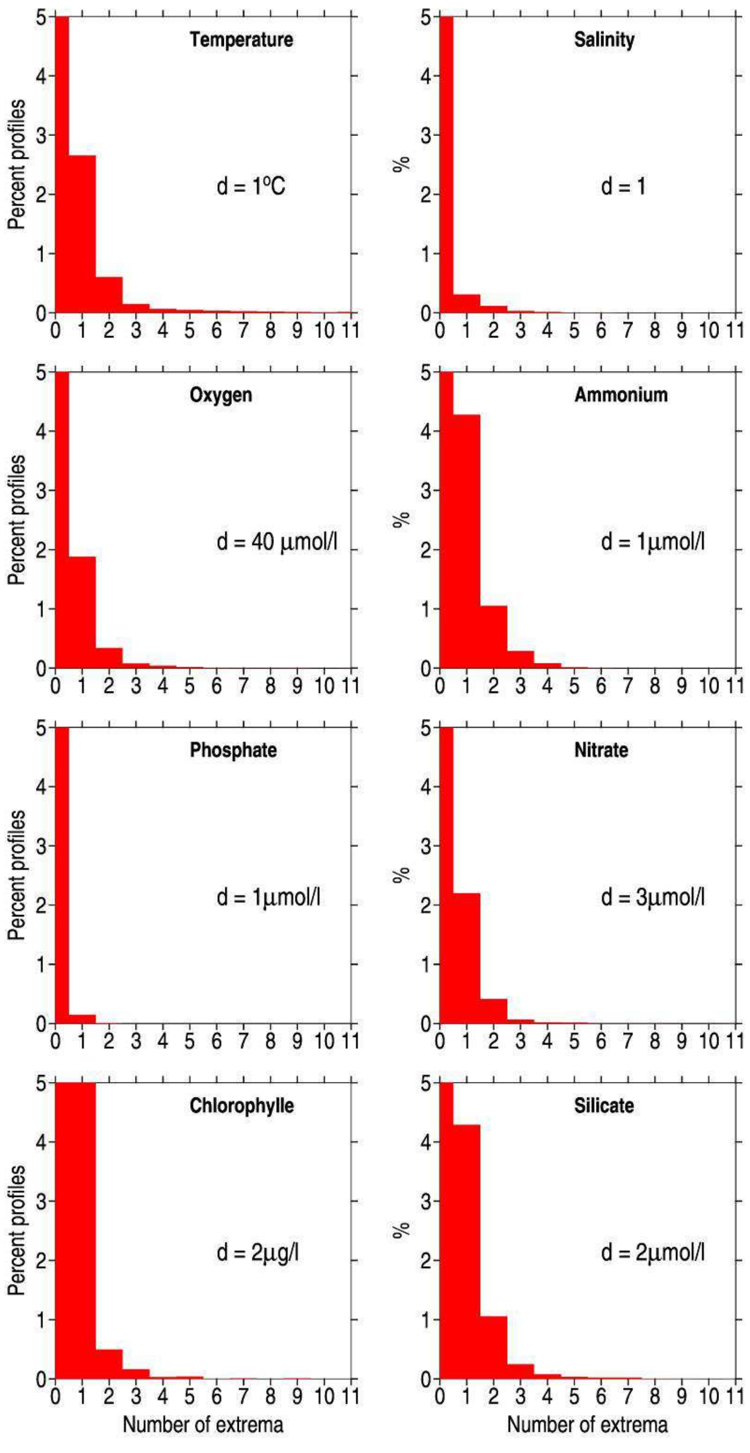


Fig. 4.20: Histograms for the number of extrema for the North Sea dataset. Note that the majority of the profiles does not exhibit local extrema.

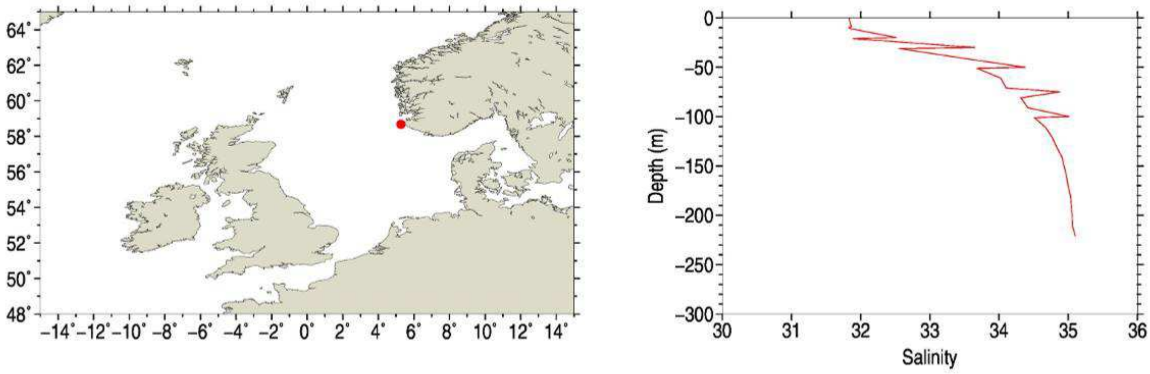


Fig. 4.21: Example of the salinity profile with the number of extrema check failed.

4.4.2 Local tests

The local checks include:

- **Observed level depth vs digital bathymetry test**
- **Local climatological range test**

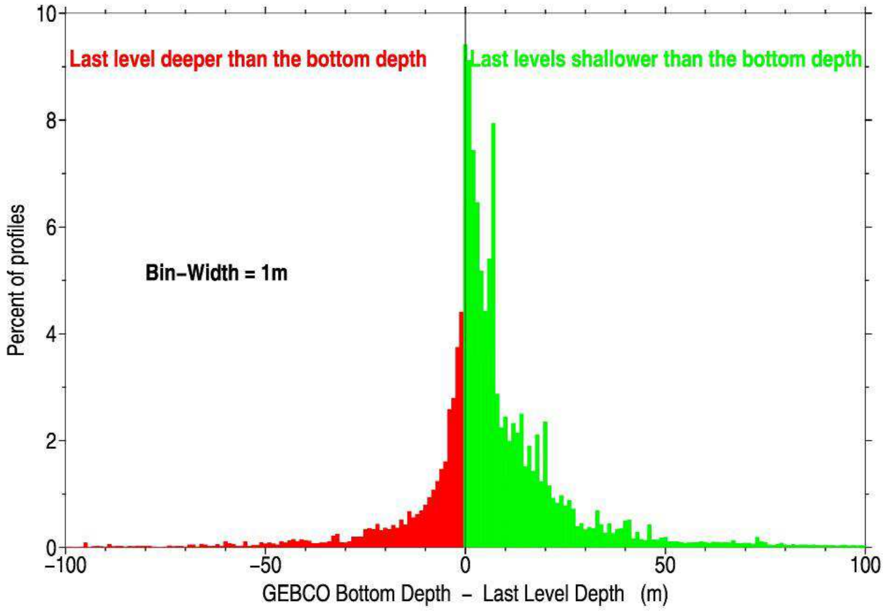
Observed level depth vs digital bathymetry check

Purpose: The depth of the deepest sampled level is compared with the bottom depth according to the digital 30x30 arc second resolution global bathymetry GEBCO2 (Weatherall et al.; 2015)). It is assumed that the digital bathymetry can effectively distinguish between the ocean and the land areas, and failing this test means that the coordinates of the temperature profile are in error.

The coordinates of the hydrographic position are known with some uncertainty. Whereas for the contemporary data the uncertainty is very small due to the usage of the satellite navigation, station positions for the older data are much less accurate. However, in the current version of the AQC we apply the uncertainty of 2 miles for each hydrographic station. In case when the digital GEBCO bathymetry indicates land everywhere within the 2-mile radius the profile is assumed to be a “land” profile and all levels are rejected. Otherwise, the deepest location within the 2-mile radius is taken as the true hydrographic station position. The GEBCO bathymetry describes the real bottom depth with some uncertainty. Therefore, the GEBCO bottom depth (H_G) is increased by the tolerance H_t=10m + 0.2H_G), and all sample depth greater than H_G+ H_t are flagged. Fig. 4.22 shows the histogram of differences GEBCO bottom depth minus profile last observed depth (upper panel) along with the positions of profiles which failed the last sample depth check.

Action:

- all levels are flagged for the 'land' profiles
- all levels below the depth H_G+ H_t are flagged for the ocean profiles



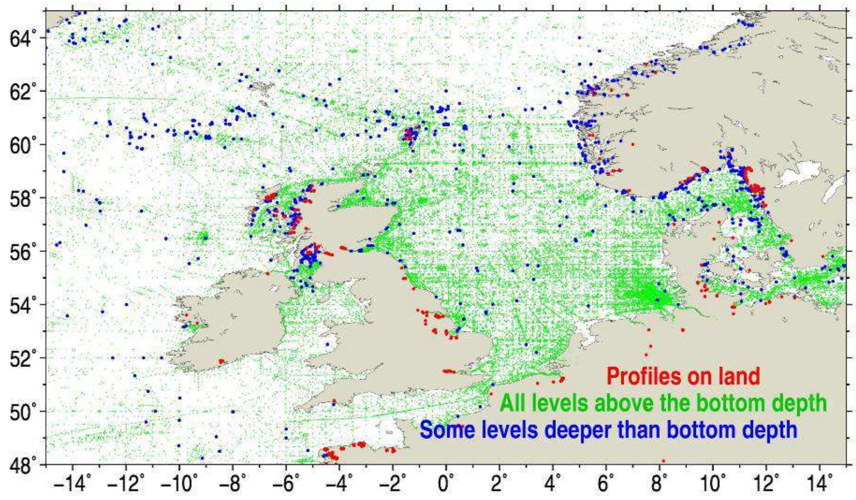


Fig. 4.22: Results of the last level depth check applied to the profiles from the combined North Sea dataset. Green: check successfully passed; red: profiles on land; blue: profiles with levels below the local bottom depth.

Local climatological range check

Purpose: Each observed parameter value p_{obs} is proved again the respective local climatological parameter range [p_{min}, p_{max}].

Action: a parameter value p_{obs} is flagged when it lies outside the local climatological parameter range.

In order to construct local climatological parameter ranges the observed level data are subjected to the

quality checks 1-8. Only the data which passed the checks are then interpolated to the standard levels. At each standard level and for each of the twelve months the ***median*** and the ***absolute median deviation (AMD)*** are calculated for the data within a certain influence radius. The calculations are done on a regular 0.25°x0.25° lat/lon grid.
The size of the influence radius depends on the local data abundance. The influence radius is increased iteratively in the range 111 to 333 km until the target number of observations (300) within the radius is achieved. Whereas the 111 km radius is chosen to represent the smallest area for the median calculations, the choice of the maximum radius is aimed to provide at least 5 observations within the influence bubble also in the data-poor western part of the extended North Sea area. Fig. 4.23 shows the maps of the median and the absolute median deviation for phosphate, along with the maps for the influence radius and for the number of values within the influence radius.

The local climatological parameter range is defined as:

$$\mathbf{P_{min} = P_{median} - 2.0*AMD}$$

$$\mathbf{P_{max} = P_{median} + 2.0*AMD}$$

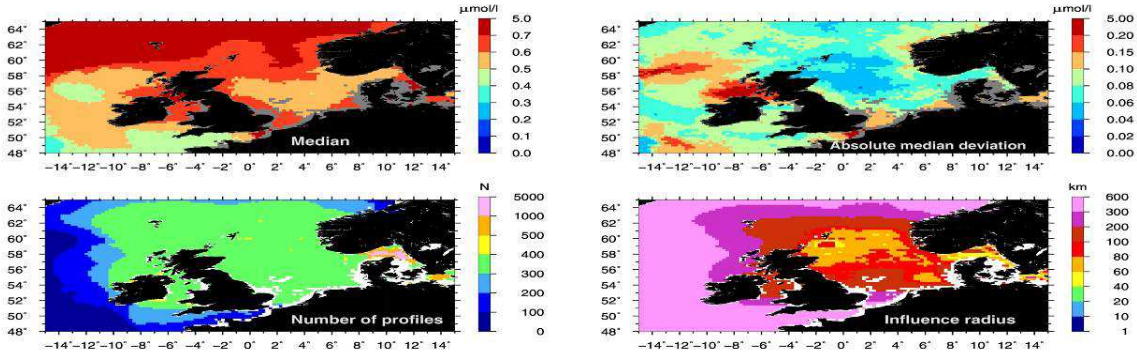


Fig. 4.23: Gridded fields of the median, median absolute deviation, number of profiles within the influence bubble, and the influence radius for phosphate at 35 m level in January. Acceptable phosphate values are within two absolute median deviations from the median.

4.4.3 Statistics for flagged observations

Important by-products of the AQC routine are the statistics of those data which failed in one or several QC checks. These statistics describe the data rejection rates both for the distinct and for the combined quality checks. Along with the geographical distribution of the flagged profiles the percentages of flagged observations are given vs time, sample depth, bottom depth, temperature, year and months of the observation. Together, these histograms allow both the control on the data rejection rates and the respective tuning of the AQC procedure. Fig. 4.24 gives example of the AQC statistics for temperature.

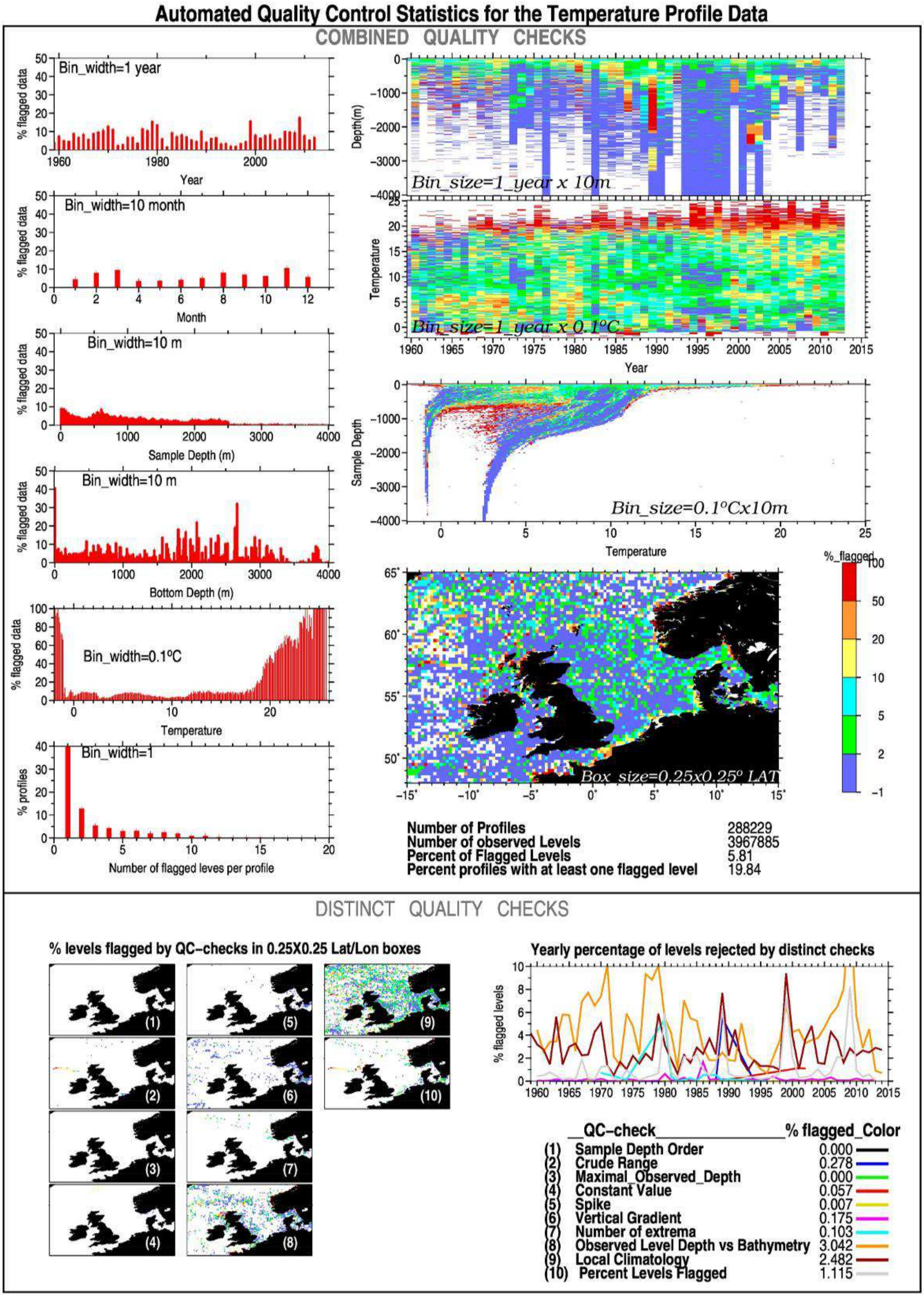


Fig. 4.24: Automated Quality Control Statistics for Temperature

As for other parameters three checks are responsible for the majority of the flagged data: 1) the last level depth versus digital bathymetry (3.042% all data), 2) the local climatological range (2.482% of all data), and 3) the vertical gradient check (0.175% of all data).

4.5 Data Binning (Level 2 data)

4.5.1 Vertical interpolation

The quality controlled profiles were interpolated on a set of unevenly spaced standard levels, using the weighted-parabola method (Reiniger and Ross, 1968). The vertical spacing is 5 meter between the surface and 35 meter, increasing linearly downwards (Fig. 4.25).

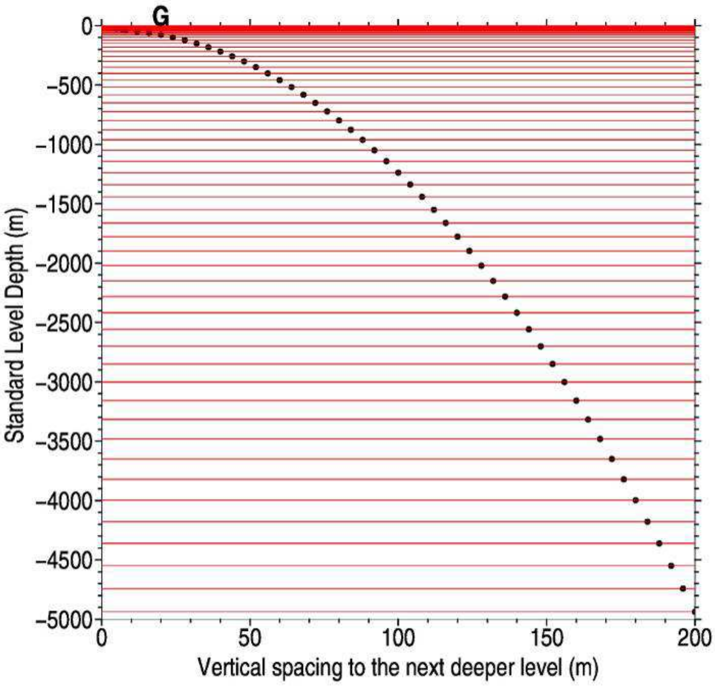


Fig. 4.25: Dependence of the vertical spacing between the standard levels on depth

4.5.2 Spatial and temporal binning of the data

The quality controlled profile data averaged at each standard level within **the 0.25°x0.25° LAT/LON** grid represent **the Level2 data product**. The current NSBC climatology represents the average parameter distribution over the time period 1960 to 2014.

The monthly climatologies were produced for the upper 0-182 m layer. Below that layer the data binning was performed regardless the calendar month. Climatological binned values are shown for all parameters at four selected standard levels (left panels of Fig. A2.6 , Fig. A2.7, Fig. A3.6, Fig. A3.7, Fig. A4.6, Fig. A4.7, Fig. A5.6, Fig. A5.7, Fig. A6.6, Fig. A6.7, Fig. A7.6, Fig. A7.7, Fig. A8.6, Fig. A8.7, Fig. A9.6 and Fig. A9.7)

4.6 Objective Interpolation (Level 3 data)

Due to the general data paucity not all bins are filled with the data with often large gaps between the neighbor bins. The Level 3 data represent the gridded parameter distributions with data voids being filled by means of the optimal interpolation. The optimal interpolation method has been introduced by Gandin (1963) and since then has been widely used in different hydro-meteorological applications, for instance for the World Ocean Circulation Experiment Climatology (Gouretski and Koltermann, 2004). A vast literature exists about the usage of the optimal interpolation, but we leave this beyond the scope of the current report and only crudely outline the optimal interpolation method below.

In this method for the arbitrary point (o) the interpolated parameter value F_o is represented as a sum of the parameter first guess value, G_o, and the weighted sum of the parameter deviations from the first guess at N observation locations (i):

$$F_o = G_o + \sum w_o[f(i)-G(i)] \quad , \ i=1,\ldots,N \qquad (1)$$

The optimal weights are defined by the covariance structure of the analyzed field. Generally, the optimal interpolation is preferred when the true covariance function can be accurately estimated, otherwise other methods can provide comparable results. In many applications the isotropic Gaussian (bell shaped) covariance function is used with the e-folding correlation length scale:

$$C(r) = s^2 \exp(-r^2/R^2) \qquad (2)$$

As noted by Sokolov and Rintoul (1999), the intrinsic covariance length scale for the optimal interpolation will be dictated more by the size of the data-void region than by the actual estimate.

The extended NS region is characterized by the strong variations in the data density, with the central North Sea being generally much better sampled compared to the neighbor regions of the North Atlantic.

As a trade-off we used the e-folding correlation scale of 166 km in all our calculations. The interpolated fields produced by the optimal interpolation may be considered as the result of applying a filter to the data. The optimal interpolation produces a spatial average of the data where smoothing length scales are independent of the data configuration, with the small scale oscillations being filtered uniformly, resulting in interpolated fields with homogeneous statistics. In data poor regions the optimal interpolation relaxes to the first-guess field.

Monthly surface climatological fields are shown for all parameters (see Fig. A2.5, Fig. A3.5, Fig. A4.5, Fig. A5.5, Fig. A6.5, Fig. A7.5, Fig. A8.5, Fig. A9.5). For four selected standard levels climatological maps are shown for February (right panels of Fig. A2.6, Fig. A3.6, Fig. A4.6, Fig. A5.6, Fig. A6.6, Fig. A7.6, Fig. A8.6 and Fig. A9.6) and for August (right panels of Fig. A2.7, Fig. A3.7, Fig. A4.7, Fig. A5.7, Fig. A6.7, Fig. A7.7, Fig. A8.7 and Fig. A9.7). The near-bottom parameter distributions are shown in Fig. A10.1. Here, the August values were taken above 100 m, and annual mean values at deeper levels.

5 Data Products

Data products are made available for users in NetCDF-Format (for further information about this data format, see the UCAR/UNIDATA web site) and can be freely accessed via https://icdc.cen.uni-hamburg.de/daten/ocean/nsbc/. Level 2 and Level 3 are the categories of data that are released and are described in the following. Common for both levels is the time period AD 1960-2014 from which climatological statistics for the different parameters are derived, as well as the horizontal edge length of the grid cells (0.25° in zonal and meridional direction). The number of depth horizons on which the data are available, differs between level 2 and level 3 data and also between the single parameters. The reason for this is the decrease in observational density with depth (see Fig. 4.13). This, in some cases, does not allow computing of bin-averages and/or reasonable fields of interpolated values on depth horizons beneath a certain depth. The maximum number of depth horizons is 57, starting at 0 m depth and increasing nonlinearly to 4938 m (see Fig. 4.25). In contrast to the physical units used in this report, the physical units in the netCDF-files are set to [mmol/m^3] (for ammonium, nitrate, oxygen, phosphate and silicate) and [mg/m^3] (for chlorophyll-a) be compliant with the CF-conventions.

Together with the parameter statistics, another file is published, containing a 3D field with flags 0 an 1 corresponding to “non-wet” and “wet” grid cells. This enables distinction between grid cells that are empty because of lack of observations and those that are empty because they are on land or beneath bottom depth. The land-sea mask is based on the bathymetry released by GEBCO (Weatherall et al. 2015) which is provided in latitude-longitude boxes with edge length of 30 arc seconds. Each 0.25°x0.25° lat-lon box of the NSBC is assigned the value of the GEBCO-bathymetry that corresponds to the center of the NSBC box. If the depth level of the current NSBC box is greater or equal the GEBCO value, flag 1 is assigned to this box, corresponding to a “wet” grid cell. Consequently, if not or if the GEBCO value is greater than 0, this box’s flag is set to 0.
It should be noted, that this land-sea mask corresponds to the Level 3 data (interpolated fields). For the Level 2 data a depth tolerance of 10 m was applied, meaning that a grid cell containing observations is regarded as “wet“ if the GEBCO depth value does not lie more than 10 m above the box’s depth level. A consequence of this tolerance is, that more potential “wet” boxes are allowed compared to the Level 3 data. Using the land-sea mask in conjunction with the Level 2 data one has to keep in mind that more “wet” boxes than actually indicated by the land-sea mask may exist. But those additional “wet” boxes account only to less than 3.5% of the number of “wet” boxes indicated by the land-sea mask.

5.1 Level 2 (bin-averaged data)

For an example of Level-2 data, see left panels in Fig. A2.6.

The following Table 5.1 gives an overview of the availability of the Level-2 data for the different parameters and different statistics.

Table 5.1: Number of depth levels for different parameters in Level-2 data

parameter	climatological monthly statistics (1960-2014)	all data statistics (1960-2014)
ammonium	16	56
chlorophyll-a	16	24
nitrate	22	56
oxygen	16	57
phosphate	16	56
salinity	16	57
silicate	16	56
temperature	16	57

Together with the climatological monthly mean, respectively the all data mean, fields of the respective standard deviation, the median plus the number of observations the statistics are based on are provided.

Note that the standard deviation is only given if a minimum of 3 observations exists.

5.2 Level 3 (interpolated, gridded fields)

For an example of Level-3 data, see right panels in Fig. A2.6.

The following Table 5.2 gives an overview of the availability of the Level-2 data for the different parameters and different statistics.

Table 5.2: Number of depth levels for different parameters in Level-3 data

parameter	climatological monthly statistics (1960-2014)	all data statistics (1960-2014)
ammonium	16	54
chlorophyll-a	16	24
nitrate	16	56
oxygen	16	56
phosphate	16	56
salinity	16	56
silicate	16	56
temperature	16	56

The data fields contained in the Level-3 data are mean and standard deviation. Note that the standard deviation is only given if a minimum of 3 observations exists. Additionally, fields concerning the optimal interpolation procedure are provided, which are the first guess field, the number of binned profiles used for the optimal interpolation and the relative interpolation error. The first guess fields can be considered as smoothed versions of climatological parameter distributions. The number of binned profiles around each grid node depends on the data density. Up to 80 binned profiles closest to the analyzed grid point were used for the optimal interpolation. The relative interpolation error represents a formal error estimate and is not a true interpolation error because the true spatial covariances and signal to noise ratios used for the interpolation are rather ad hoc values. The formal error is still useful for the estimation of the reliability of the mapped values.

5.3 Time Series

We have also produced time series of all parameters in order to illustrate seasonal and inter-annual variability for the extended North Sea region and for several sub-areas.

5.3.1 Monthly Time Series

Monthly time series of the area-averaged parameter values for selected standard depths between the surface and the depth of 98 m for the proper North Sea [2W-10E; 51-60N] have been calculated on the basis of the optimally interpolated 0.25x0.25LAT/LON fields (Fig. 5.1). These time series show that only the surface- and the 20 m – layers are situated above the summer thermocline. The values of the 50 m layer are partly enhanced in late summer and early fall. The same is true for salinity: Surface and 20 m data are significantly lower than the deep values. Only the 50 m values appear somewhat lower than the deep values of the 78 m and 98 m layer. The classical textbook like annual cycle of the nutrients nitrate, phosphate and silicate can be seen here: The layers above the seasonal mixed layer depth are more or less exhausted in summer while the lower layers show enhanced values in summer due to remineralization in the deep pelagic and benthic system. Ammonium as first nitrogen product during remineralization peaks in summer also in the upper layers; surface values are elevated in winter too. Upper layer oxygen values are temperature triggered with minimum in September while the deep values are reduced at the same time due to biological consumption during remineralization. Chlorophyll near surface values are highest during the spring bloom in April and May. Deep values peak in June probably within a deep Chlorophyll Maximum (DCM). Numerical values of the monthly anomalies are given in Table A11.1.

5.3.2 Yearly Time Series

The optimally interpolated fields served as a baseline climatology for the calculation of the yearly anomaly time series between 1965 and 2010, following the method outlined by *Gouretski et al., 2012*. The calculations were done to identify annual variability and trends over a longer time period (Fig. 5.2 a and Fig. 5.2 b). First, the point anomalies were calculated as a difference between the observed parameter and the respective monthly climatological value. Here, the quality controlled profiles interpolated on standard levels were used. To reduce the effect of outliers, for each parameter separately all anomaly values within the running 10-year window and falling outside the interval [Q1-1.5*IQR; Q3+1.5*IQR] have been discarded (Q1, Q3, and IQR are the first quartile, the third quartile, and the inter-quartile range IQR=Q3 – Q1 respectively). The point anomalies were then averaged onto a 1-degree grid, with the median used as the estimate for the grid-box average. Finally, the parameter time series were calculated by taking an area-weighted average of the one-degree boxes sampled in each year. The time series in Fig. 5.2 a and Fig. 5.2 b were smoothed with the 11-point binomial filter (e.g. plus/minus 5 years around the central year). Only for the extended North Sea region the unsmoothed time series are shown for each parameter and level.

The time series were calculated for two selected levels (surface and 35 meters) and for four regions: the extended North Sea region [15W-15E; 48-65N], the proper North Sea [2W-10E; 51-60N], the southern North Sea [2W-10E; 51-56N] and the northern North Sea [2W-10E; 56-60N]. The yearly time series of the percentage of 1-degree boxes sampled are also available for each parameter and level (Fig. 5.2 a and Fig. 5.2 b). They clearly demonstrate a much better spatial coverage within the proper North Sea area. Numerical values of the yearly anomalies are given in Table A11.2-Table A11.5.

The main uncertainty in anomaly calculations is due to the limited and uneven observational coverage, especially in the earlier years. Its estimation is not straightforward and has not been done in this report. However, in many cases the time series for the extended North Sea region and for the selected sub-regions exhibit a high degree of similarity what we interpret as an indication of the stability of the obtained anomaly estimates. The base-line climatology along with the mapping procedure is another source of uncertainty in time series (*Boyer et al., 2016*). This issue has not been investigated in this report. Finally, we note that our quality controlled profile data still may be subject to systematic biases (*Gouretski and Jancke, 2001*) which could bring artificial variability in our yearly time series. A proper cruise by cruise analysis which would be necessary in this case was beyond the scope of this report.

The temperature values show a general increase from 1985 on. Surface data in the SNS show an amplitude of 0.7 K, while the deep values at 35 m show a somewhat smaller amplitude. The warmest years were 1990 and 2006. The values of the NNS and the SNS run coherently. The surface salinity of the North Sea was decreasing over the total time period ($\Delta S < -0.1$). In most cases NNS- and SNS – values run coherent but sometimes a time lag of one year can be identified: SNS seems to react on NNS variability. Nitrate data show a general decrease since 1983. The values before 1983 are still lower than nowadays. The deep North Sea data decrease by about 0.3 μmol/l, strongest in the SNS. The values in the NNS and the SNS run coherently. Starting in 1967 the NS ammonium time series show a general decreasing trend ($\Delta NH4_{SNS} < -0.2$ μmol/l) though surface values start to increase slightly after 2000. While surface values run coherently in the NNS and the SNS the deep values do not. Phosphate generally decreases since 1980, but surface values start to increase again since the late 90ies, deep values don’t. Very high values appear in the SNS in the 70ies. Deep values run coherently in the NNS and SSN, surface values don’t. The course of the phosphate means of the NS and the extended NS is “hat” or “elephant-in-a-snake” shaped. The silicate values are oscillating, only the deep values slightly decreases since 1976 ($\Delta SiO4 \approx -0.1$ μmol/l). The deep values run more or less coherently in the SNS and NNS. Surface chlorophyll values increase until 2000 ($\Delta Chl \approx 0.1$ μg/l). Highest surface value can be found for 1992 in the SNS. In the same year lowest values appear in the NNS. The deep peak value in the NNS appears in 1989, the values before and after 1989 are all lower. Surface oxygen values increase since 1990, lowest values coincide with the local maximum of SST in 1990. The deep oxygen concentrations decrease moderately since 1994 in the NS ($\Delta O_2 \approx -6$ μmol/l and even stronger in the NNS ($\Delta O_2 \approx -12$ μmol/l). The values of the NNS and the SNS do not run always coherently.

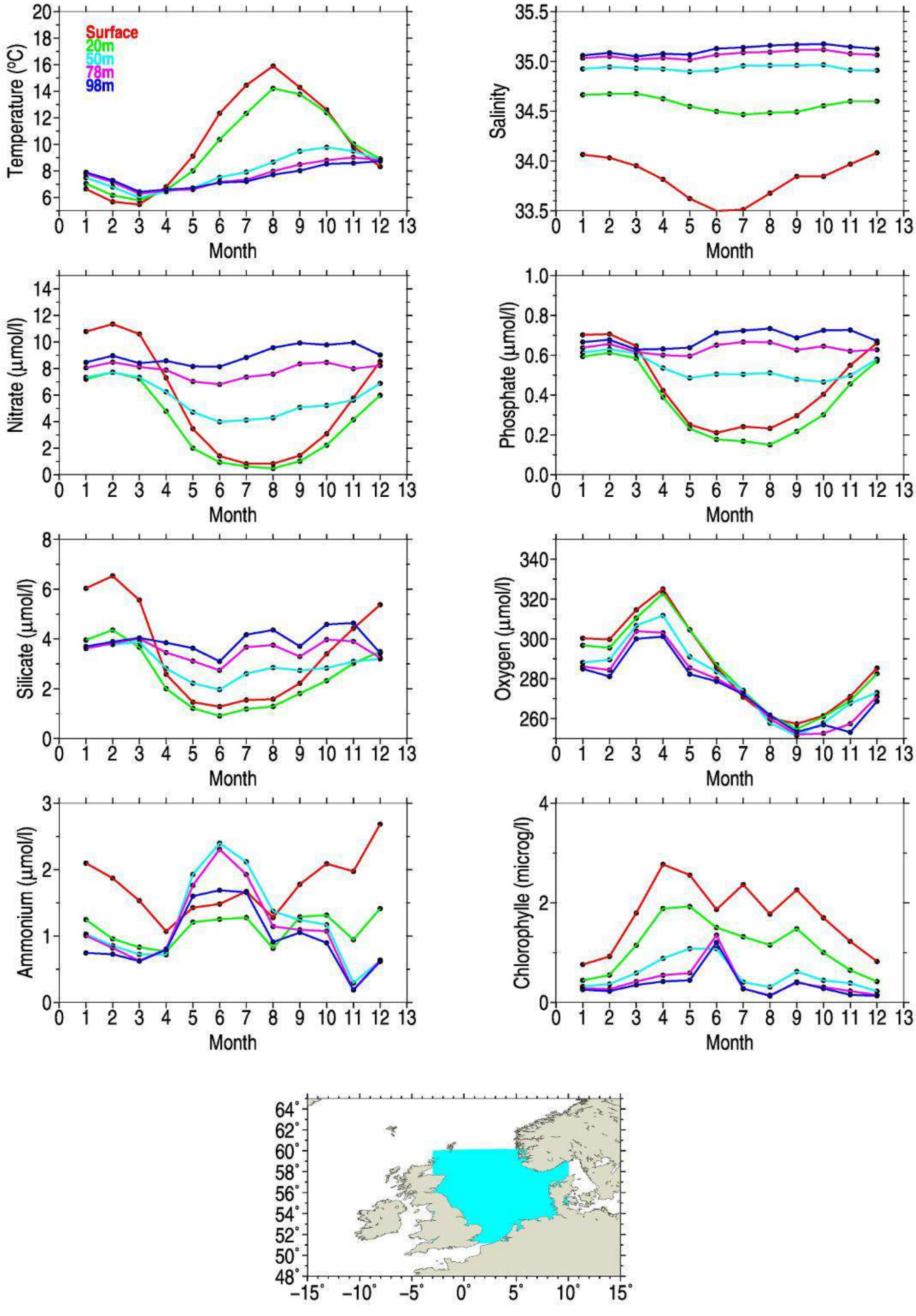


Fig. 5.1: Monthly time series of the area-averaged (see lower panel) parameter values for selected standard depth levels

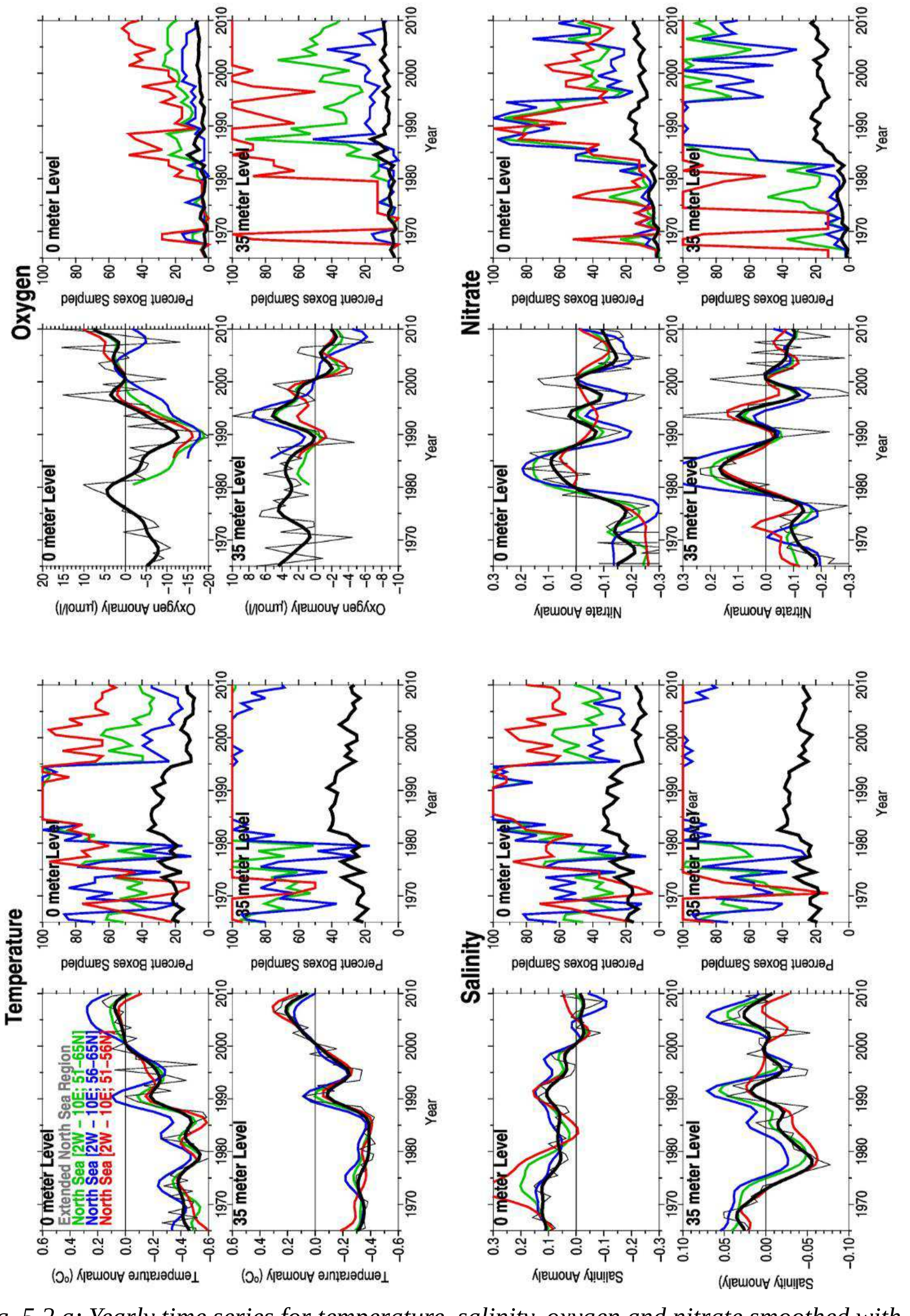


Fig. 5.2 a: Yearly time series for temperature, salinity, oxygen and nitrate smoothed with 11-point binomial filter for four regions (thick lines). Unsmoothed yearly time series are shown only for the extended North Sea region (thin black lines) Also shown are percentages of sampled 1-degree boxes for each area. Time series are not plotted for the years with not-sufficient data coverage. The right-hand side panels for each parameter show the yearly percentage of sampled 1x1-degree boxes.

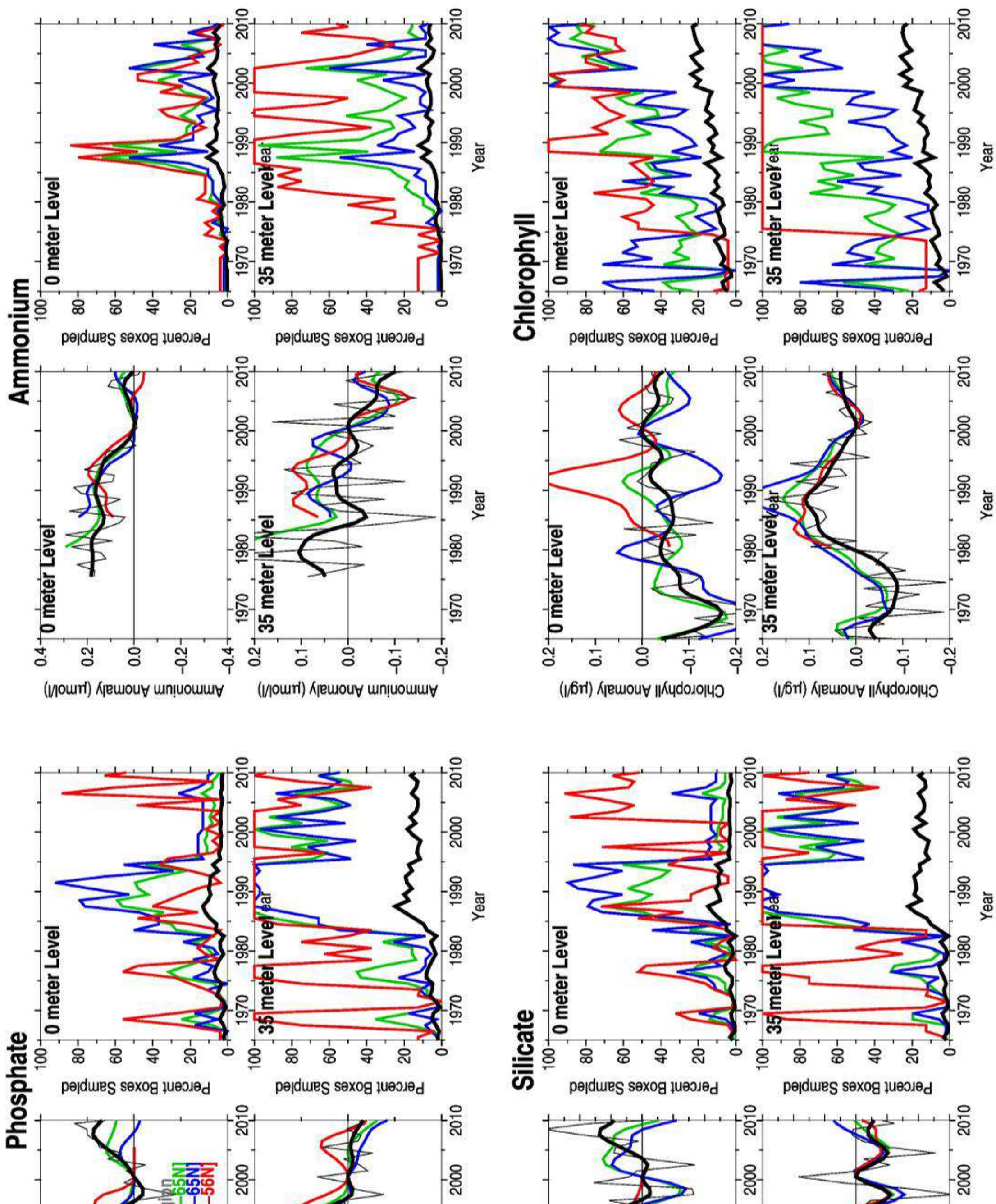


Fig. 5.2 b: Same as Fig. 5.2 a but for Phosphate, Silicate, Ammonium and Chlorophyll

Acknowledgements

This work would not have been possible without the wealth of scientific observations in the North Sea region. To take measurements at sea and analyze the samples is often a stressful, yet important, work. The authors are grateful to all the scientists and technicians that were involved in sampling, analyzing and publishing the observational data via the data centers.

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Appendix 1

Parameter codes (XX)

In the following, the parameter codes for different parameters are listed for the data sources EMODNet, DOD and NOWESP:

DOD

The DOD parameter codes are listed for the different parameters appearing in alphabetical order. The numerical value (01, 02, 03 etc.), as used for “XX” in the second header line of the observed profiles, is followed by four strings that stand for “**sample method**”, “**physical treatment**”, “**chemical treatment**” and “**laboratory method**”. All combinations of these four strings occurring in the DOD observations are listed here, sorted by parameter. For a list of the abbreviations describing the “**sample method**”, “**physical treatment**”, “**chemical treatment**” and “**laboratory method**”, see below.

```
----------------------------------------
alkalinity
----------------------------------------
01 WAS NOT HCA PHM
02 WAS NOT NDT PTM
----------------------------------------
ammonium
----------------------------------------
01 BUC FP4 SAL PTMA
02 BUC FPR OPA FTMA
03 BUC FPR SAL PTMA
04 PMP50 NOT IND PTMA
05 PMP8 MIX IND PTM
06 PRVCTD F IND PTMA
07 PRVCTD FP PHE PTM
08 PRVCTD FP4 PHE PTM
09 PRVCTD FP4 PHE PTMA
10 PRVCTD FP4 SAL PTMA
11 PRVCTD FPR OPA FTMA
12 PRVCTD FPR SAL PTMA
13 PRVCTD NFH MO PTMA
14 PRVCTD NFH MOM PTMA
15 PRVCTD NFH PHE PTMA
16 PRVCTDSB NOT NDT PTM
17 PRVCTDSB NOT NDT PTMA
18 PRVCTDSB NOT PHE PTM
19 PRVCTDSB NOT PHE PTMA
20 PRVMBT NOT PHE PTMA
21 PRVOM NOT NDT PTM
22 PRVXBT NOT NDT PTM
23 ROSCTD FP4 PHE PTMA
24 ROSCTD FP4 SAL PTMA
25 ROSCTD NOT PHE PTM
26 WAS F IND PTMA
27 WAS F PHE PTMA
28 WAS FM PHE PTMA
29 WAS FM SAL PTMA
```

```
30 WAS FP4 PHE PTM
31 WAS FP4 PHE PTMA
32 WAS NOT KOR PTM
33 WAS NOT MO PTM
34 WAS NOT NDT PTM
35 WAS NOT NDT PTMA
36 WAS NOT SAL PTMA
37 WAS XXX XXX XXXXXX
38 WASGFL F CD PTMA
39 WASGFL F SAL PTMA
40 WASGFL NOT IND PTMA
41 WASGOF2H F IND PTMA
42 WASGOF2H F SAL PTMA
43 WASGOF2H FM SAL PTMA
44 WASHYD FM PHE PTMA
45 WASHYDFF5 FM SAL PTMA
46 WASHYDFF5 FPA PHE PTMA
47 WASHYDFF5 NOT SAL PTMA
48 WASPET F CD PTM
49 WASPET F CD PTMA
50 WASPET F IND PTM
51 WASPET F IND PTMA
52 WASPET F SAL PTMA
53 WASPET FP4 IND PTM
54 WASPET NOT IND PTMA
55 WASRUT FP4 PHE PTMA
56 WASSTL F IND PTM
57 WASSTLBO5 FP PHE PTM
58 WASSTLBO5 FP4 PHE PTM
59 WASTFL F SAL PTMA
60 XXX FM SAL PTMA
61 XXX NOT SAL PTMA
 -----------------------------------------
```

chlorophyll a

```
-----------------------------------------
01 PRVCTD F ACE PTM
02 PRVCTD F ETH FLM
03 PRVCTD FM ACE PTMLOR
04 PRVCTD NOT NDT XXXXXX
05 PRVOM F ACE PTMLOR
06 PRVOM F ACE PTMUN
07 WAS F ACE FLM
08 WAS F ACE PTM
09 WAS F ACE PTMLOR
10 WAS F ACE PTMUN
11 WAS F ACH PTMLOR
12 WAS F ETH FLM
13 WAS FGN ALC FLM
14 WAS H ALC PTM
15 WAS NOT ACE PTMA
16 WAS NOT NDT PTM
17 WAS NOT NDT XXXXXX
18 WAS XXX XXX XXXXXX
19 WASGOF2H F ALC PTM
20 WASHYD F ALC PTM
21 WASHYDFF5 F ACE PTM
22 WASHYDFF5 F ACE PTMA
23 WASHYDFF5 H ALC PTM
```

24 WASHYDFF5 NOT ACE PTMA
25 WASPET F EXT PTMA
26 WASPET F SAL PTMA
27 WASRUT FVG ACE PTMA
28 WASSTL F ACE PTM
29 WASSTL F ACH PTMLOR
30 XXX NOT ACE PTMA
----
dissolved inorganic carbon
----
01 WASPET HUV EXT IRS
----
dissolved oxygen
----
01 PMP50 NOT NDT ELC
02 PRV NOT NDT PTFE
03 PRV NOT NDT TITWK
04 PRVCTD NOT NDT DOXBSH
05 PRVCTD NOT NDT DOXSEB
06 PRVCTD NOT NDT ELC
07 PRVCTD NOT NDT PRESS
08 PRVCTD NOT NDT PTFE
09 PRVCTD NOT NDT SENE
10 PRVCTD NOT NDT TITWK
11 PRVCTD NOT NDT TITWKA
12 PRVCTDNB NOT NDT ELC
13 PRVCTDSB NOT NDT DOXSEB
14 PRVCTDSB NOT NDT ELC
15 PRVCTDSB NOT NDT PRESS
16 PRVCTDSB NOT NDT PTFE
17 PRVCTDSB NOT NDT SENE
18 PRVCTDSB NOT NDT TITWK
19 PRVCTDSB NOT NDT TITWKA
20 PRVMBT NOT NDT TITWKA
21 PRVOM NOT NDT PTFE
22 PRVOM NOT NDT TITWK
23 PRVOTS NOT NDT ELC
24 ROSCTD NOT NDT TITWKA
25 SBE1 NOT NDT PRESS
26 SBE1 NOT NDT TITWKA
27 SBE2 NOT NDT DOXSEB
28 SBE2 NOT NDT PRESS
29 SBE3 NOT NDT PRESS
30 SBE3 NOT NDT TITWKA
31 SBE5 NOT NDT PRESS
32 WAS NOT NDT ELC
33 WAS NOT NDT SENE
34 WAS NOT NDT TITWK
35 WAS NOT NDT TITWKA
36 WAS NOT NDT XXXXXX
37 WAS XXX XXX XXXXXX
38 WASGFL NOT NDT ELC
39 WASGOF2H NOT NDT TITWK
40 WASHYD NOT NDT ELC
41 WASHYDFF5 NOT NDT SENE
42 WASHYDFF5 NOT NDT TITWK
43 WASPET NOT NDT ELC
44 WASPET NOT NDT TITWK

45 WASRUT NOT NDT TITWK
46 WASSTL NOT NDT TITWK
47 WASSTLBO5 NOT NDT TITWK
48 WASSTLBO5 NOT NDT TITWKA
49 WASTFL NOT NDT TITWK
50 XXX NOT NDT SENE
----
nitrate
----
01 PMP50 F CD PTMA
02 PMP50 NOT CD PTMA
03 PMP8 MIX CD PTM
04 PRVCTD FP CDS PTMA
05 PRVCTD FP4 CDS PTMA
06 PRVCTD FP4 CDX PTMA
07 PRVCTD NOT NDT PTM
08 PRVCTD NOT NDT XXXXXX
09 PRVCTDSB NOT CDS PTM
10 PRVCTDSB NOT CDS PTMA
11 PRVCTDSB NOT NDT PTM
12 PRVCTDSB NOT NDT PTMA
13 PRVMBT NOT CDS PTMA
14 PRVOM NOT NDT PTM
15 PRVXBT NOT NDT PTM
16 ROSCTD FP4 CDS PTMA
17 ROSCTD NOT CDS PTMA
18 WAS F CD PTMA
19 WAS F CDS PTMA
20 WAS F SND PTMA
21 WAS FM CDS PTMA
22 WAS FM CDX PTMA
23 WAS FP4 CDS PTM
24 WAS FP4 CDX PTMA
25 WAS FP4 SND PTM
26 WAS NOT CDS PTMA
27 WAS NOT KOR PTM
28 WAS NOT MO PTM
29 WAS NOT NDT CALC
30 WAS NOT NDT PTM
31 WAS NOT NDT PTMA
32 WAS NOT NDT XXXXXX
33 WAS XXX XXX XXXXXX
34 WASGFL F CD PTMA
35 WASGFL F EXT IEC
36 WASGFL NOT CD PTMA
37 WASGOF2H F CD PTMA
38 WASGOF2H FM CD PTMA
39 WASGOF2H FM CDX PTMA
40 WASGOF2H FM SAL PTMA
41 WASHYD FM CDX PTMA
42 WASHYDFF5 FM CD PTMA
43 WASHYDFF5 FM CDS PTMA
44 WASHYDFF5 FP4 CDX PTMA
45 WASHYDFF5 NOT CDS PTMA
46 WASHYDFF5 NOT KCS PTMA
47 WASHYDFF5 NOT NDT CALC
48 WASPET F CD PTM
49 WASPET F CD PTMA

```
50 WASPET F EXT IEC
51 WASPET F SND PTMA
52 WASPET FP4 CD PTM
53 WASPET NOT CD PTMA
54 WASPET NOT HCU PTMA
55 WASRUT FP4 CDX PTMA
56 WASSTL F CD PTM
57 WASSTLBO5 FP CDS PTMA
58 WASSTLBO5 FP4 CDS PTMA
59 WASTFL F EXT IEC
60 XXX FM CDS PTMA
61 XXX NOT CDS PTMA
 -----------------------------------------
```
phosphate
```
-----------------------------------------
01 BUC FP4 MOM PTMA
02 BUC FPR MOM PTMA
03 PMP50 F KOR PTM
04 PMP50 F KOR PTMA
05 PMP50 NOT KOR PTM
06 PRVCTD F MO PTMA
07 PRVCTD FP MOM PTMA
08 PRVCTD FP4 MBC PTMA
09 PRVCTD FP4 MOM PTMA
10 PRVCTD FPR MOM PTMA
11 PRVCTD NFH MOM PTMA
12 PRVCTD NOT NDT PTM
13 PRVCTD NOT NDT XXXXXX
14 PRVCTDSB NOT MBB PTM
15 PRVCTDSB NOT MBB PTMA
16 PRVCTDSB NOT NDT PTM
17 PRVCTDSB NOT NDT PTMA
18 PRVMBT NOT MBB PTMA
19 PRVOM NOT NDT PTM
20 ROSCTD FP4 MOM PTMA
21 ROSCTD NOT MBB PTMA
22 ROSCTD NOT NDT PTM
23 WAS F MO PTMA
24 WAS FM MBB PTMA
25 WAS FP MO PTMA
26 WAS FP NDT PTM
27 WAS FP NDT PTMA
28 WAS FP4 MBC PTMA
29 WAS FP4 MO PTM
30 WAS FP4 MOM PTM
31 WAS NOT KOR PTM
32 WAS NOT MBB PTMA
33 WAS NOT MO PTM
34 WAS NOT MO PTMA
35 WAS NOT NDT PTM
36 WAS NOT NDT PTMA
37 WAS NOT NDT XXXXXX
38 WAS XXX XXX XXXXXX
39 WASGFL NOT MO PTM
40 WASGOF2H F MO PTMA
41 WASGOF2H FM MO PTMA
42 WASGOF2H NOT MO PTMA
43 WASHYD FM MBB PTMA
```

44 WASHYDFF5 FM MBB PTMA
45 WASHYDFF5 FM MO PTMA
46 WASHYDFF5 FP4 MBC PTMA
47 WASHYDFF5 NOT MBB PTMA
48 WASPET F CD PTM
49 WASPET F CD PTMA
50 WASPET F MO PTM
51 WASPET F MO PTMA
52 WASPET F SAD PTMA
53 WASPET F SAL PTMA
54 WASPET FP4 MO PTM
55 WASPET NOT KOR PTMA
56 WASPET NOT MO PTM
57 WASRUT FP4 MBC PTMA
58 WASSTL F MO PTM
59 WASSTLBO5 FP MOM PTMA
60 WASSTLBO5 FP4 MOM PTMA
61 WASTFL F SAL PTMA
62 XXX FM MBB PTMA
63 XXX NOT MBB PTMA
----

pH

----

01 PMP50 NOT NDT ELC
02 PMP50 NOT NDT PHM
03 PRV NOT NDT PHM
04 PRVCTD NOT NDT PHM
05 PRVCTD NOT NDT SENE
06 PRVCTDSB NOT NDT SENE
07 PRVWTW NOT NDT PHM
08 ROSCTD NOT NDT PHM
09 WAS NOT NDT ELC
10 WAS NOT NDT PHM
11 WAS NOT NDT PTMA
12 WAS NOT NDT SENE
13 WAS NOT NDT XXXXXX
14 WAS XXX XXX XXXXXX
15 WASGFL NOT NDT PHM
16 WASGOF2H NOT NDT ELC
17 WASGOF2H NOT NDT PHM
18 WASHYD NOT NDT PHM
19 WASHYDFF5 NOT NDT ELC
20 WASPET NOT NDT ELC
21 WASPET NOT NDT PHM
22 WASRUT NOT NDT PHM
23 WASSTL NOT NDT PHM
24 WASTFL NOT NDT PHM
25 XXX NOT NDT SENE
----

salinity

----

01 BUC NOT NDT CON
02 BUC NOT NDT CONSAL
03 BUC NOT NDT TIT
04 BUC NOT NDT TITPRC
05 DLG NOT NDT CON
06 PMP NOT NDT CON
07 PMP50 NOT NDT CHL

08 PRV NOT NDT CON
09 PRV NOT NDT CONSAL
10 PRV NOT NDT XXXXXX
11 PRV XXX XXX XXXXXX
12 PRVCTD NOT NDT CON
13 PRVCTD NOT NDT CONISC
14 PRVCTD NOT NDT CONPRC
15 PRVCTD NOT NDT CONSAL
16 PRVCTD NOT NDT SVSOM
17 PRVCTD NOT NDT XXXXXX
18 PRVCTDNB NOT NDT CON
19 PRVCTDNB NOT NDT CONPRC
20 PRVCTDNB NOT NDT ELC
21 PRVCTDSB NOT NDT CON
22 PRVCTDSB NOT NDT CONISC
23 PRVCTDSB NOT NDT CONPRC
24 PRVCTDSB NOT NDT CONSAL
25 PRVMBT NOT NDT CON
26 PRVOM NOT NDT CON
27 PRVOM NOT NDT CONSAL
28 PRVOTS NOT NDT CON
29 PRVOTS NOT NDT CONISC
30 PRVOTS NOT NDT CONPRC
31 PRVWTW NOT NDT CON
32 PRVWTW NOT NDT CONPRC
33 PRVWTW NOT NDT THE
34 ROSCTD CLC NDT CONSAL
35 ROSCTD DEV NDT CONPRC
36 ROSCTD NOT NDT CON
37 ROSCTD NOT NDT CONISC
38 ROSCTD NOT NDT CONPRC
39 ROSCTD NOT NDT CONSAL
40 ROSCTD PCL NDT CONISC
41 SBE1 NOT NDT CON
42 SBE1 NOT NDT CONPRC
43 SBE2 NOT NDT CONPRC
44 SBE3 NOT NDT CON
45 SBE3 NOT NDT CONPRC
46 SBE5 NOT NDT CONPRC
47 SBE6 NOT NDT CON
48 SGS NOT NDT CON
49 WAS NOT NDT CON
50 WAS NOT NDT CONISC
51 WAS NOT NDT CONPRC
52 WAS NOT NDT CONSAL
53 WAS NOT NDT ELC
54 WAS NOT NDT TIT
55 WAS NOT NDT TITMK
56 WAS NOT NDT TITPRC
57 WASGFL NOT NDT ELC
58 WASHYD NOT NDT CONSAL
59 WASPET NOT NDT CHL
60 WASPET NOT NDT CON
61 WASPET XXX XXX XXXXXX
62 WASRUT NOT NDT TITMK
63 WASSTL NOT NDT CHL
64 WASSTLBO5 NOT NDT CONSAL
65 WASSTLBO5 NOT NDT XXXXXX

66 XXX NOT NDT CONISC
67 XXX NOT NDT CONPRC
----
silicate
----
01 BUC FP4 MO PTMA
02 BUC FPR MO PTMA
03 PMP50 NOT MO PTMA
04 PRV NOT NDT PTM
05 PRVCTD F MO PTMA
06 PRVCTD FP MO PTMA
07 PRVCTD FP4 KJA PTMA
08 PRVCTD FP4 MO PTMA
09 PRVCTD FPR MO PTMA
10 PRVCTD NFH MO PTMA
11 PRVCTD NFH PHE PTMA
12 PRVCTD NOT NDT PTM
13 PRVCTD NOT NDT XXXXXX
14 PRVCTDSB NOT MBC PTM
15 PRVCTDSB NOT MBC PTMA
16 PRVCTDSB NOT NDT PTM
17 PRVCTDSB NOT NDT PTMA
18 PRVMBT NOT MBC PTMA
19 PRVOM NOT NDT PTM
20 ROSCTD FP4 MO PTMA
21 ROSCTD NOT MBC PTMA
22 ROSCTD NOT NDT PTM
23 WAS F MO PTMA
24 WAS FM MBB PTMA
25 WAS FP MO PTMA
26 WAS FP NDT PTMA
27 WAS FP4 KJA PTMA
28 WAS FP4 MBC PTMA
29 WAS FP4 MO PTM
30 WAS FP4 MOK PTM
31 WAS NOT KOR PTM
32 WAS NOT MBB PTMA
33 WAS NOT MO PTM
34 WAS NOT NDT PTM
35 WAS NOT NDT PTMA
36 WAS NOT NDT XXXXXX
37 WAS XXX XXX XXXXXX
38 WASGFL NOT KOR PTMA
39 WASGFL NOT NDT PTMA
40 WASGOF2H F MO PTMA
41 WASGOF2H FM MO PTMA
42 WASGOF2H FM SAL PTMA
43 WASGOF2H NOT MO PTMA
44 WASHYD FM MBB PTMA
45 WASHYDFF5 FM MBB PTMA
46 WASHYDFF5 FM MO PTMA
47 WASHYDFF5 FPA KJA PTMA
48 WASHYDFF5 NOT MBB PTMA
49 WASPET F CD PTMA
50 WASPET F MO PTM
51 WASPET F MO PTMA
52 WASPET F SAL PTMA
53 WASPET FP4 MO AESICP

54 WASPET NOT KOR PTMA
55 WASPET NOT MO PTM
56 WASPET NOT MO PTMA
57 WASPET NOT NDT AESICP
58 WASPET NOT NDT PTMA
59 WASRUT FP4 MBC PTMA
60 WASSTL F MO PTM
61 WASSTLBO5 FP MO PTMA
62 WASSTLBO5 FP4 MO PTMA
63 XXX FM MBB PTMA
64 XXX NOT KCS PTMA

----

suspended particulate matter

----

01 PMP FMD NDT WGH
02 PMP NOT NDT CALC
03 PMP50 FD NDT WGH
04 WAS FD NDT WGH
05 WASGFL FD NDT WGH
06 WASGFL10 FPA NDT WGH
07 WASGOF2H FD NDT WGH
08 WASHYDFF5 F NDT WGH
09 WASMERCOS FD NDT WGH
10 WASMERCOS FPA NDT WGH
11 WASPET FD NDT WGH
12 WASSTL FD NDT WGH

----

temperature

----

01 BUC NOT NDT THE
02 BUC NOT NDT THM
03 BUC NOT NDT THR
04 DLG NOT NDT ELCINF
05 PMP50 NOT NDT ELC
06 PRV NOT NDT THE
07 PRV NOT NDT THM
08 PRV NOT NDT THR
09 PRV NOT NDT XXXXXX
10 PRV XXX XXX XXXXXX
11 PRVCTD NOT NDT SENE
12 PRVCTD NOT NDT THE
13 PRVCTD NOT NDT THEPRC
14 PRVCTD NOT NDT XXXXXX
15 PRVCTDNB NOT NDT ELC
16 PRVCTDNB NOT NDT THE
17 PRVCTDNB NOT NDT THEPRC
18 PRVCTDSB NOT NDT SENE
19 PRVCTDSB NOT NDT THE
20 PRVCTDSB NOT NDT THEPRC
21 PRVMBT NOT NDT ELC
22 PRVMBT NOT NDT ELCINF
23 PRVMBT NOT NDT ELCINT
24 PRVMBT NOT NDT ELCSTD
25 PRVMBT NOT NDT THE
26 PRVMBT NOT NDT THM
27 PRVOM NOT NDT THE
28 PRVOTS NOT NDT THE
29 PRVOTS NOT NDT THEISC

```
30 PRVOTS NOT NDT THEPRC
31 PRVWTW NOT NDT THE
32 PRVWTW NOT NDT THEPRC
33 PRVXBT NOT NDT ELC
34 PRVXBT NOT NDT ELCINF
35 PRVXBT NOT NDT ELCINT
36 PRVXBT NOT NDT THM
37 ROSCTD NOT NDT THE
38 ROSCTD NOT NDT THEPRC
39 ROSCTD NOT NDT THM
40 ROSCTD PCL NDT THEPRC
41 SBE1 NOT NDT THE
42 SBE1 NOT NDT THEPRC
43 SBE2 NOT NDT THEPRC
44 SBE3 NOT NDT THE
45 SBE3 NOT NDT THEPRC
46 SBE5 NOT NDT THEPRC
47 SBE6 NOT NDT THE
48 SGS NOT NDT THE
49 THR MIX NDT THE
50 THR NOT NDT THE
51 THR NOT NDT THM
52 WAS NOT NDT CON
53 WAS NOT NDT CONPRC
54 WAS NOT NDT ELC
55 WAS NOT NDT ELCINF
56 WAS NOT NDT SENE
57 WAS NOT NDT THE
58 WAS NOT NDT THEPRC
59 WAS NOT NDT THM
60 WAS NOT NDT THR
61 WASHYD NOT NDT THEPRC
62 WASPET NOT NDT THE
63 WASRUT NOT NDT ELC
64 WASSTLBO5 NOT NDT THE
65 WASSTLBO5 NOT NDT THEPRC
66 XXX NOT NDT SENE
67 XXX NOT NDT THEPRC
68 XXX NOT NDT THR
```

Lists for “sample method”, “physical treatment”, “chemical treatment” and “laboratory method”, as provided by DOD:

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------------------------------------
sample method
------------------------------------
Code;description
BUC;Bucket (Puetz) surface water sampler
PMP;Submerged Pump
PRV;Profiler, unknown
PRVCTD;CTD-Profiler
PRVCTDNB;CTD-Profiler, Neil Braun
PRVCTDSB;CTD-Profiler, SeaBird
PRVMBT;Bathythermograph
PRVOTS;Oxygen-Temperature-Salinity-profiler
PRVXBT;Bathythermograph, Drop
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ROSCTD;CTD-Profiler with bottle rosette
SBE1;CTD-Profile with Seabird sensors for temperature, conductivity, oxygen and pressure in Sea cats used by BSH
SBE2;CTD-Profile with Seabird sensors for temperature, conductivity, oxygen and pressure in Sea cats used by BSH
SBE3;CTD-Profile with Seabird sensors for temperature, conductivity, oxygen and pressure in Sea cats used by BSH
SBE5;CTD-Profile with Seabird sensors for temperature, conductivity, oxygen and pressure in Sea cats used by BSH
SBE6;CTD-Profile with Seabird sensors for temperature, conductivity, oxygen and pressure in Sea cats used by BSH
THR;Thermometer
WAS;Water sampler
WASGFL;Glass flask water sampler
WASGFL10;Glass flask water sampler (10 litres)
WASHYD;Hydrobios water sampler
WASHYDFF5;HYDROBIOS Free Flow water sampler, capacity of 5,0 l
WASMERCOS;MERCOS Teflon water sampler (0.5 litre)
WASPET;Polyethylene water sampler
WASRUT;Water sampler after Ruttner
WASSTLBO5;Bottom water sampler (0,5 m distance to bottom, 1,7 litre)
WASTFL;Teflon water sampler
XXX;unknown sampler

----
physical treatment

Code;Beschreibung
F;Physical Separation, Filtering or grain size Fractioning
FD;Oven dried after filtration
FGN;Filtered with glass fibre filter (particle retention diameter 0.7 µm) and freeze dried with fluid nitrogen
FM;Filtered with Membran filter
FP4;Filtered with polycarbonate 0.45 µm
FPA;Filtered with Polycarbonate filter, Air dried
FPR;Filtered with polycarbonate 0.45 µm and stored in freezer (-18°C)
FVG;Filtration under vacuum with glass fibre (fibrous Whatman -GF/F)
H;Homogenization
NFH;not filtered, HgCl2 fixed
NOT;No physical Treatment
XXX;Not specified

----
chemical treatment

Code;Beschreibung
ACE;Extraction with ACETON
ALC;Extraction with alcohol
CD;Cadmium reduction
CDS;Cadmium reduktion and Sulfanilamid and N-1-Naphtylethylendiamindihydrochlorid
CDX;Calculated from TOx-N after cadmium reduction.
ETH;Ethanol
EXT;Unknown Chemical Extraction
IND;Indophenol additive
KCS;Koroleff-method, Cadmium reduction + Sulfanilamid and N-1-Naphtylethylendiamindihydrochlorid
KJA;Reduction with KJ-Ascorbic acid in dilute HCL solution
MBB;Molybdenium blue method

```
MBC;Molybdenium blue complex
MO;Complexation through Molybdenum (Mo)
MOK;Complexation through Molybdenum (Mo) and Koroleff method
MOM;Complexation through Molybdenum (Mo) after Murphy and Riley
NDT;Non Destructive Total Determ., No chemical treatment
OPA;ortho-phthaldialdehyde treatment
PHE;Indophenol blue method (Phenol additive)
SAL;Salicylate treatment
SND;Sulfanilamid and N-1-Naphtylethylendiamindihydrochlorid
XXX;Not specified

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laboratory method

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Code;Beschreibung
AESICP;Inductive Coupled Plasma Atomic Emission Spectroscopy (ICPOES)
CALC;Calculated
CON;Determination by electric conductivity
CONISC;Determination by electric conductivity, in situ calibration
CONPRC;Determination by electric conductivity, precise calibration
CONSAL;Determination by electric conductivity, Salinometry
DOXSEB;SeaBird CTD oxygen sensor
ELC;Electrochemical Determination
ELCINF;Bathythermograph inflexion points
ELCINT;Bathythermograph depth intervalls
ELCSTD;Bathythermograph standard depth
FLM;Fluorometry
FTMA;Fluorometric Determination, Autoanalizer
IEC;Ion Exchange Chromatography
PHM;Hydrogen Ion Concentration by pH-meter
PRESS;Pressure sensor of the Profiler
PTM;Photometric Determination
PTMA;Photometric Determination, Autoanalizer
PTMLOR;PTM after Lorenzen
PTMUN;PTM after UNESCO
SENE;Electrical sensor
THE;Thermometer, electric
THEISC;Thermometer, electric / in situ calibration
THEPRC;Thermometer, electric / precise calibration
THM;Thermometer, mechanic / reverse
THR;Thermometer
TIT;Titration
TITMK;Mohr-Knudson-Titration
TITPRC;Precise Titration
TITWK;Winkler-Kalle-Titration
TITWKA;Winkler-Kalle-Titration with automaticaly estimated end
WGH;Weigh, determination of mass
XXXXXX;Not specified
```

EMODNet

The parameter codes with the respective methods of observation are listed in the following for the different parameters in the EMODNet data. Also listed in capital letters are the variable names according to SeaDataNet, as provided by EMODNet.

alkalinity

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1 ALKYZZXX: Total alkalinity per unit volume of the water body
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ammonium

1 AMONAAD1: Concentration of ammonium {NH4} per unit volume of the water body [dissolved plus reactive particulate <GF/F phase] by filtration and colorimetric autoanalysis

2 AMONAAD2: Concentration of ammonium {NH4} per unit volume of the water body [dissolved plus reactive particulate <0.4/0.45um phase] by filtration and colorimetric autoanalysis

3 AMONAAD3: Concentration of ammonium {NH4} per unit volume of the water body [dissolved plus reactive particulate <GF/C phase] by filtration and colorimetric autoanalysis

4 AMONAAD4: Concentration of ammonium {NH4} per unit volume of the water body [dissolved plus reactive particulate <1um phase] by filtration and colorimetric autoanalysis

5 AMONAAD5: Concentration of ammonium {NH4} per unit volume of the water body [dissolved plus reactive particulate <0.2um phase] by filtration and colorimetric autoanalysis

6 AMONAADZ: Concentration of ammonium {NH4} per unit volume of the water body [dissolved plus reactive particulate <unknown phase] by filtration and colorimetric autoanalysis

7 AMONAATX: Concentration of ammonium {NH4} per unit volume of the water body [dissolved plus reactive particulate phase] by colorimetric autoanalysis

8 AMONAAZX: Concentration of ammonium {NH4} per unit volume of the water body [unknown phase] by colorimetric autoanalysis

9 AMONMATX: Concentration of ammonium {NH4} per unit volume of the water body [dissolved plus reactive particulate phase] by manual colorimetric analysis

10 AMONZZXX: Concentration of ammonium {NH4} per unit volume of the water body [unknown phase]

chlorophyll a

1 CPHLFLP1: Concentration of chlorophyll-a {chl-a} per unit volume of the water body [particulate >GF/F phase] by filtration, acetone extraction and fluorometry

2 CPHLFLP2: Concentration of chlorophyll-a {chl-a} per unit volume of the water body [particulate >0.4/0.45um phase] by filtration, acetone extraction and fluorometry

3 CPHLFLP3: Concentration of chlorophyll-a {chl-a} per unit volume of the water body [particulate >GF/C phase] by filtration, acetone extraction and fluorometry

4 CPHLFLPZ: Concentration of chlorophyll-a {chl-a} per unit volume of the water body [particulate >unknown phase] by filtration, acetone extraction and fluorometry

5 CPHLHPP1: Concentration of chlorophyll-a {chl-a} per unit volume of the water body [particulate >GF/F phase] by filtration, acetone extraction and high performance liquid chromatography (HPLC)

6 CPHLPM01: Concentration of chlorophyll-a {chl-a} per unit volume of the water body [particulate >unknown phase] by in-situ chlorophyll fluorometer and manufacturer's calibration applied

7 CPHLSPPC: Concentration of chlorophyll-a {chl-a} per unit volume of the water body [particulate >unknown phase] by centrifugation, acetone extraction and spectrophotometry and processing following the Lorenzen protocol

8 CPHLSPPZ: Concentration of chlorophyll-a {chl-a} per unit volume of the water body [particulate >unknown phase] by filtration, acetone extraction and spectrophotometry and processing following the Lorenzen protocol

9 CPHLSSP2: Concentration of chlorophyll-a {chl-a} per unit volume of the water body [particulate >GF/C phase] by filtration, acetone extraction and trichromatic spectrophotometry following the Jeffrey and Humphrey protocol

nitrate

1 CHEMM012: Concentration of nitrate {NO3} per unit volume of the water body [dissolved plus reactive particulate phase] by colorimetric autoanalysis and correction for nitrite

2 MDMAP005: Concentration of nitrate {NO3} per unit mass of the water body [unknown phase]

3 NTRAAA04: Concentration of nitrate {NO3} per unit volume of the water body [dissolved plus reactive particulate <0.4/0.45um phase] by filtration and colorimetric autoanalysis and correction for nitrite

4 NTRAAAD1: Concentration of nitrate {NO3} per unit volume of the water body [dissolved plus reactive particulate <GF/F phase] by filtration and colorimetric autoanalysis and correction for nitrite

5 NTRAAAD4: Concentration of nitrate {NO3} per unit volume of the water body [dissolved plus reactive particulate <GF/C phase] by filtration and colorimetric autoanalysis and correction for nitrite

6 NTRAZZXX: Concentration of nitrate {NO3} per unit volume of the water body [unknown phase]

7 ODSDM2UM: Concentration of nitrate {NO3} per unit volume of the water body [dissolved plus reactive particulate <0.2um phase] by filtration and colorimetric autoanalysis and correction for nitrite

nitratenitrite

1 NTRZAA01: Concentration of nitrate+nitrite {NO3+NO2} per unit volume of the water body [dissolved plus reactive particulate <1um phase] by filtration and colorimetric autoanalysis

2 NTRZAAD1: Concentration of nitrate+nitrite {NO3+NO2} per unit volume of the water body [dissolved plus reactive particulate <GF/F phase] by filtration and colorimetric autoanalysis

3 NTRZAAD2: Concentration of nitrate+nitrite {NO3+NO2} per unit volume of the water body [dissolved plus reactive particulate <0.4/0.45um phase] by filtration and colorimetric autoanalysis

4 NTRZAAD3: Concentration of nitrate+nitrite {NO3+NO2} per unit volume of the water body [dissolved plus reactive particulate <GF/C phase] by filtration and colorimetric autoanalysis

5 NTRZAAD5: Concentration of nitrate+nitrite {NO3+NO2} per unit volume of the water body [dissolved plus reactive particulate <0.2um phase] by filtration and colorimetric autoanalysis

6 NTRZAADZ: Concentration of nitrate+nitrite {NO3+NO2} per unit volume of the water body [dissolved plus reactive particulate <unknown phase] by filtration and colorimetric autoanalysis

7 NTRZAATX: Concentration of nitrate+nitrite {NO3+NO2} per unit volume of the water body [dissolved plus reactive particulate phase] by colorimetric autoanalysis

8 NTRZAAZX: Concentration of nitrate+nitrite {NO3+NO2} per unit volume of the water body [unknown phase] by colorimetric autoanalysis

9 NTRZMADZ: Concentration of nitrate+nitrite {NO3+NO2} per unit volume of the water body [dissolved plus reactive particulate <unknown phase] by filtration and manual colorimetric analysis

10 NTRZZZXX: Concentration of nitrate+nitrite {NO3+NO2} per unit volume of the water body [unknown phase]

oxygen

1 DOXYCZ01: Concentration of oxygen {O2} per unit volume of the water body [dissolved plus reactive particulate phase] by in-situ sensor and calibration against sample data

2 DOXYPE01: Concentration of oxygen {O2} per unit volume of the water body [dissolved plus reactive particulate phase] by in-situ pulsed electrode

3 DOXYSE01: Concentration of oxygen {O2} per unit volume of the water body [dissolved plus reactive particulate phase] by YSI in-situ oxygen and temperature probe

4 DOXYVMTX:

5 DOXYWITX: Concentration of oxygen {O2} per unit volume of the water body [dissolved plus reactive particulate phase] by Winkler titration

6 DOXYZZ01: Concentration of oxygen {O2} per unit volume of the water body [dissolved plus reactive particulate phase] by in-situ sensor

7 DOXYZZXX: Concentration of oxygen {O2} per unit volume of the water body [dissolved plus reactive particulate phase]

8 OXYSZW01: Saturation of oxygen {O2} in the water body [dissolved plus reactive particulate phase] by Winkler titration and computation from concentration

9 OXYSZZ01: Saturation of oxygen {O2} in the water body [dissolved plus reactive particulate phase]

phosphate

1 MDMAP906: Concentration of phosphate {PO4} per unit mass of the water body [unknown phase]

2 PHOSAA01: Concentration of phosphate {PO4} per unit volume of the water body [dissolved plus reactive particulate <1um phase] by filtration and colorimetric autoanalysis

3 PHOSAAD1: Concentration of phosphate {PO4} per unit volume of the water body [dissolved plus reactive particulate <GF/F phase] by filtration and colorimetric autoanalysis

4 PHOSAAD2: Concentration of phosphate {PO4} per unit volume of the water body [dissolved plus reactive particulate <0.4/0.45um phase] by filtration and colorimetric autoanalysis

5 PHOSAAD3: Concentration of phosphate {PO4} per unit volume of the water body [dissolved plus reactive particulate <GF/C phase] by filtration and colorimetric autoanalysis

6 PHOSAAD5: Concentration of phosphate {PO4} per unit volume of the water body [dissolved plus reactive particulate <0.2um phase] by filtration and colorimetric autoanalysis

7 PHOSAADZ: Concentration of phosphate {PO4} per unit volume of the water body [dissolved plus reactive particulate <unknown phase] by filtration and colorimetric autoanalysis

8 PHOSAATX: Concentration of phosphate {PO4} per unit volume of the water body [dissolved plus reactive particulate phase] by colorimetric autoanalysis

9 PHOSAAZX: Concentration of phosphate {PO4} per unit volume of the water body [unknown phase] by colorimetric autoanalysis

10 PHOSMADZ: Concentration of phosphate {PO4} per unit volume of the water body [dissolved plus reactive particulate <unknown phase] by filtration and manual colorimetric analysis

11 PHOSMAZX: Concentration of phosphate {PO4} per unit volume of the water body [unknown phase] by manual colorimetric analysis

12 PHOSZZXX: Concentration of phosphate {PO4} per unit volume of the water body [unknown phase]

salinity

1 ODSDM021: Salinity of the water body

2 PPSUCS01: Practical salinity of the water body by conductivity cell and computation using UNESCO 1983 algorithm

3 PSALBSTX: Practical salinity of the water body by bench salinometer and computation using UNESCO 1983 algorithm

4 PSALM021:

5 PSALSG01: Practical salinity of the water body by thermosalinograph and computation using UNESCO 1983 algorithm and calibration against independent measurements

6 PSALST01: Practical salinity of the water body by CTD and computation using UNESCO 1983 algorithm

7 PSLTZZ01: Practical salinity of the water body

8 SSALAGT1: Salinity of the water body by titration against silver nitrate (AgNO3)

9 SSALBSTX: Salinity of the water body by bench salinometer

10 SSALPR01: Salinity of the water body by conductivity cell

11 SSALSG01: Salinity of the water body by thermosalinograph

12 SSALST01: Salinity of the water body by CTD

SPM

1 ISEDTR01: Concentration of suspended particulate material (inorganic) {SPM} per unit volume of the water body [particulate >unknown phase] by in-situ optical attenuance measurement and calibration against sample data

2 ISEDZZZZ: Concentration of suspended particulate material (inorganic) {SPM} per unit volume of the water body

3 OSEDTR01: Concentration of suspended particulate material (organic) {SPM} per unit volume of the water body [particulate >unknown phase] by in-situ optical attenuance measurement and calibration against sample data

4 OSEDZZZZ: Concentration of suspended particulate material (organic) {SPM} per unit volume of the water body

5 TSEDGVP1: Concentration of suspended particulate material {SPM} per unit volume of the water body [particulate >GF/F phase] by filtration, drying and gravimetry

6 TSEDGVPZ: Concentration of suspended particulate material {SPM} per unit volume of the water body [particulate >unknown phase] by filtration, drying and gravimetry

7 TSEDTR01: Concentration of suspended particulate material {SPM} per unit volume of the water body [particulate >unknown phase] by in-situ optical attenuance measurement and calibration against sample data

8 TSEDZZZZ: Concentration of suspended particulate material {SPM} per unit volume of the water body

temperature

1 PSSTTS01: Temperature of the water body by in-situ thermometer

2 TEMPPR01: Temperature of the water body

3 TEMPRTNX: Temperature of the water body by reversing thermometer

4 TEMPS901: Temperature (ITS-90) of the water body by CTD or STD

5 TEMPSG01: Temperature of the water body by thermosalinograph and verification against independent measurements

6 TEMPST01: Temperature of the water body by CTD or STD

7 TEMPTC01: Temperature of the water body by in-situ thermistor

8 TEMPZZXX: Temperature of the water body

NOWESP

In the following, the parameter codes in NOWESP data together with the corresponding method of observation are listed.

1st column: parameter code as provided in the second header line of the NOWESP profiles
2nd column: parameter code as provided in the original NOWESP data (.dat-format)
3rd column: method of observation, as provided in NOWESP data

```
chlorophyll (18):
 1       4001010001      unknown
 2       4001010201      SCOR-UNESCO method
 3       4001010301      Lorenzen method
 4       4001010701      High Pressure Liquid Chromatography
 5       4001010901      Photometry
 6       4001011401      UNKOWN
 7       4001011501      UNKOWN
 8       4001011601      UNKOWN
 9       4001011901      UNESCO method, Sidney
10       4001012001      discrete samples using the LORENZEN and JEFFREY(1978) method
11       4001014001      glass fibre filters, aceton extract; spectrophotometric
12       4001140101      unknown
13       4001140301      Lorenzen method
14       4001140601      Fluorometer
15       4001142101      UNESCO(1966) method, spectrophotometric
16       4001142201      Lorenzen(1967) method, spectrophotometric
17       4001143701      glass fibre filters (GFF), SCOR-UNESCO algorithms
(Strickland & Parsons, 1968)
18       4001143801      Whatman GFF, Turner Designs bench fluorometer, equation in
Tett (1987)

nitrate (20):
 1       5002010001      unknown
 2       5002012301      Reduction of nitrate to nitrite by a copper-cadmium reductor
column. Then analys
 3       5002014801      Hydrazine method described in Strickland, J. and Parsons,
T.R. (1960), time not
 4       5002014901      Cadmium reduction method of Morris and Riley (1963, Anal.
Chin. Acta. 29
 5       5002015001      Alpkem RFA/2 autoanalyser, time not measured
 6       5002016601      Colorimetric
 7       5002020001      unknown
 8       5002020101      PHOTOMETRY
 9       5002030001      unknown
10       5002030096      unknown
11       5002030097      unknown
12       5002030098      unknown
13       5002030099      unknown
14       5002030101      PHOTOMETRY
15       5002033401      Strickland and Parsons (1960)
16       5002033501      ICES COOP. RES. REP.(1972)
17       5002034001      Grasshoff, K. (1976)
18       5002035101      Water bottle, method acc. to Strickland and Parson (1972)
19       5002036601      Colorimetric
20       500211501       Autoanalyzer adaption of the cadmium copper reduction to
nitrite, followed by a
```

ammonium (18):

1	5005010001	unknown
2	5005012401	Reaction with sodium salicylate, sodium nitroprusside and sodium hypochlorite at
3	5005015001	Alpkem RFA/2 autoanalyser, time not measured
4	5005020101	PHOTOMETRY
5	5005030001	unknown
6	5005030095	unknown
7	5005030096	unknown
8	5005030098	unknown
9	5005030099	unknown
10	5005031301	Chemlab AA-II segmented continous flow autoanalyzer
11	5005032801	filtered samples (Whatman puradisc PP 0.45 mym filters) using a Tecator Flow Inj
12	5005033601	Gillbricht (1961)
13	5005033701	Benesch and Mangelsdorf (1972)
14	5005033801	Grasshoff and Johannsen (1973)
15	5005035101	Water bottle, method acc. to Strickland and Parson (1972)
16	5005035201	flow injection analysis, Willason and Johnson(1986) and Howland et al.
17	500511401	Autoanalyzer adaption of the phenol-hypochlorite method, formation of indophenol
18	500511901	Phenol-hypochlorite method, formation of indophenol blue complex. Manual method

phosphate (24):

1	5001010001	unknown
2	5001010095	unknown
3	5001012601	Reaction with ammonium molybdate and potassium antimonyltartrate. Then reduction
4	5001014301	Reduction with stannous chloride, time not measured
5	5001014401	Reduction with asorbic acid, time not measured
6	5001014501	Alpkem RFA/2 autoanalyser, Murphy and Riley 1962, time not measured
7	5001016701	Colorimetric
8	5001020001	unknown
9	5001020101	PHOTOMETRY
10	5001030001	unknown
11	5001030094	unknown
12	5001030096	unknown
13	5001030098	unknown
14	5001030099	unknown
15	5001030101	PHOTOMETRY
16	5001030601	Nitrapyrine inhibition
17	5001031301	Chemlab AA-II segmented continous flow autoanalyzer
18	5001032001	Autoanalyzer
19	5001033101	filtered samples (Whatman puradisc PP 0.45 mym filters) by the ascorbic acid red
20	5001033501	ICES COOP. RES. REP.(1972)
21	5001034101	Kalle (1934)
22	5001035101	Water bottle, method acc. to Strickland and Parson (1972)
23	5001036701	Colorimetric
24	500111601	Autoanalyzer adaption of the phospho-molybdic complex method

silicate (18):

1	5003010001	unknown
2	5003012001	Autoanalyzer

3	5003014601	Method of Mullin, J.B. and Riley, J.B. (1955), time not measured
4	5003014701	Alpkem RFA/2 autoanalyser, Mullin and Riley procedure, time not measured
5	5003016801	Colorimetric
6	5003020001	unknown
7	5003030001	unknown
8	5003030098	unknown
9	5003030099	unknown
10	5003030101	PHOTOMETRY
11	5003030601	Nitrapyrine inhibition
12	5003031301	Chemlab AA-II segmented continous flow autoanalyzer
13	5003032001	Autoanalyzer
14	5003033401	Strickland and Parsons (1960)
15	5003033501	ICES COOP. RES. REP.(1972)
16	5003035101	Water bottle, method acc. to Strickland and Parson (1972)
17	5003036801	Colorimetric
18	500311701	Formation of molybdic complex at well defined pH to prevent interference with ph

SPM (19):

1	6077130001	unknown
2	6077130101	Winkler Titration
3	6077131201	CTD
4	6077131301	BACKSCATTERANCE
5	6077131401	wgh fd fp
6	6077131501	wgh fd nd
7	6077131601	wgh fd
8	6077131701	trfa
9	6077131801	aasgf
10	6077131901	aasgf f
11	6077132001	Sartorius Waage 1801
12	6077132201	wgh of MP(0.45MYM) sf, weight of Millipore (0.45MYM) filters after suction-filtr
13	6077132401	wgh of NP(0.40MYM) sf, weight of Nuclepore (0.40MYM) filters after suction-filtr
14	6077132601	wgh of MP(0.45MYM) and NP(0.40MYM), weight of Millipore(0.45MYM) and Nuclepore(0
15	6077133401	Filtration on 0.45mym Filters-oven drying at 70 degr.-weighing
16	6077134301	Filtration
17	6077134401	separated with glass microfibre GF/L filters (nominal pore size 1MYM)
18	6077135601	vacuum filtration system onto a pre-weighed ashed glass fibre filter (GFF)
20	6077136001	Nucleopore filters

salinity (17):

1	1002020001	unknown
2	1002020101	CTD
3	1002020301	SALINO
4	1002020401	TITRATION
5	1002020501	Beckman RS7b Salinometer
6	1002020601	Seabird SBE9 or Seabird Seacat SBE19 probes
7	1002020801	calculated
8	1002021101	WTW conductivity meter LF196
9	1002021301	Determined from tables of T and density (Gillbricht), 0.1 PSU

10	1002021401	Autolab industries, Sydney, inductive coubling
11	1002021501	Guideline Autosal, Canada, galvan. method, 0.003 PSU
12	1002021701	Titration against silver nitrate, time not measured
13	1002021801	Inductively coupled salinometer (initially 'Autolab', later 'Plessey 6230N'),tim
14	1002022201	Waterbottle (Salinity at E1)
15	1002022401	Seabird SBE 25 probe
16	1002022801	Guideline Autosal salinometer
17	1002023201	Calculated from measurements with a Neil Brown Mark III CTD profiler

temperature (13):

1	1001010001	unknown
2	1001010101	CTD
3	1001010201	THERM
4	1001010601	Seabird SBE9 or Seabird Seacat SBE19 probes
5	1001010701	ELECTRODE
6	1001011001	integrated temperature sensor of the conductivity meter
7	1001011201	Puetzprobe, surface thermometer from Richter and Wiese, 0.05 GRD C
8	1001011601	Nansen-Pettersen insulated water bottle, read to the nearest 0.1 celsius, time n
9	1001012101	Waterbottle (Temperature at E1)
10	1001012401	Seabird SBE 25 probe
11	1001012901	SIS RTM-4002 digital reversing thermometer
12	1001013101	Measured with sensor mounted on a Neil Brown Mark III CTD profiler
13	1001013301	Rosemount PT100 sensor

Country Code

Country codes as used in WOD13:

DE GERMANY
DU EAST_GERMANY
BE BELGIUM
CA CANADA
DK DENMARK
ES SPAIN
US UNITED_STATES
FI FINLAND
FR FRANCE
IE IRELAND
IS ICELAND
NO NORWAY
NL NETHERLANDS
PL POLAND
GB GREAT_BRITAIN
SE SWEDEN
SU SOVIET_UNION
99 UNKNOWN
RU RUSSIAN_FEDERATION

Appendix 2 (Temperature)

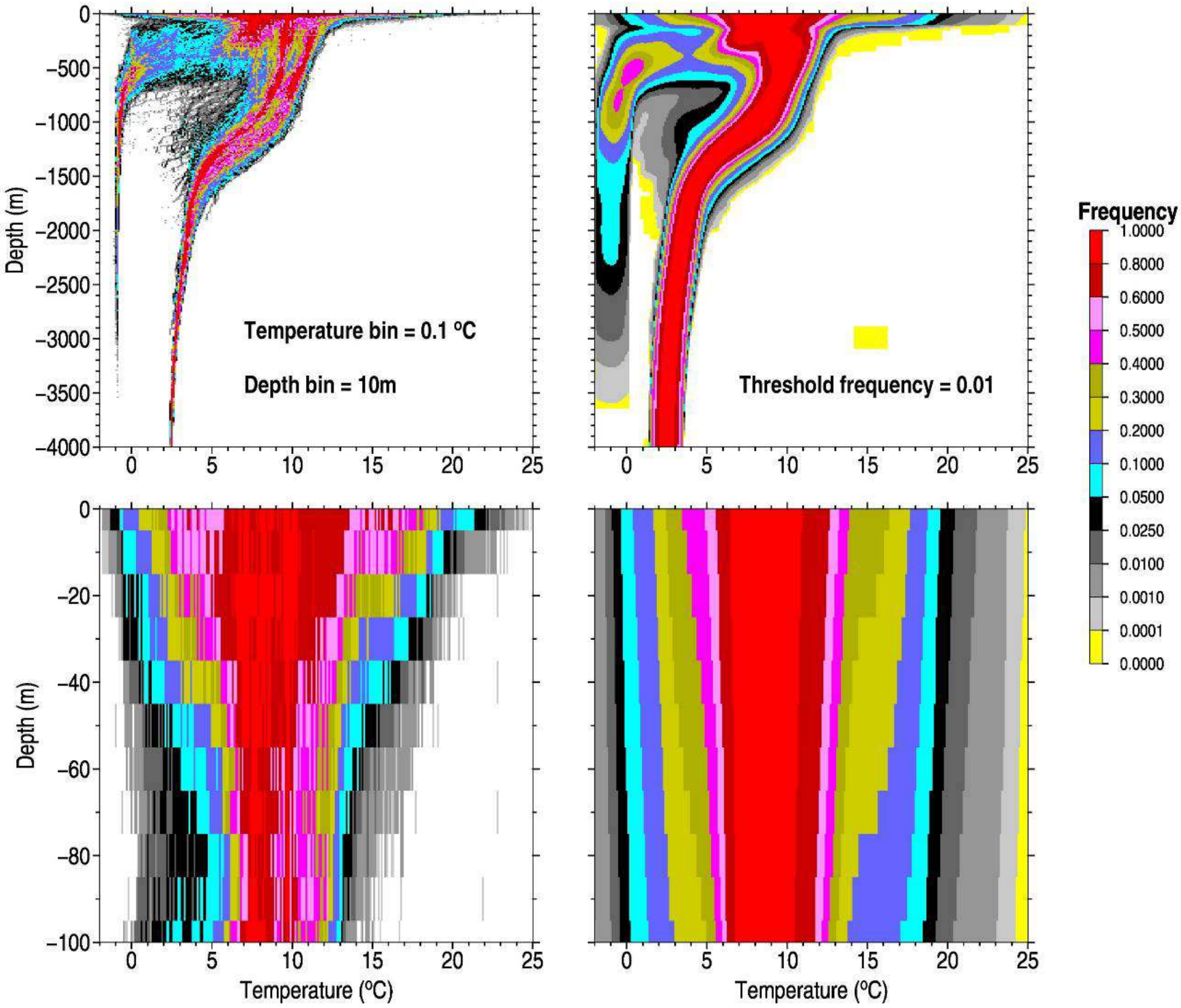

Fig. A2.1: Normalized temperature depth histogram. For each level the number of observations in each bin is divided by the value for the most populated bin of the same level. Left: unsmoothed histograms, right: histograms smoothed with 11x11 point kernel

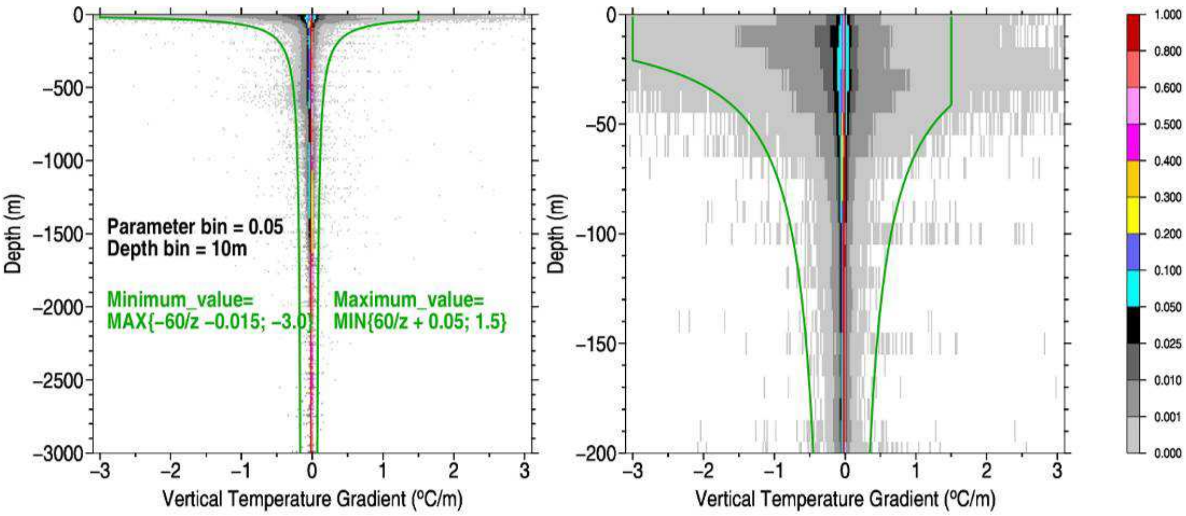

Fig. A2.2: Normalized temperature vertical gradient histogram. For each level the original number of the data in each bin is divided by the value for the most populated bin. The min-max vertical gradient limits shown in green are approximated by the reciprocal function of depth

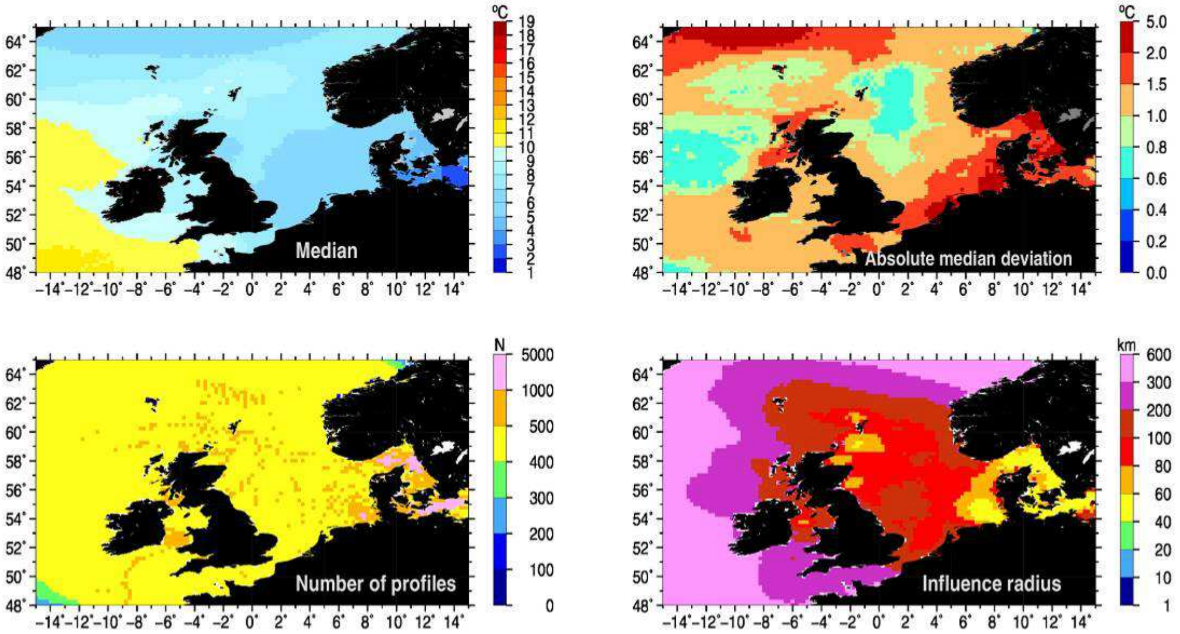

Fig. A2.3: Median temperature (Tmed), absolute median deviation (Tamd), number of profiles, influence radius at 15 m depth for January. Climatological temperature limits are defined as (Tmed – 2*Tamd; Tmed + 2*Tamd)

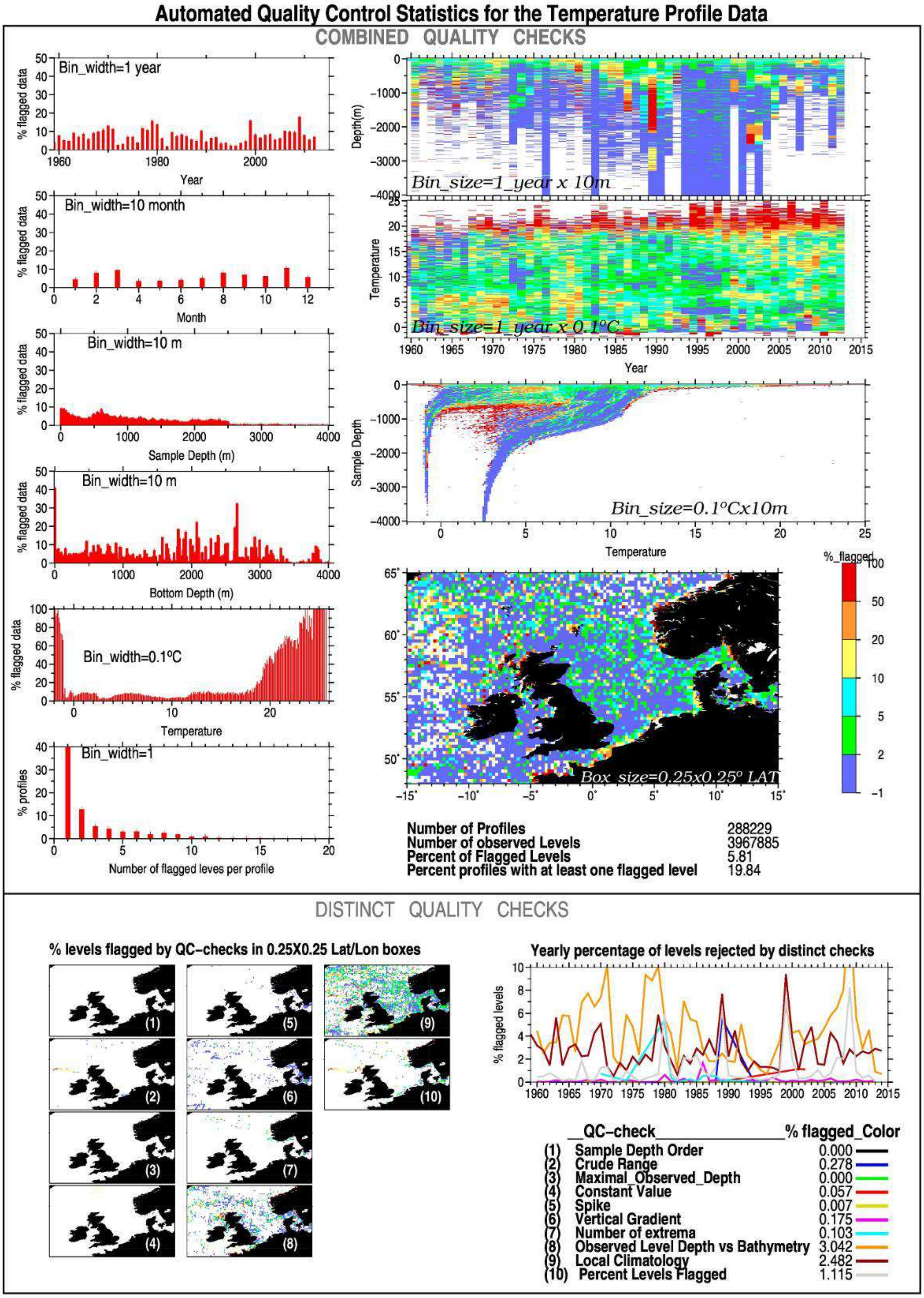

Fig. A2.4: Automated Quality Control Statistics for Temperature

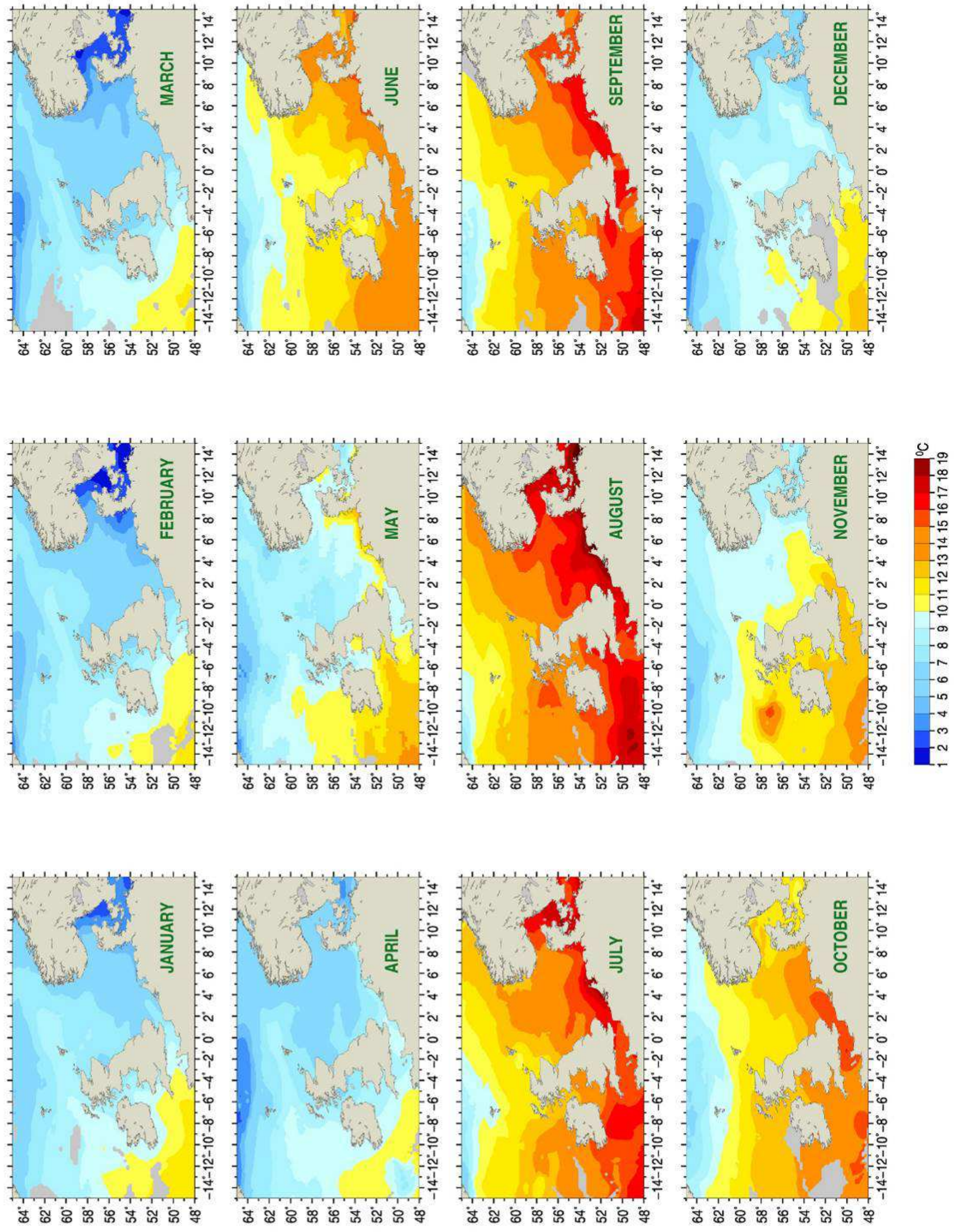

Fig. A2.5: Climatological monthly mean surface temperature

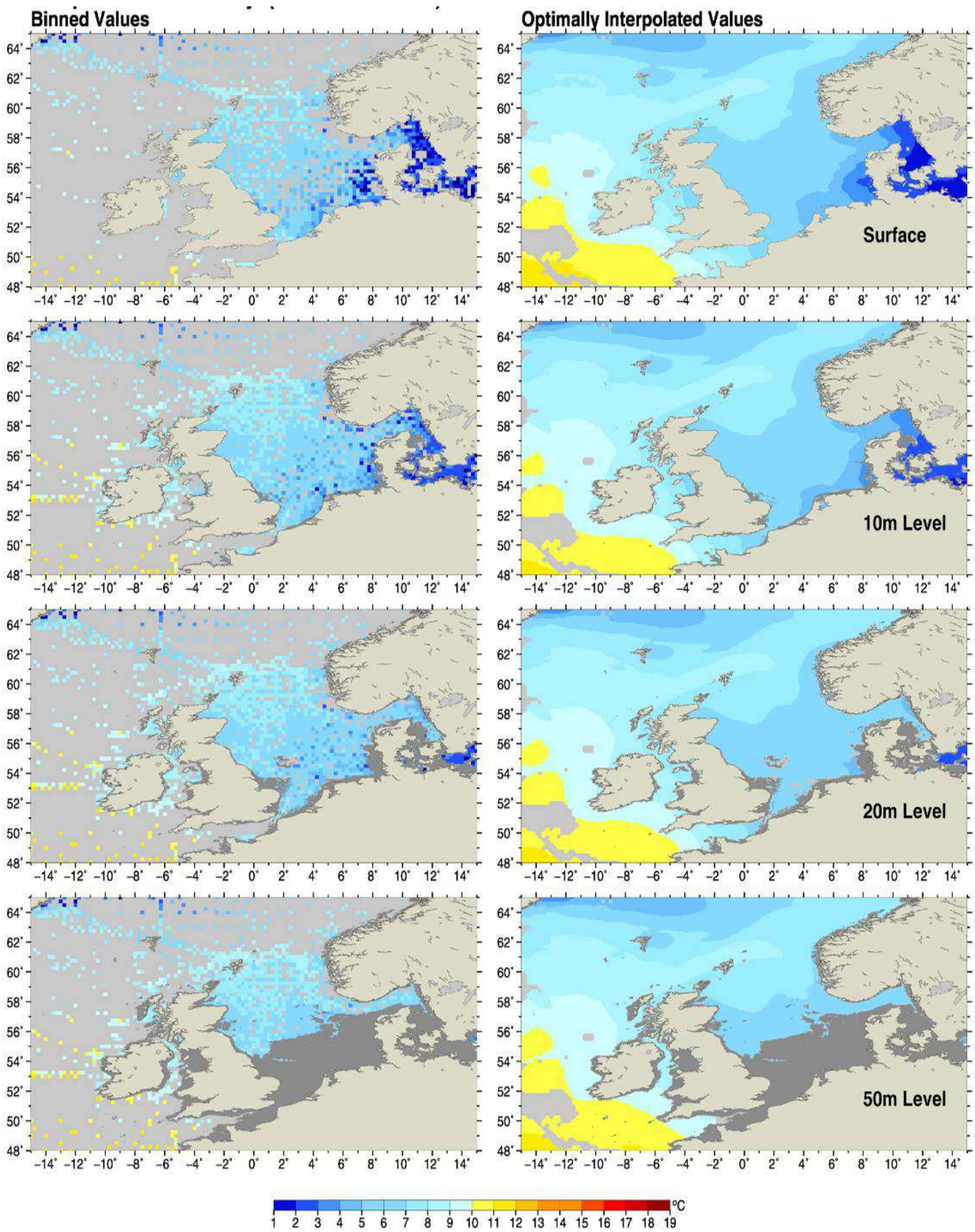

Fig. A2.6: Climatological temperature distributions at four selected levels in February

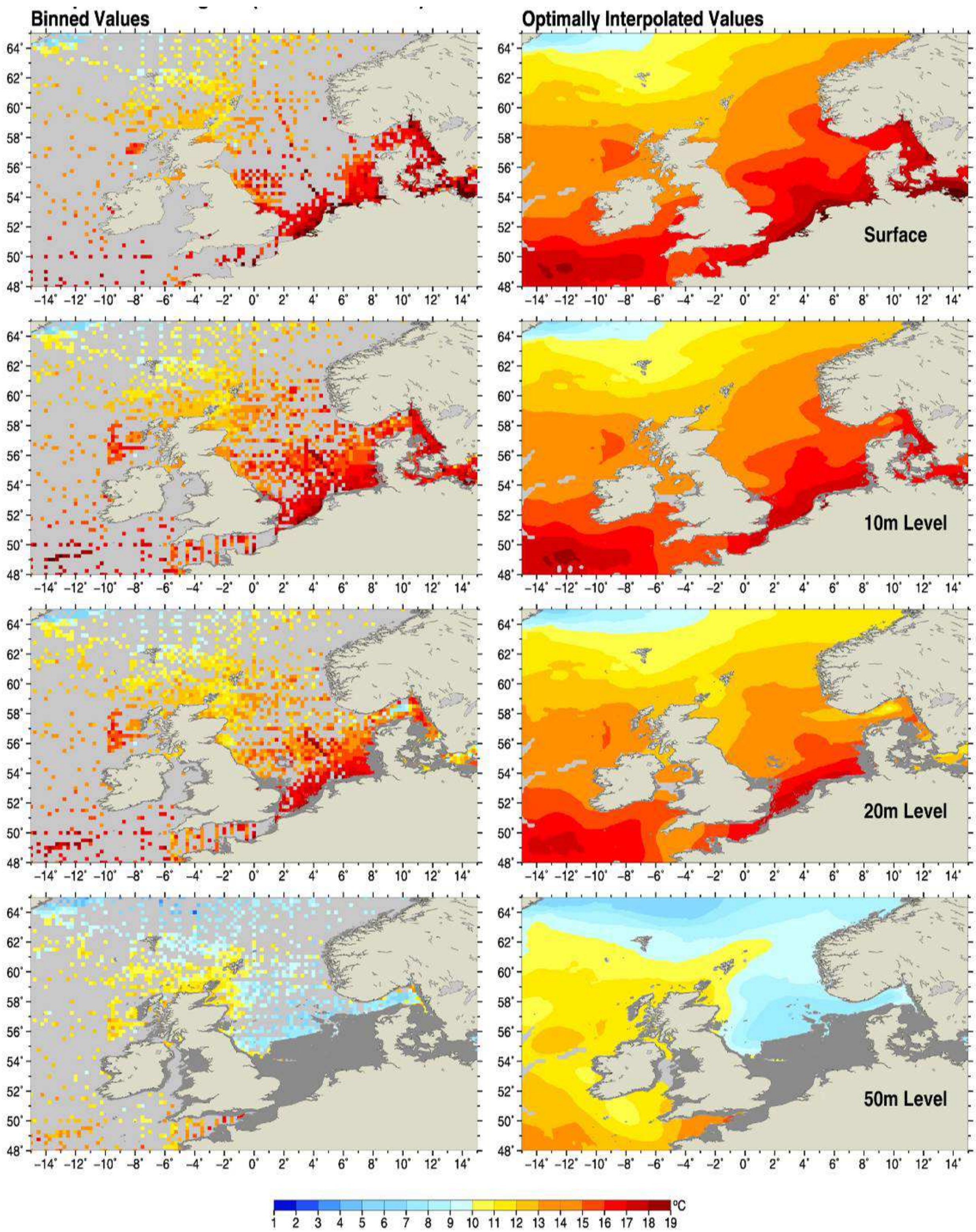

Fig. A2.7: Climatological temperature distributions at four selected levels in August

Appendix 3 (Salinity)

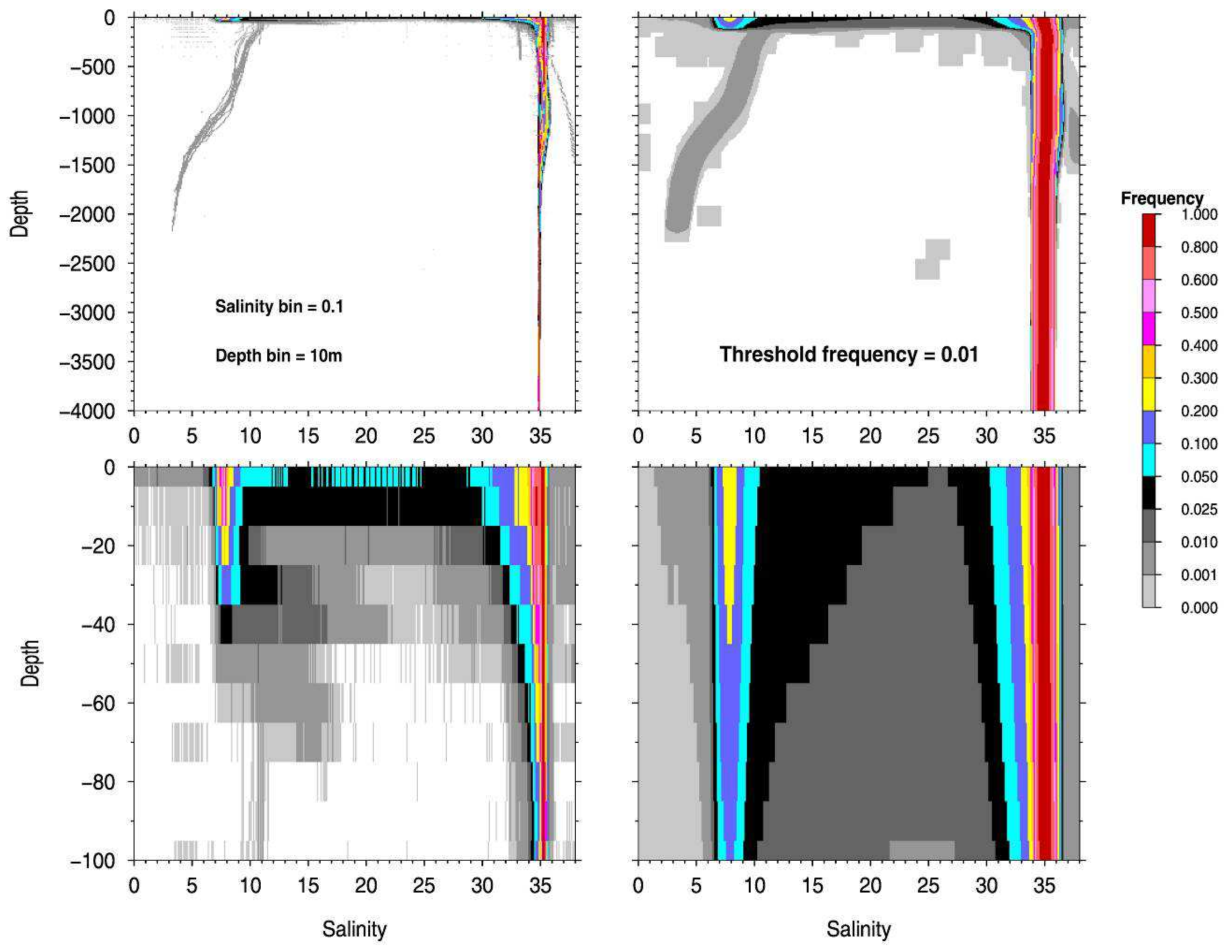

Fig. A3.1: Normalized salinity-depth histogram. For each level the number of observations in each bin is divided by the value for the most populated bin of the same level. Left; unsmoothed histograms, right: histograms smoothed with 11x11 point kernel

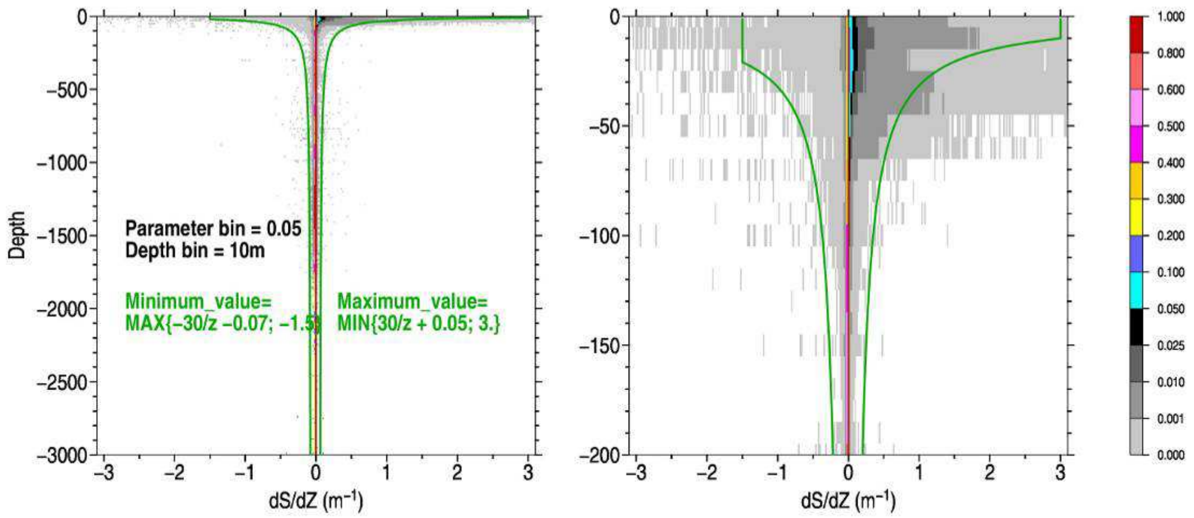

Fig. A 3.2: Normalized salinity vertical gradient histogram. For each level the original number of the data in each bin is divided by the value for the most populated bin. The min-max vertical gradient limits shown in green are approximated by the reciprocal function of depth

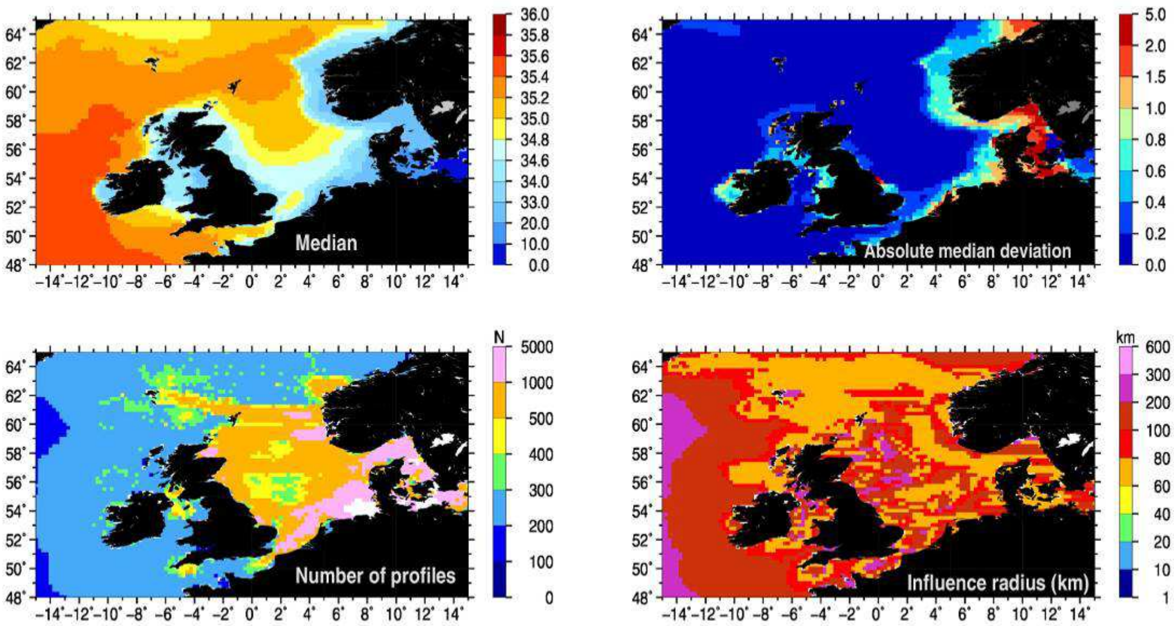

Fig. A 3.3: Median salinity (Smed), absolute median deviation (Samd), number of profiles, influence radius at 15 m depth for January. Climatological salinity limits are defined as (Smed – 2*Samd; med + 2*Samd)

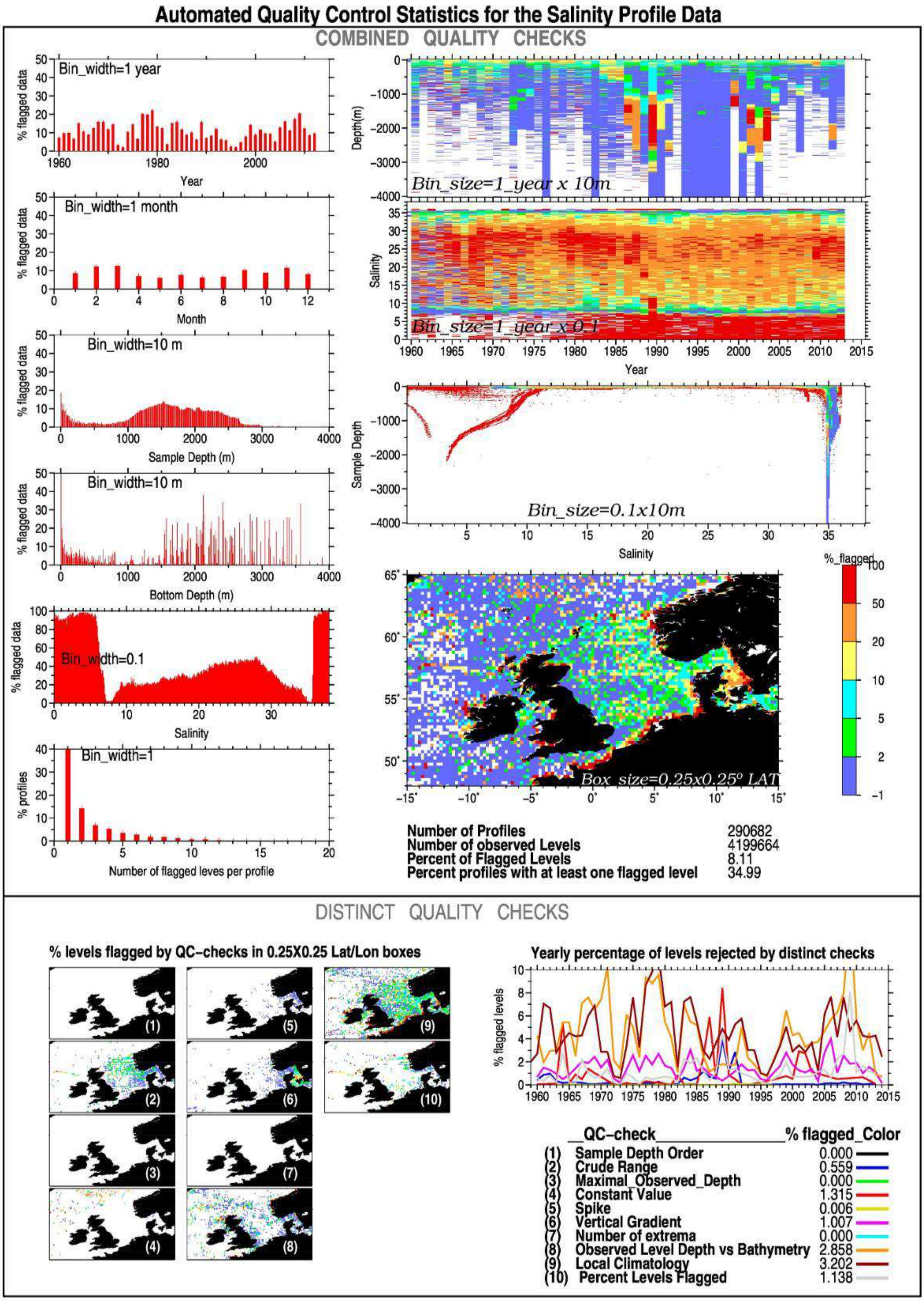

Fig. A3.4: Automated Quality Control Statistics for Salinity

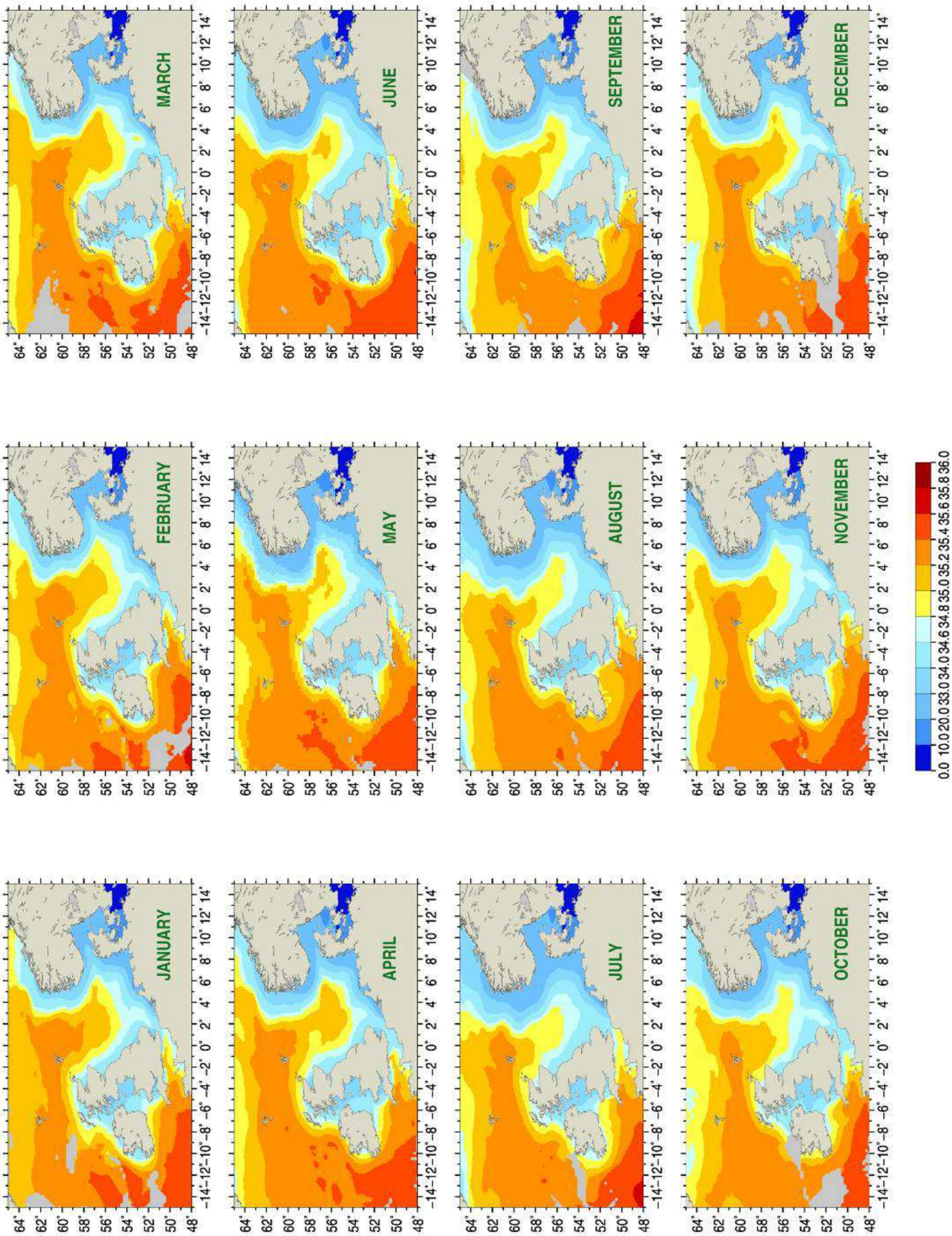

Fig. A3.5: Climatological monthly mean surface salinity

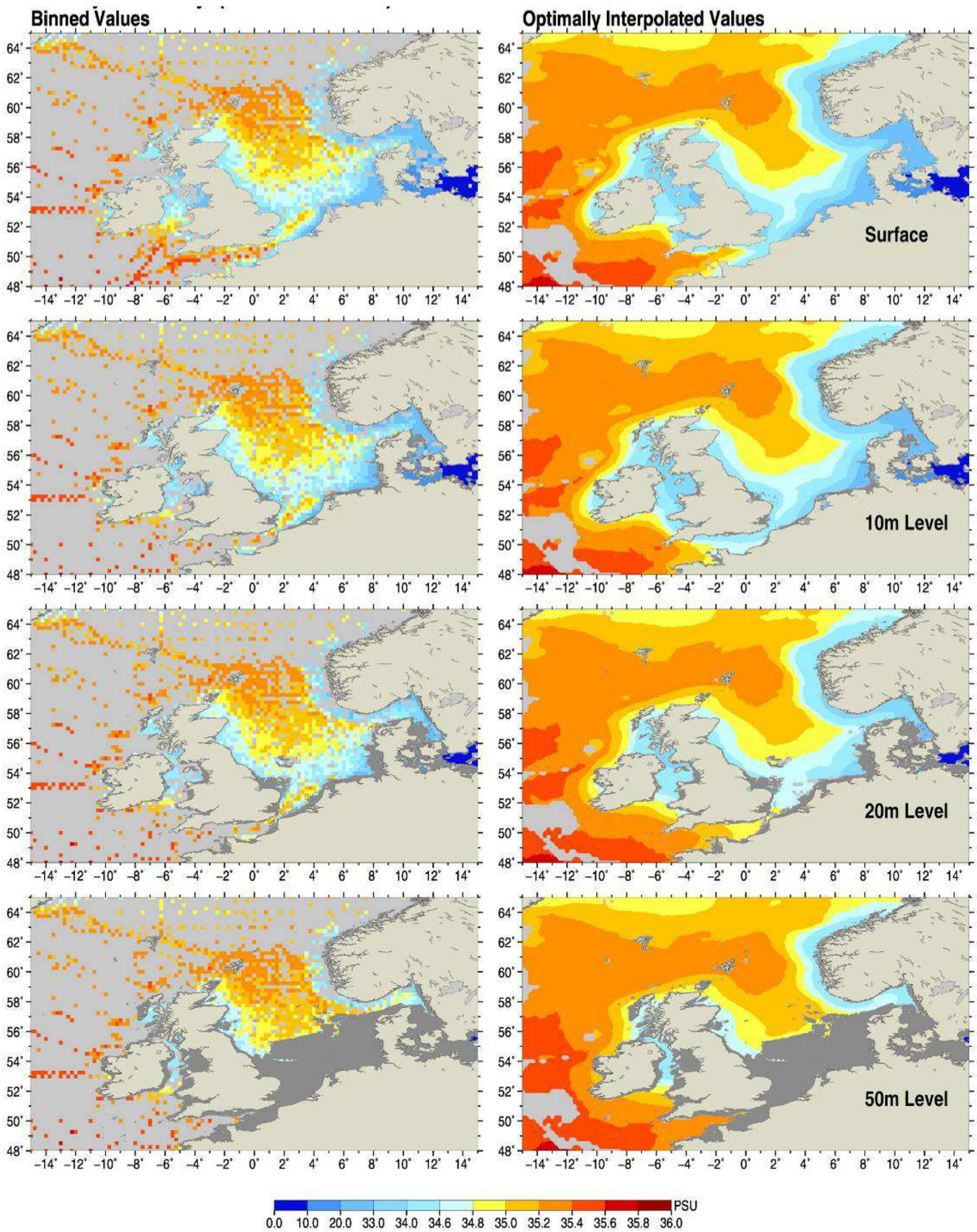

Fig. A3.6: Climatological salinity distributions at four selected levels in February

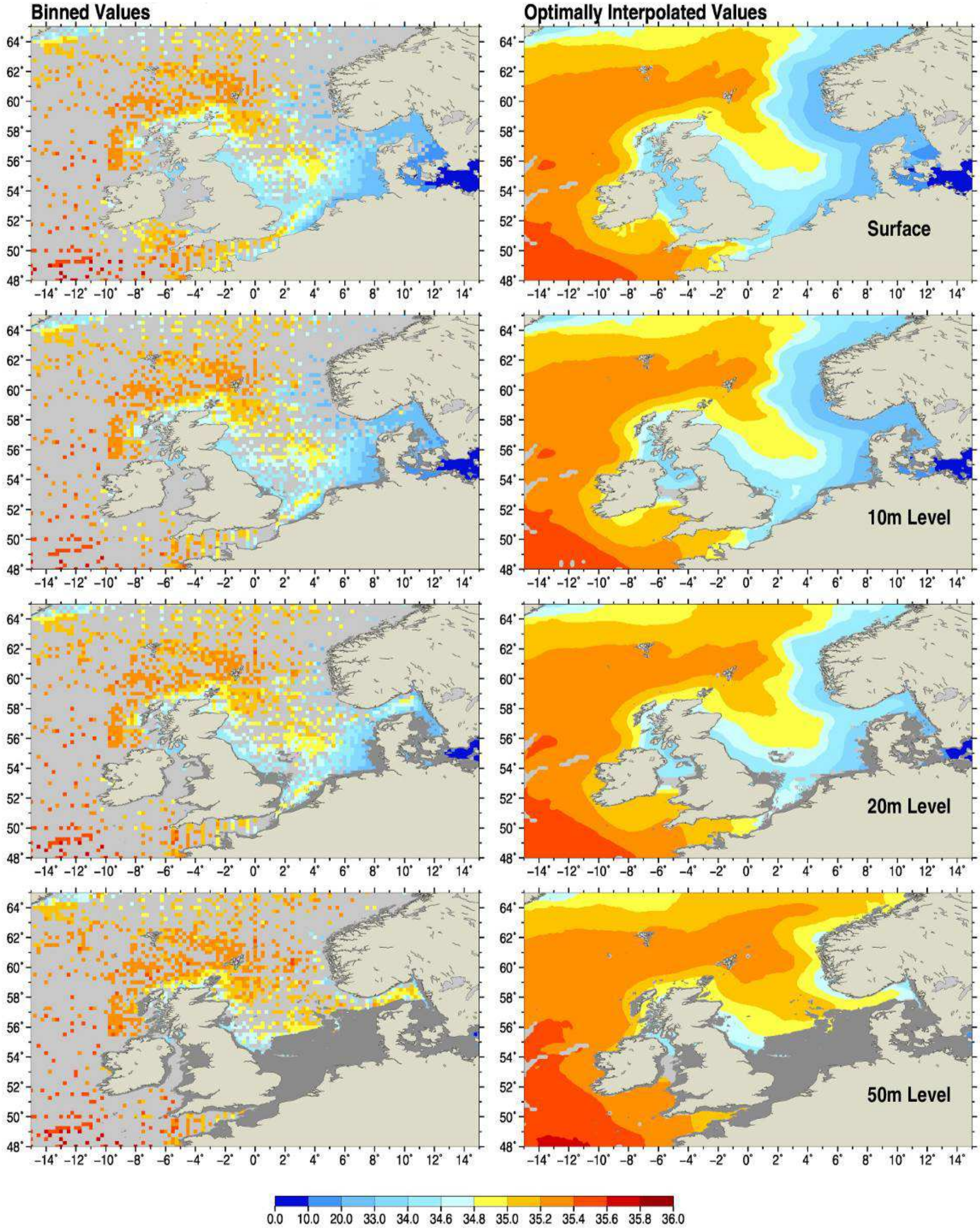

Fig. A3.7: Climatological salinity distributions at four selected levels in August

Appendix 4 (Oxygen)

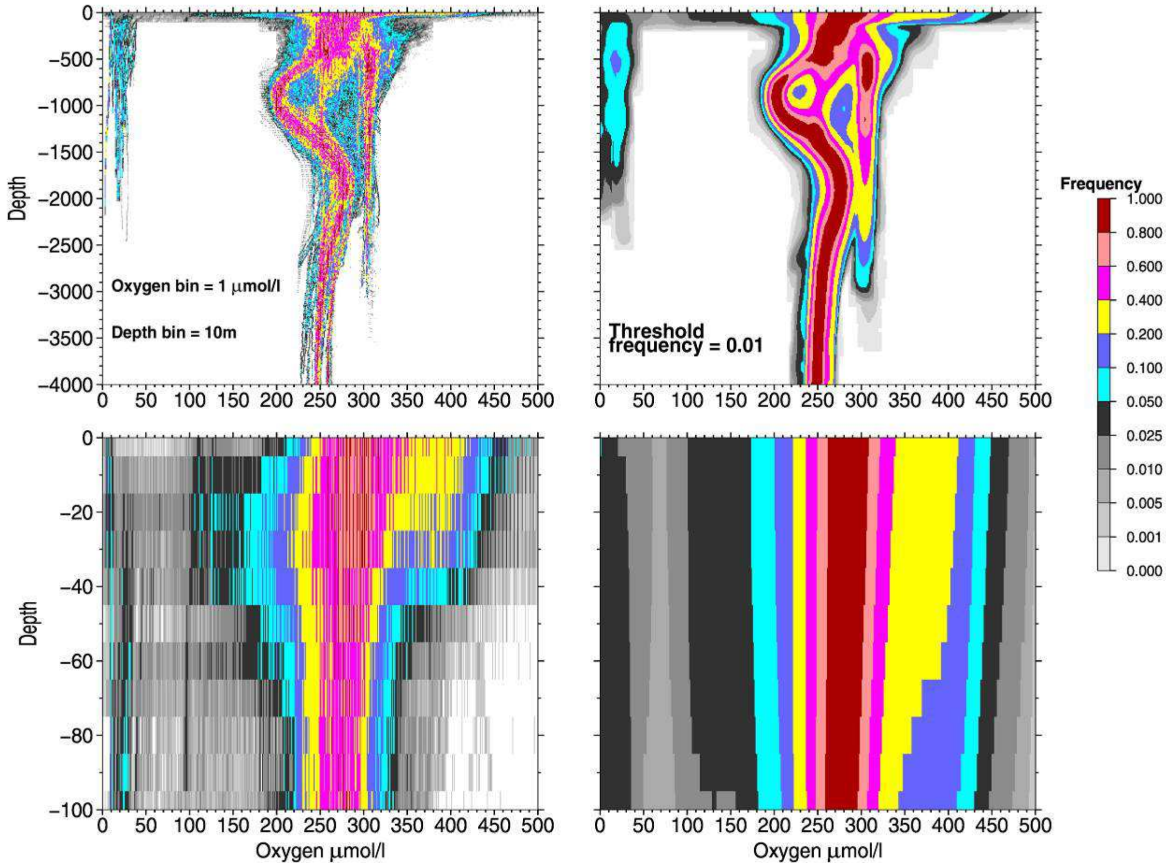

Fig. A4.1: Normalized oxygen-depth histogram. For each level the number of observations in each bin is divided by the value for the most populated bin of the same level. Left; unsmoothed histogram, right: histograms smoothed with 11x11 point kernel

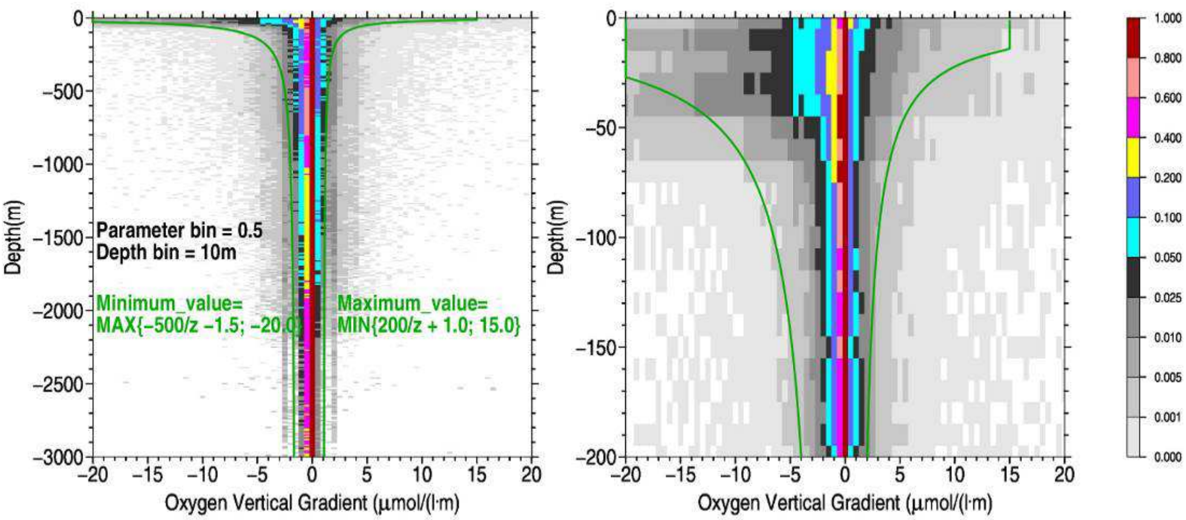

Fig. A4.2: Normalized oxygen vertical gradient histogram. For each level the original number of the data in each bin is divided by the value for the most populated bin. The min-max vertical gradient limits shown in green are approximated by the reciprocal function of depth

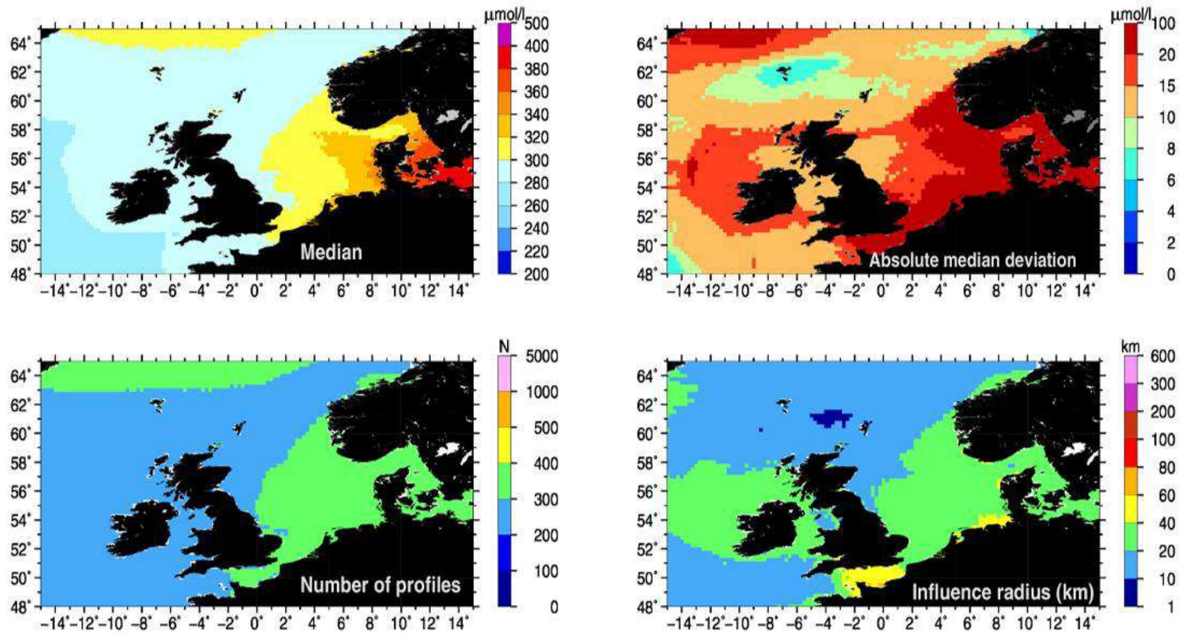

Fig. A4.3: Median oxygen (O_2med), absolute median deviation (O_2amd), number of profiles, influence radius at 15 m depth for January. Climatological oxygen limits are defined as (O_2med – 2* O_2amd; O_2med + 2 O_2amd)

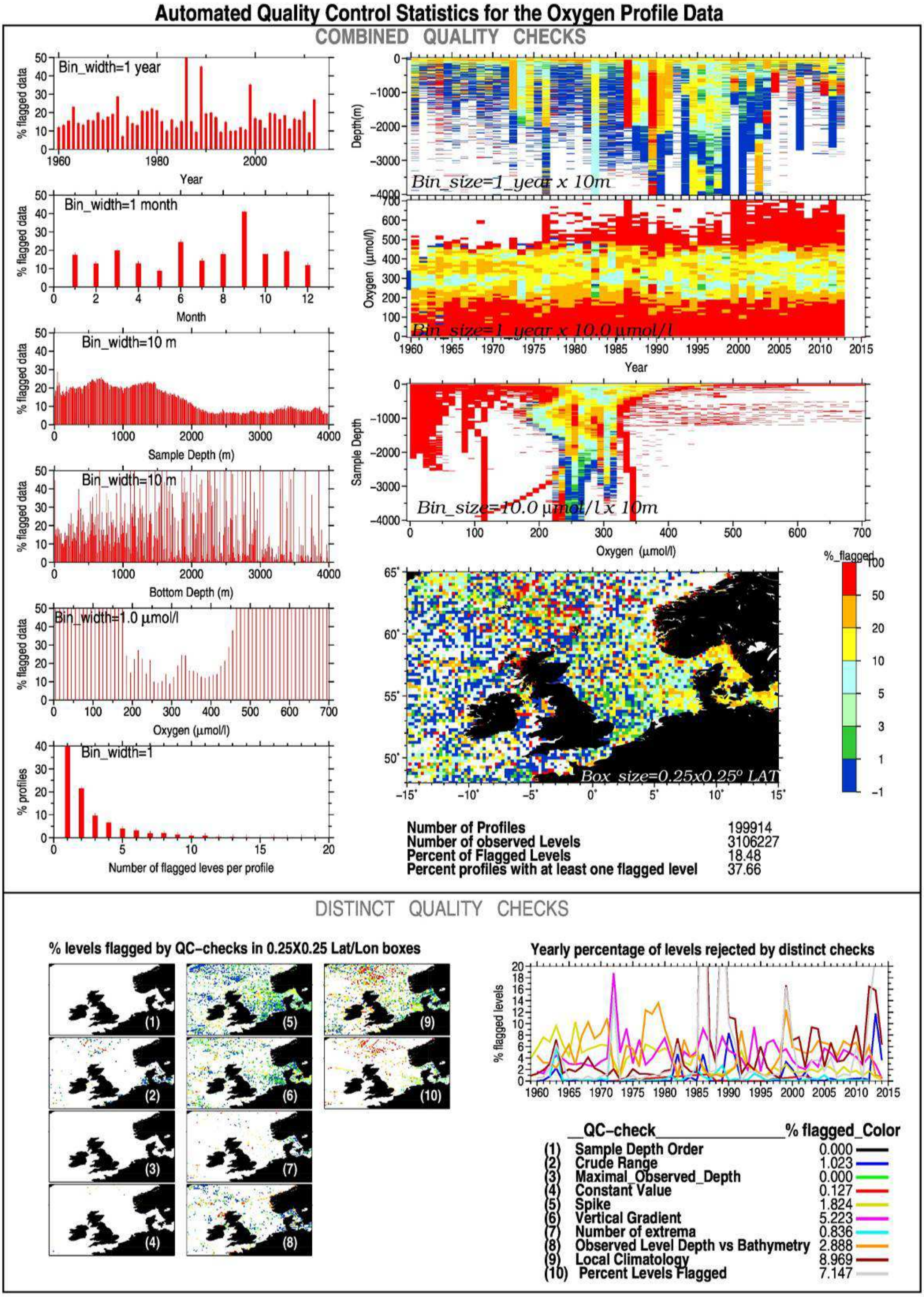

Fig. A4.4: Automated Quality Control Statistics for Oxygen

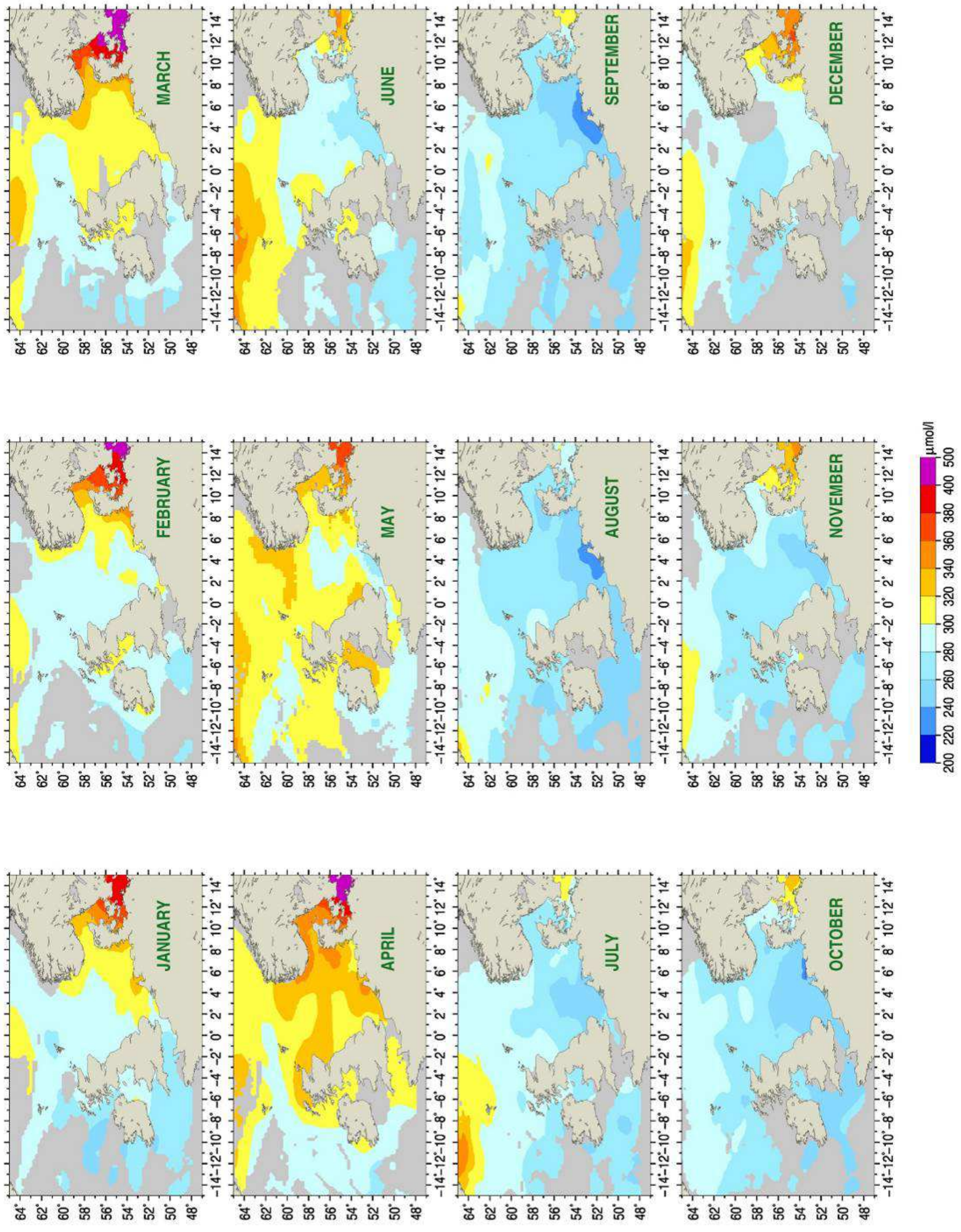

Fig. A4.5: Climatological monthly mean surface oxygen

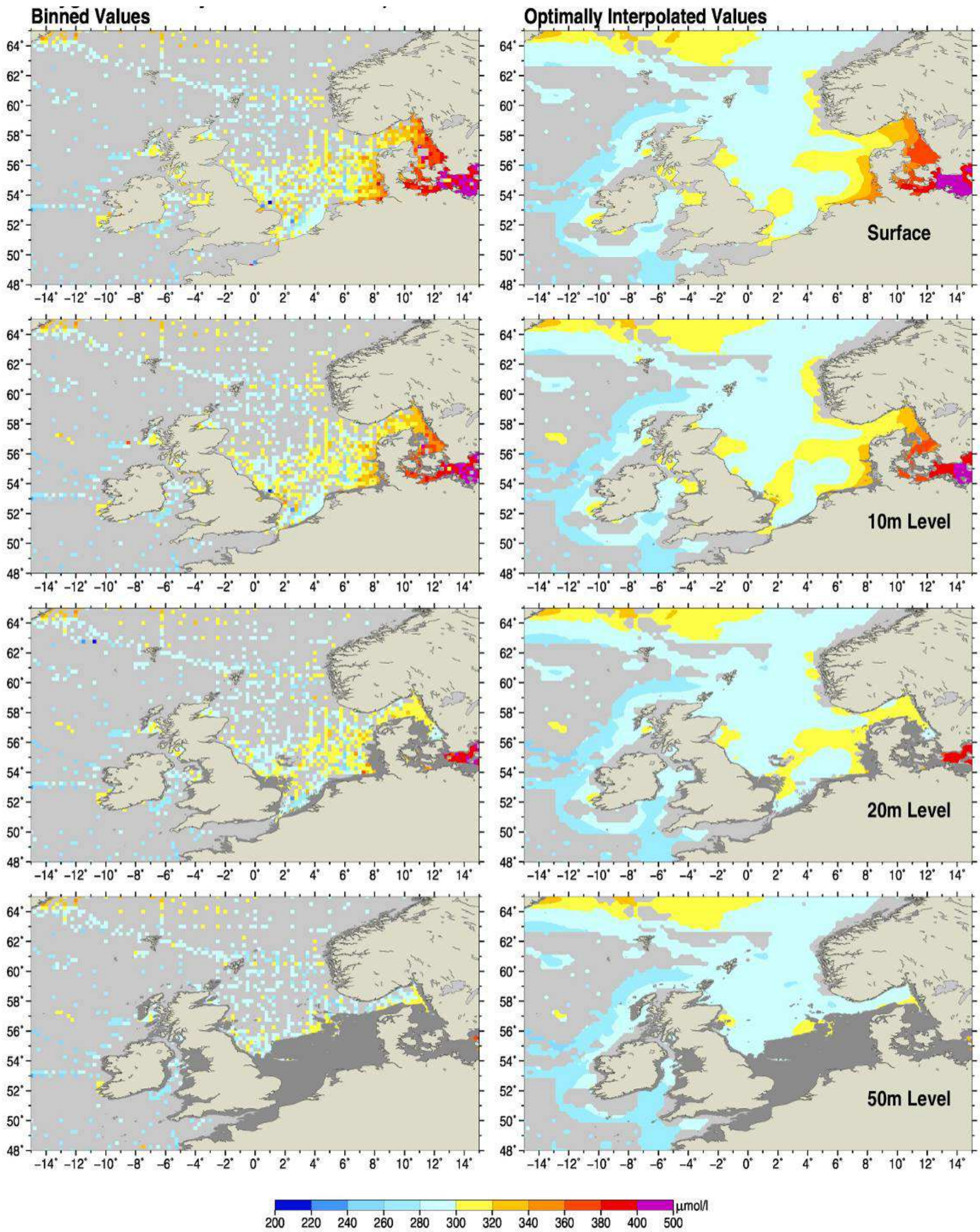

Fig. A4.6: Climatological oxygen distributions at four selected levels in February

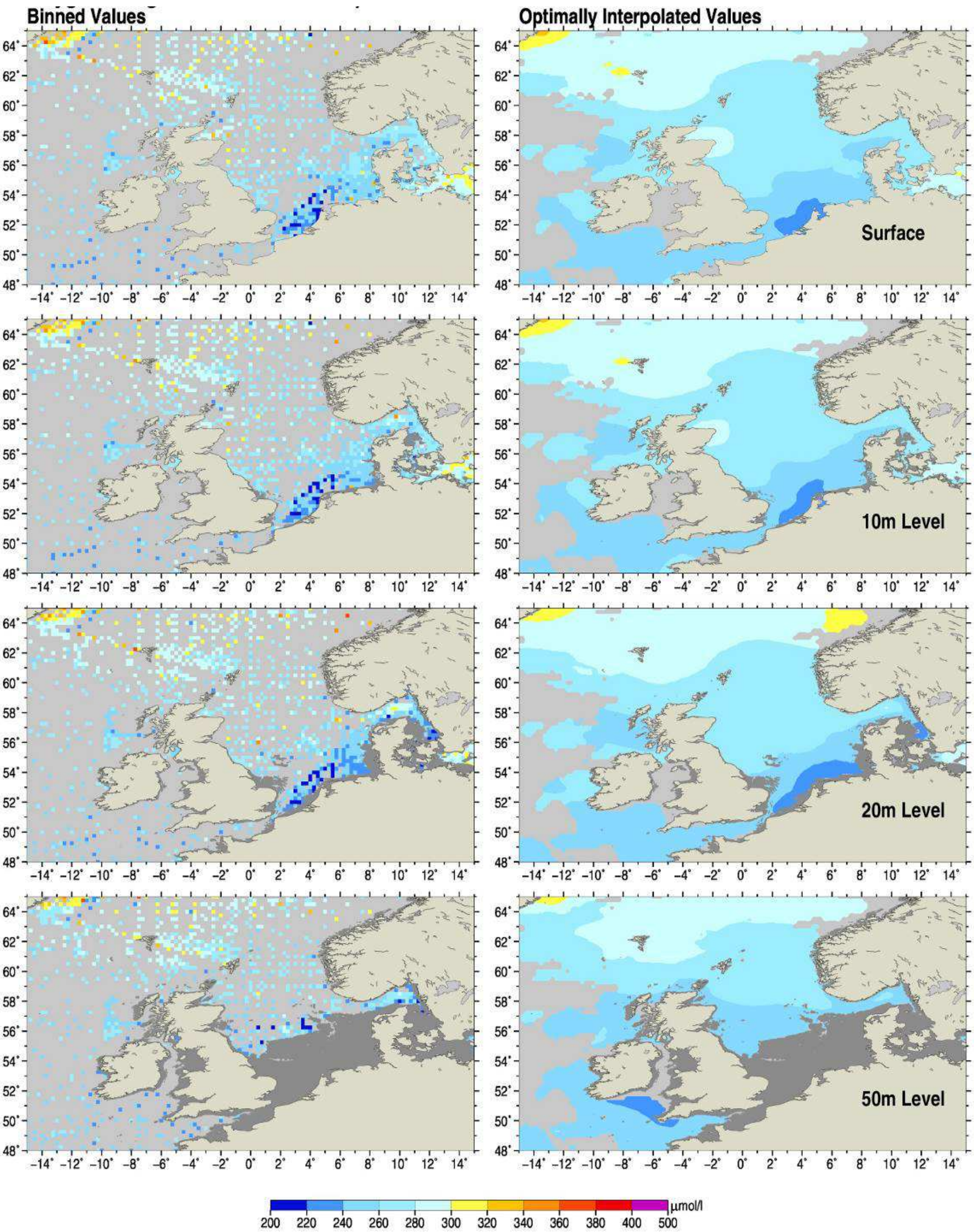

Fig. A4.7: Climatological oxygen distributions at four selected levels in August

Appendix 5 (Nitrate)

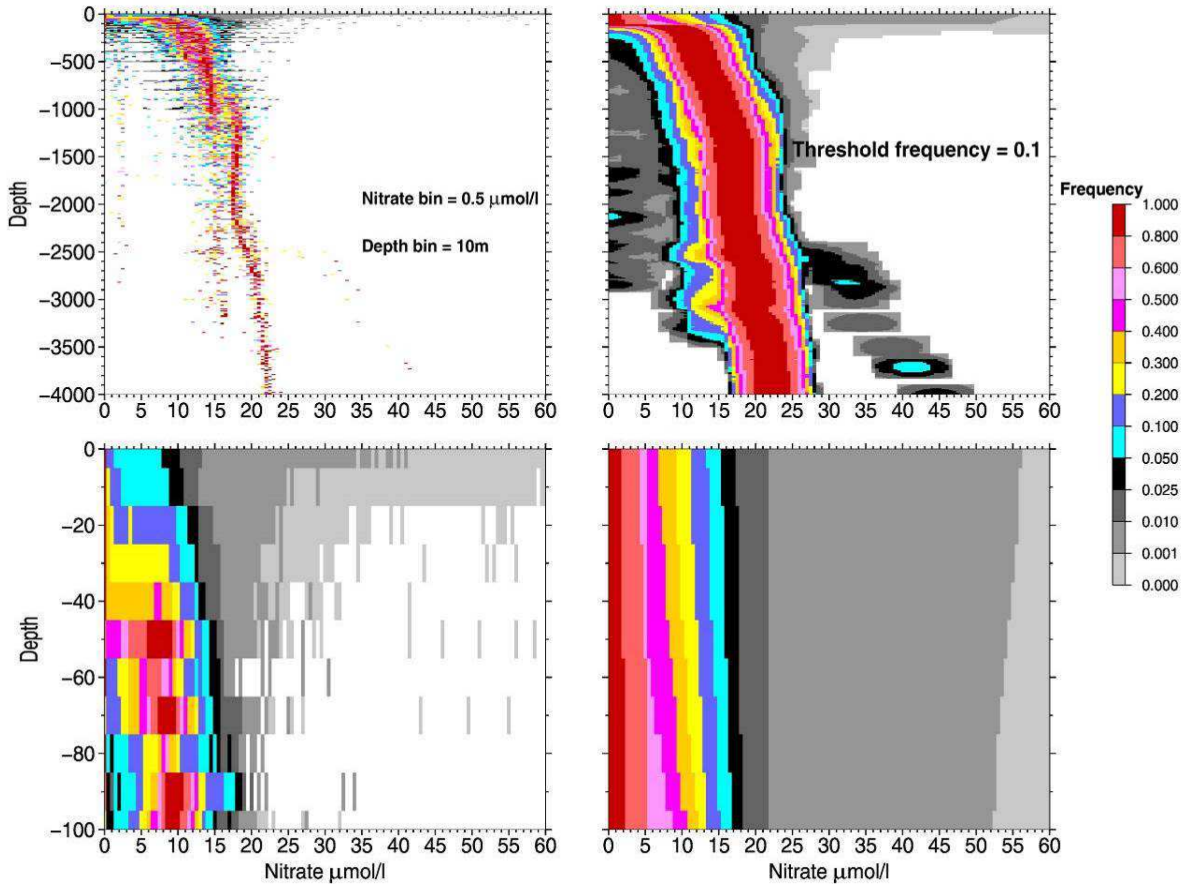

Fig. A5.1: Normalized nitrate depth histogram. For each level the number of observations in each bin is divided by the value for the most populated bin of the same level. Left; unsmoothed histogram, right: histograms smoothed with 11x11 point kernel

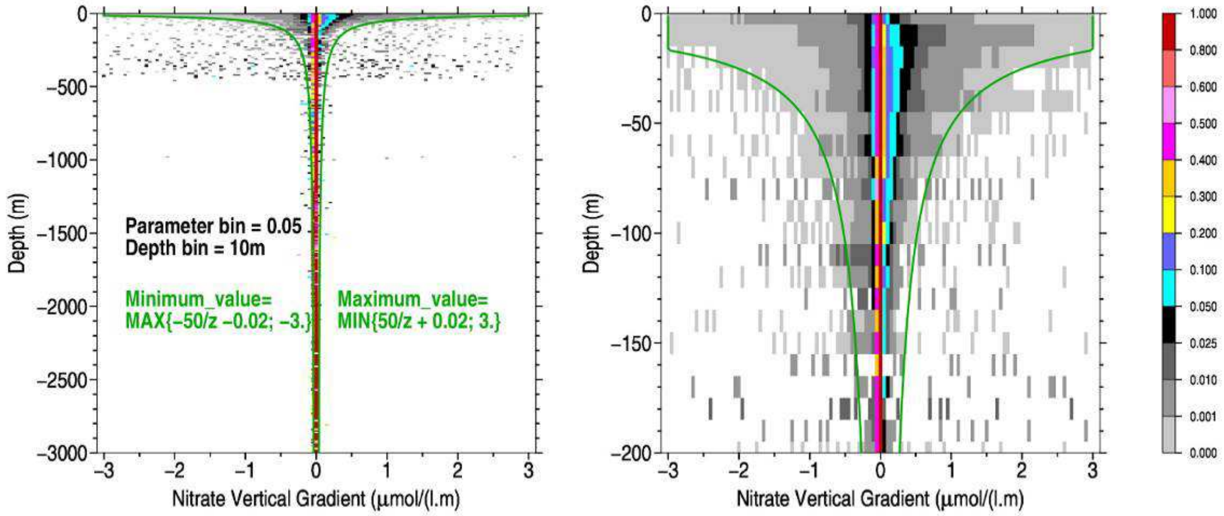

Fig. A5.2: Normalized nitrate vertical gradient histogram. For each level the original number of the data in each bin is divided by the value for the most populated bin. The min-max vertical gradient limits shown in green are approximated by the reciprocal function of depth

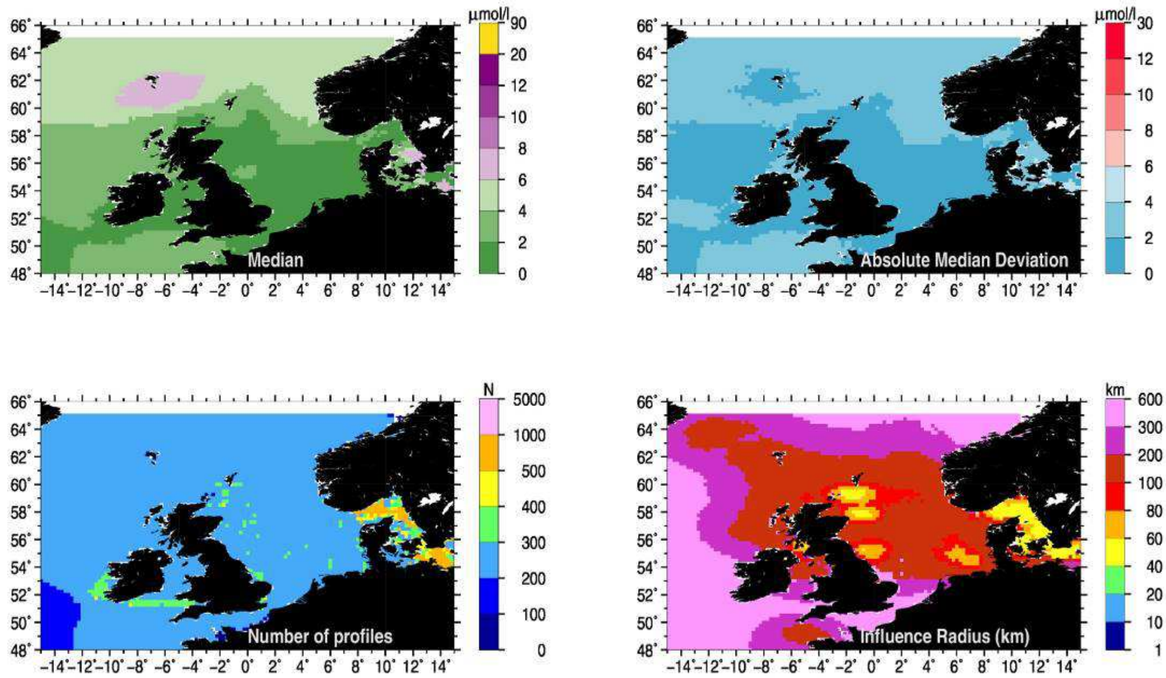

Fig. A5.3: Median nitrate (NO_3med), absolute median deviation (NO_3amd), number of profiles, influence radius at 15 m depth for January. Climatological salinity limits are defined as (NO_3med – 2* NO_3amd; NO3med + 2 NO_3amd)

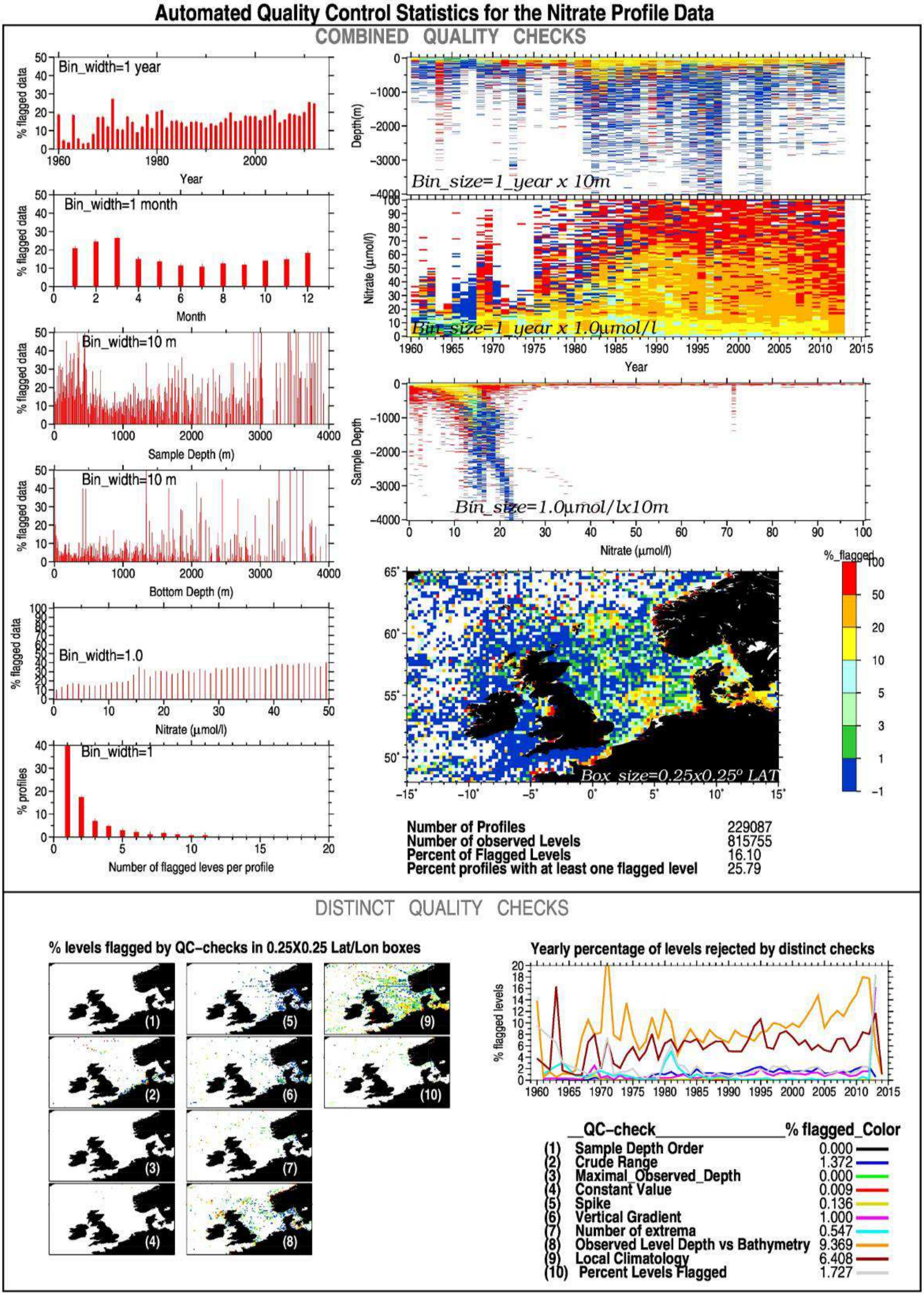

Fig. A5.4: Automated Quality Control Statistics for Nitrate

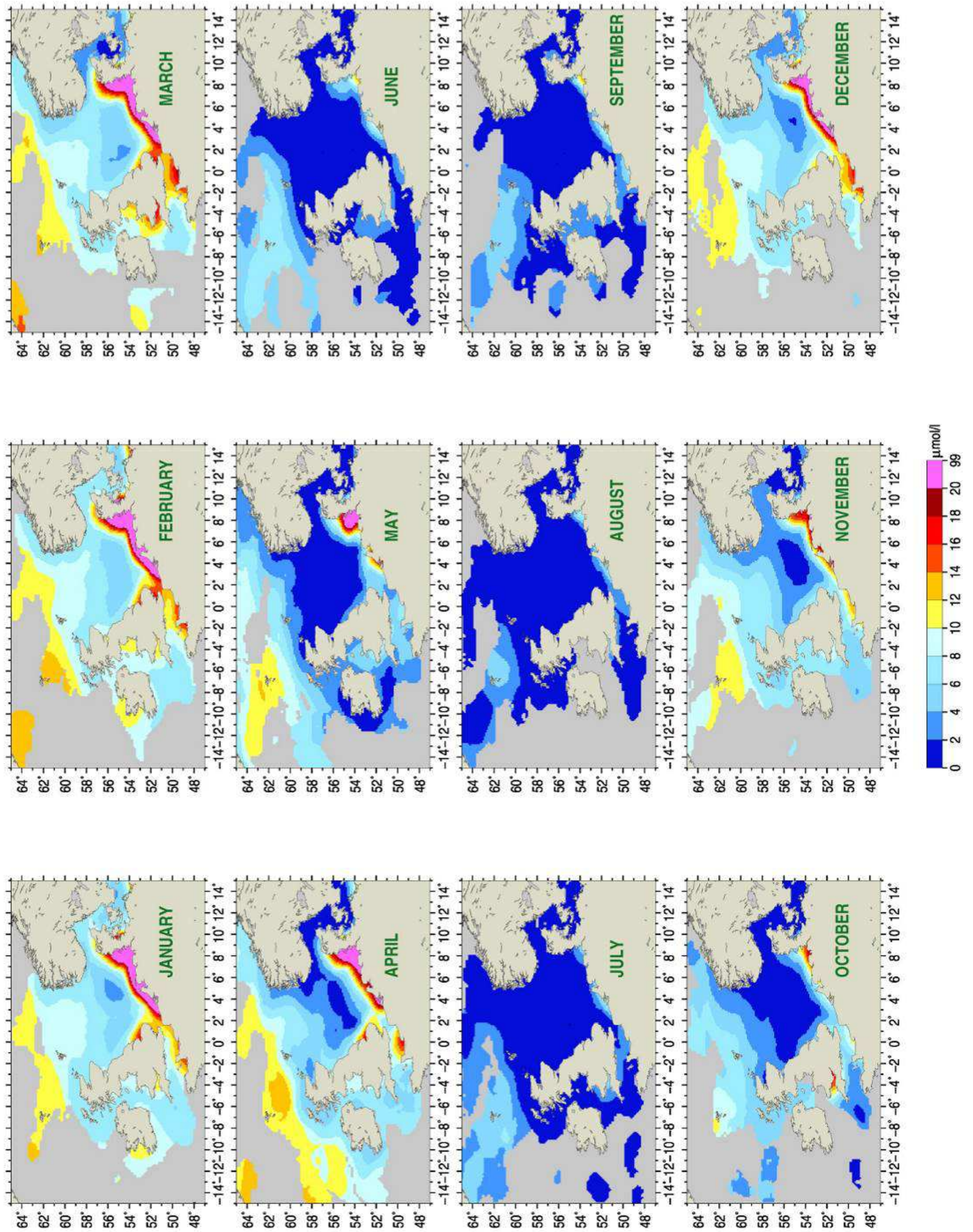

Fig. A5.5: Climatological monthly mean surface nitrate

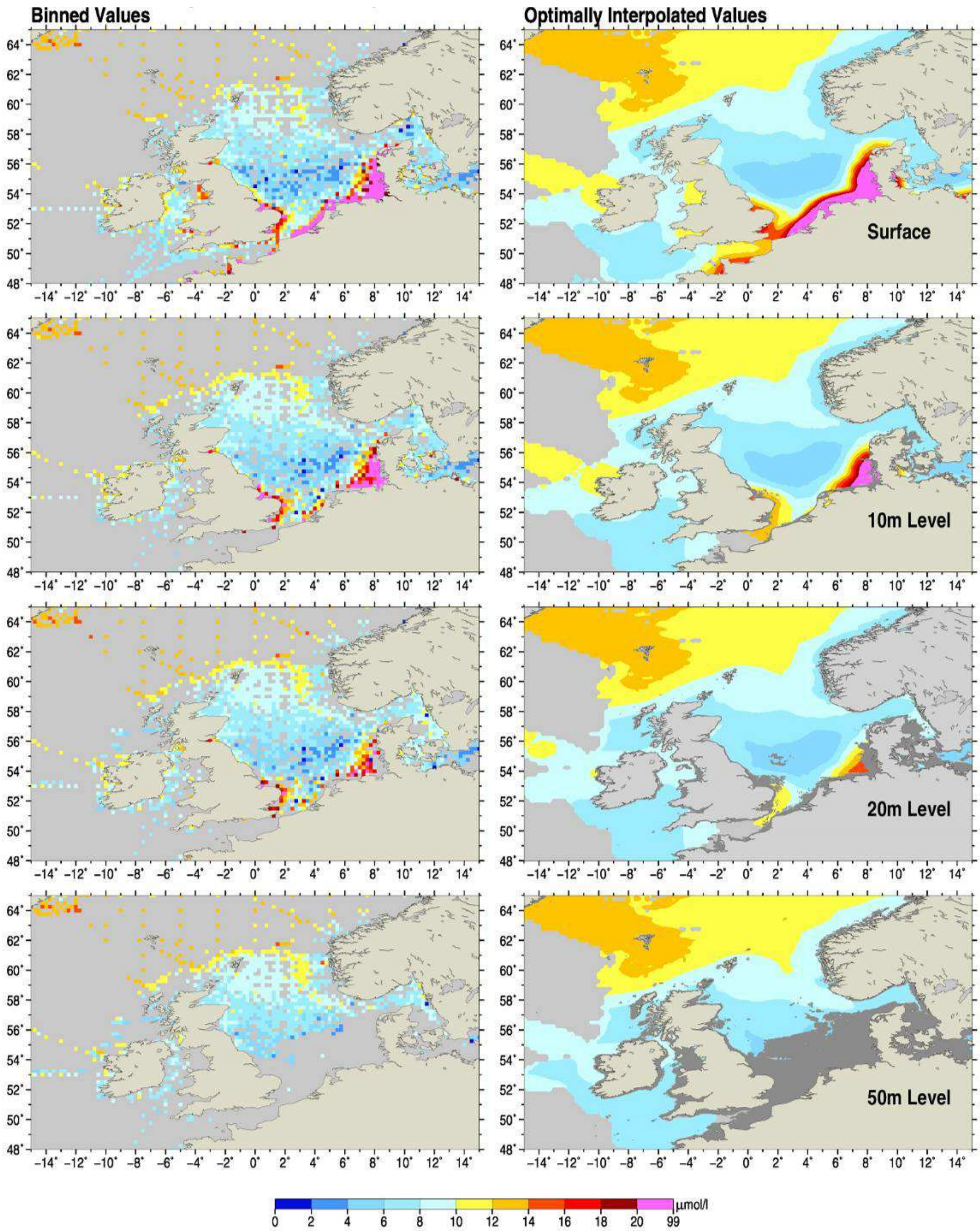

Fig. A5.6: Climatological nitrate distributions at four selected levels in February

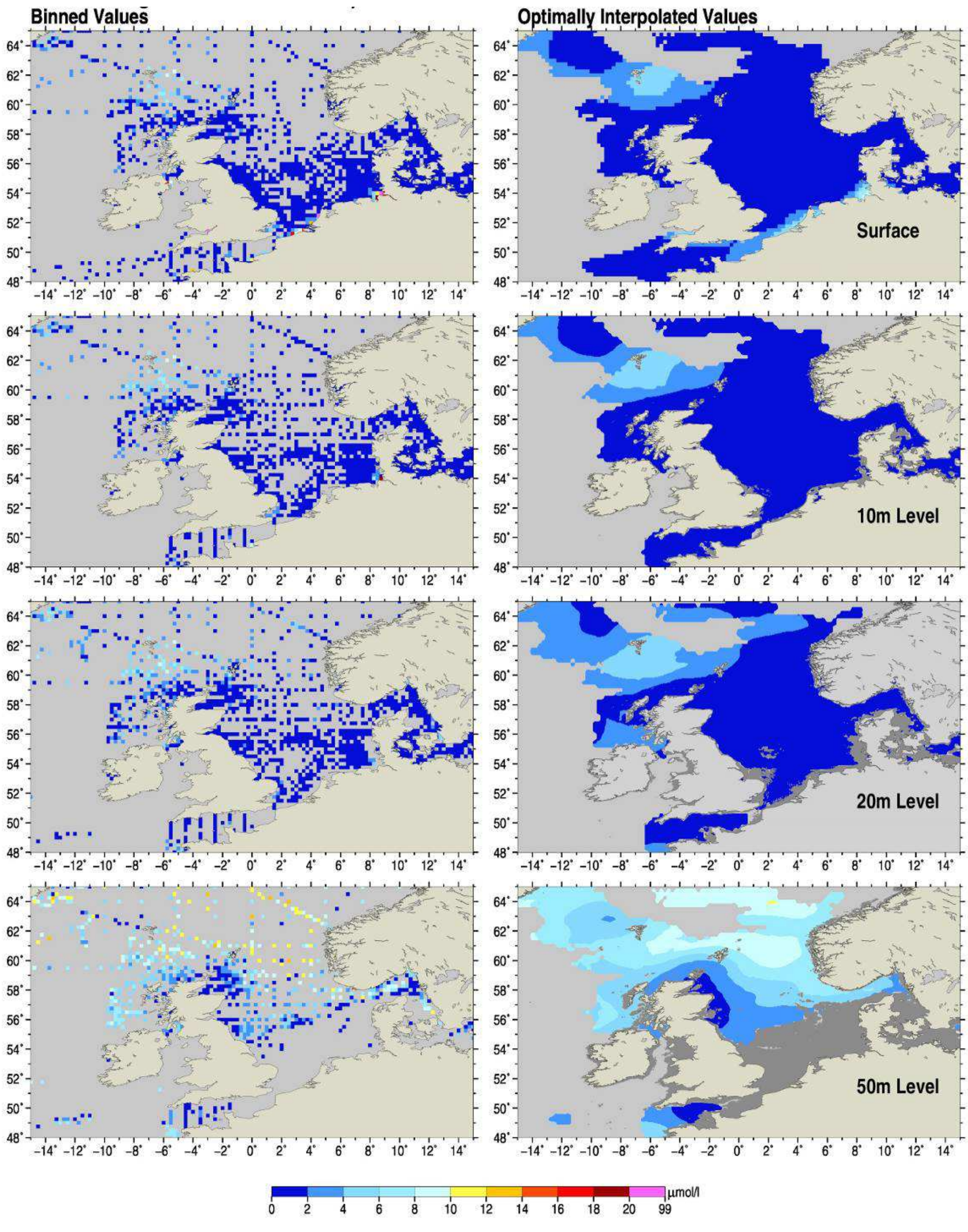

Fig. A5.7: Climatological nitrate distributions at four selected levels in August

Appendix 6 (Phosphate)

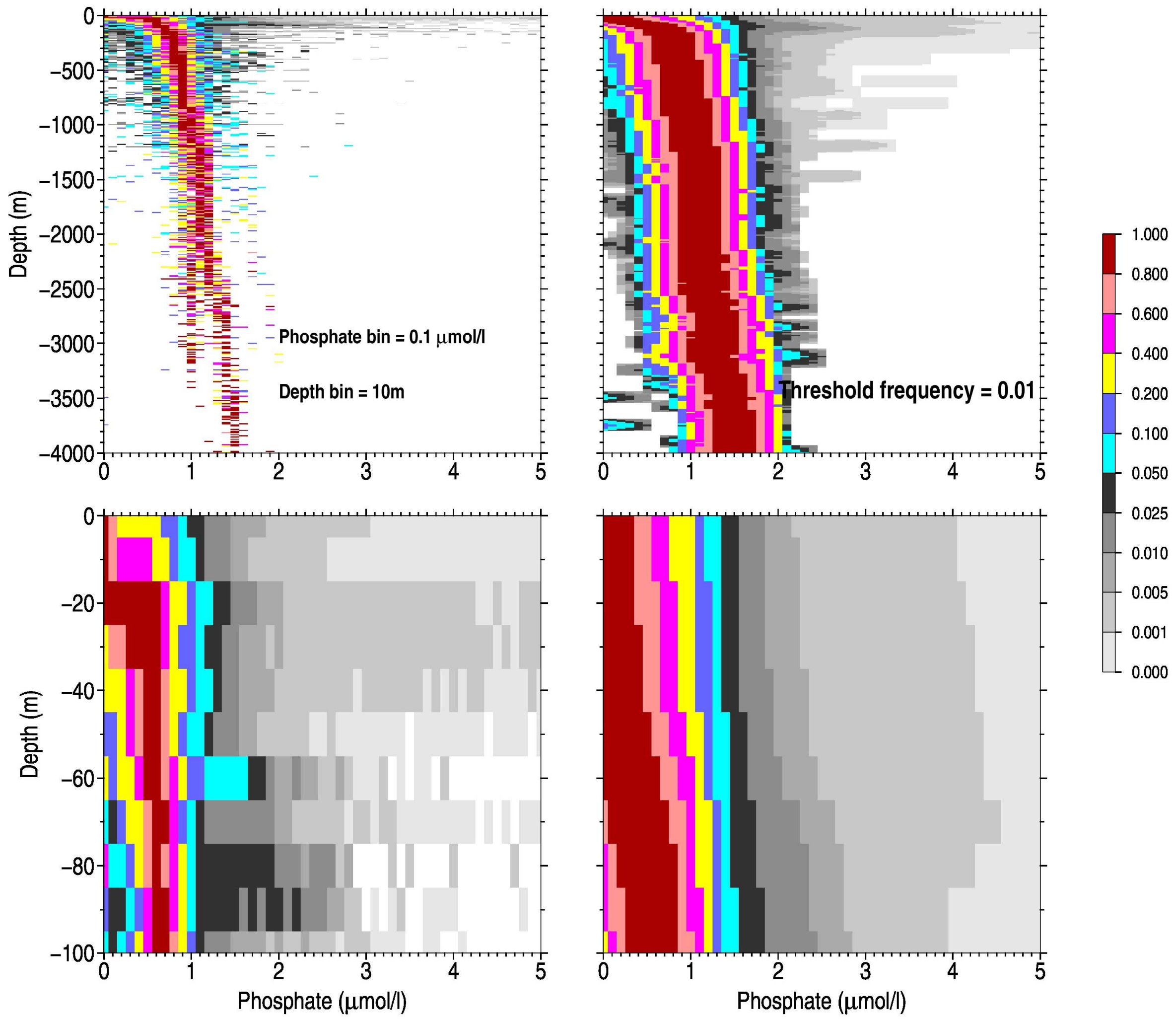

Fig. A6.1: Normalized phosphate depth histogram. For each level the number of observations in each bin is divided by the value for the most populated bin of the same level. Left; unsmoothed histogram, right: histograms smoothed with 11x11 point kernel

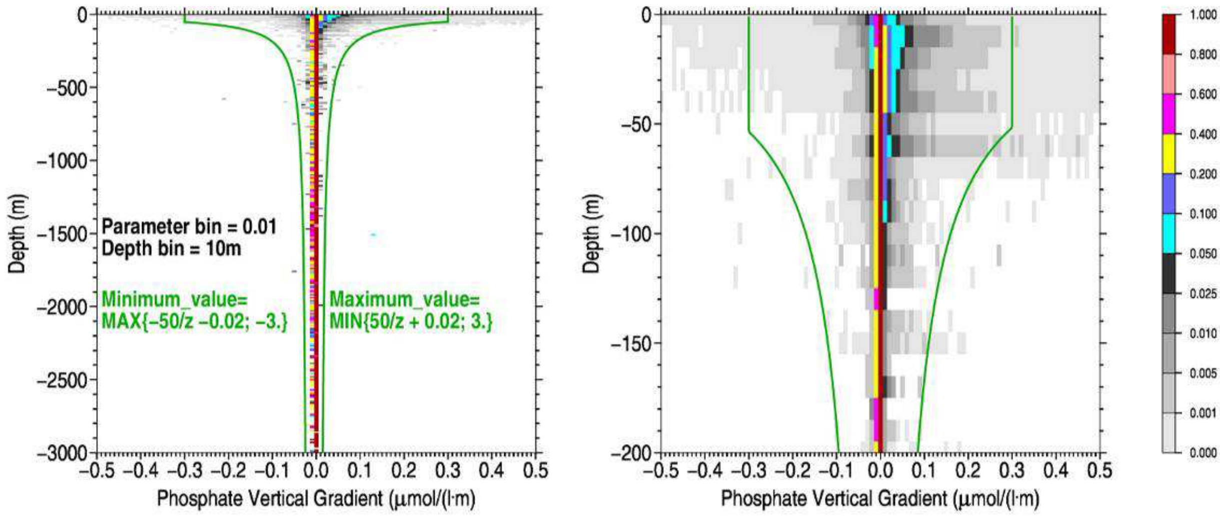

Fig. A6.2: Normalized phosphate vertical gradient histogram. For each level the original number of the data in each bin is divided by the value for the most populated bin. The min-max vertical gradient limits shown in green are approximated by the reciprocal function of depth

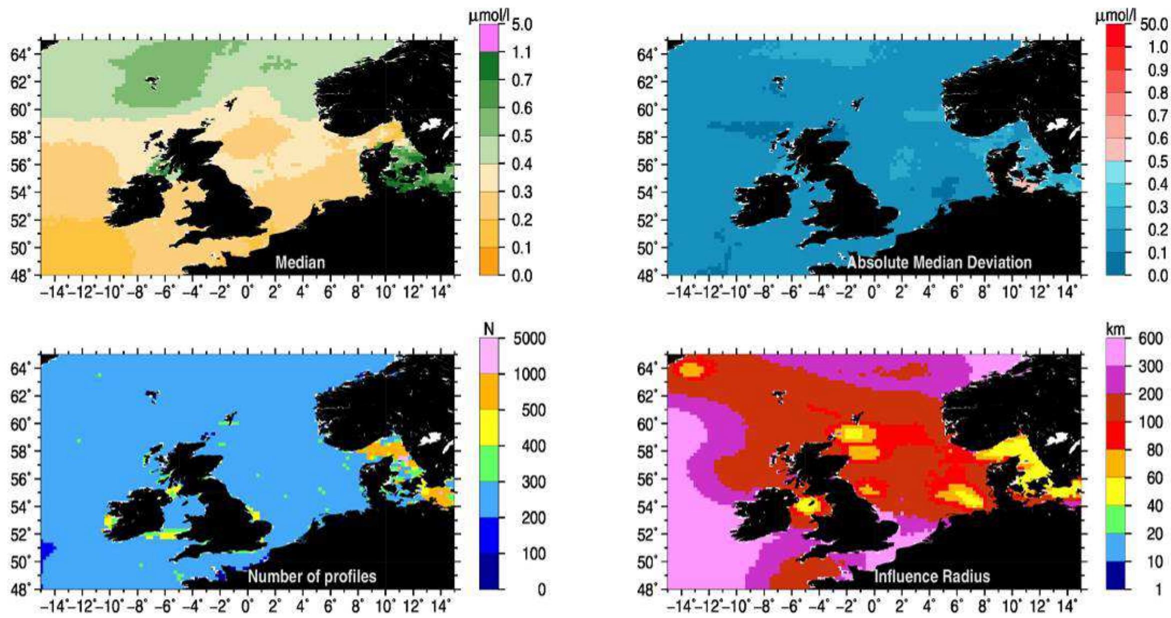

Fig. A6.3: Median phosphate (med), absolute median deviation (amd), number of profiles, influence radius at 15 m depth for January. Climatological salinity limits are defined as (med – 2*amd; med + 2amd)

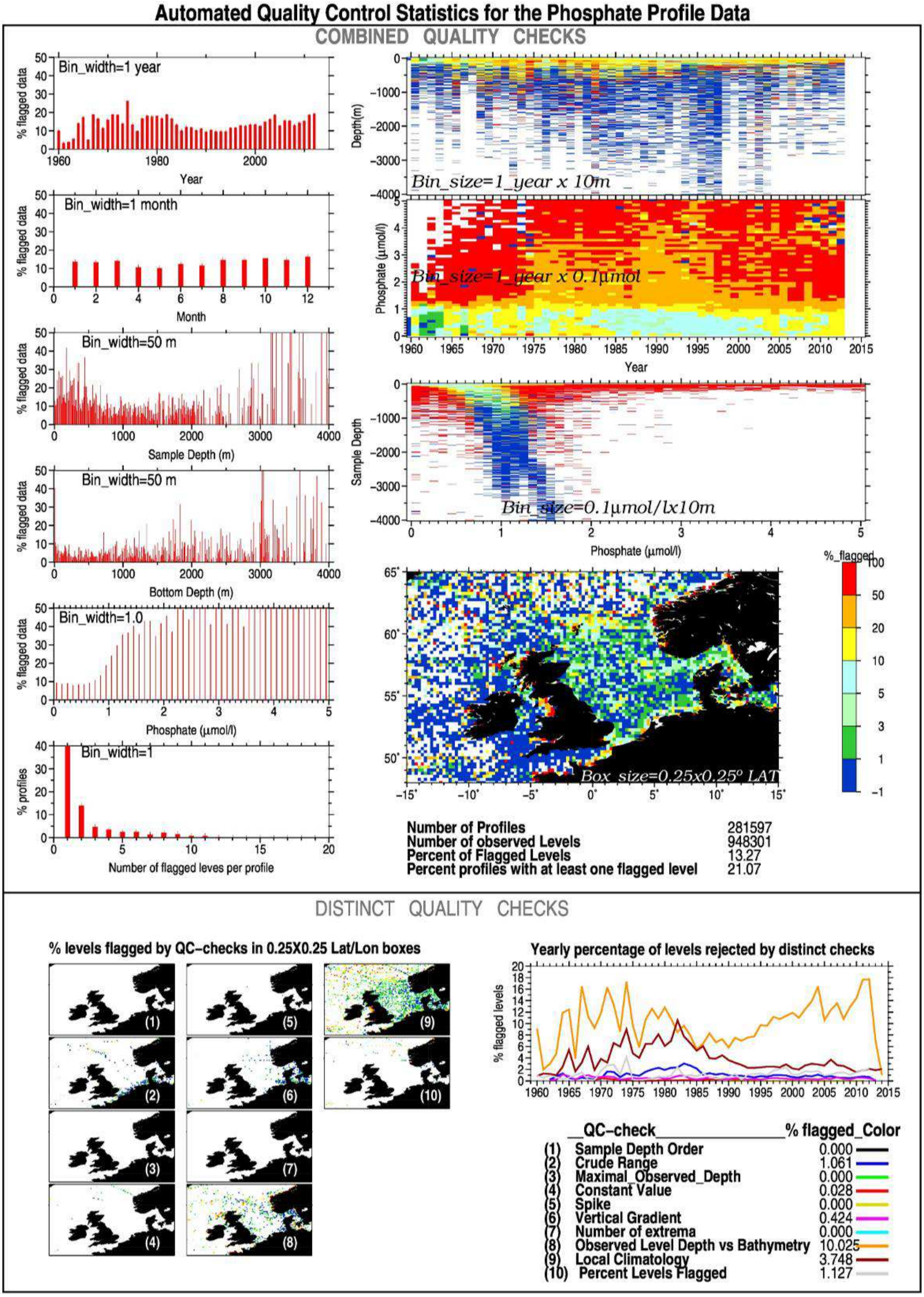

Fig. A6.4: Automated Quality Control Statistics for Phosphate

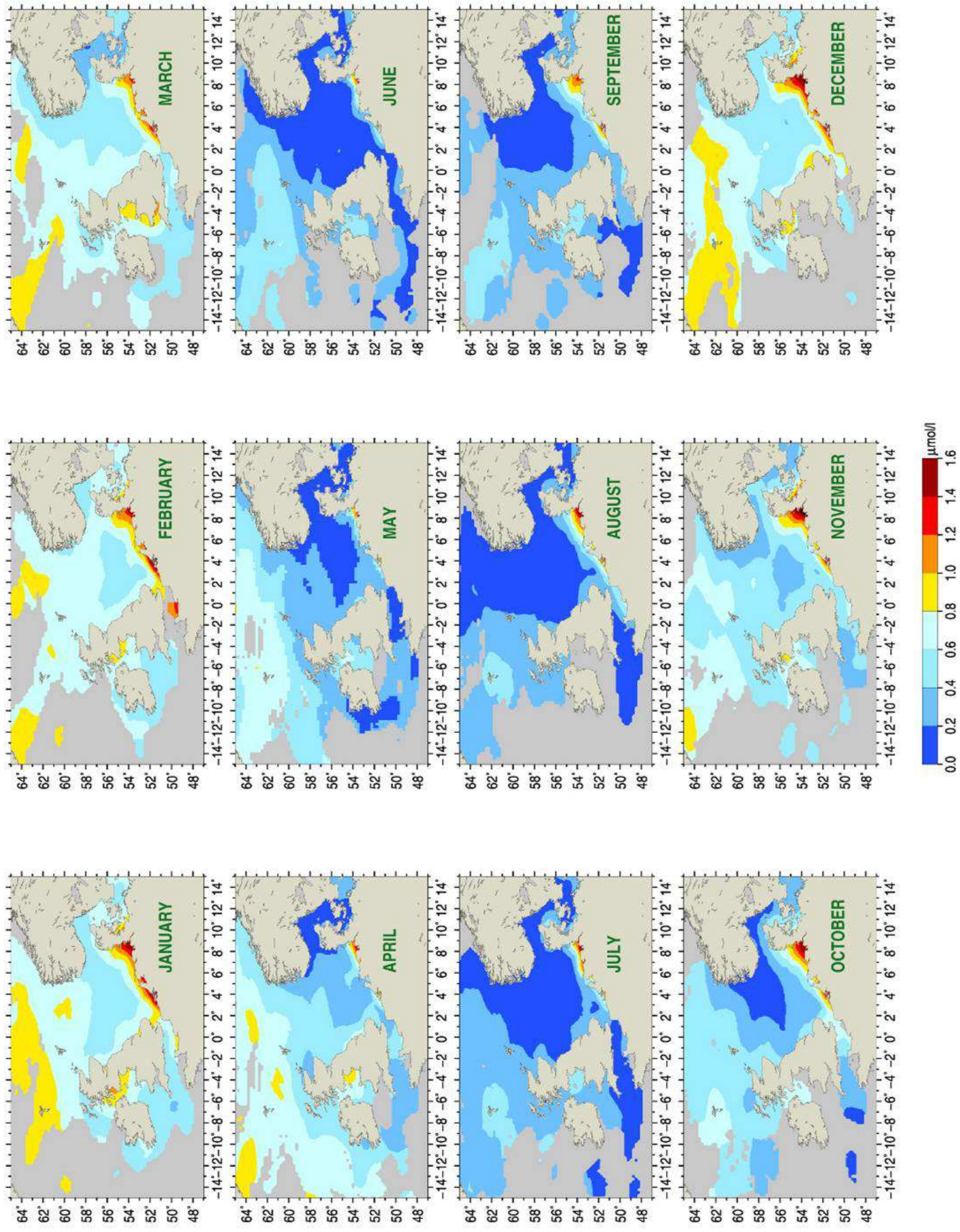

Fig. A6.5: Climatological monthly mean surface phosphate

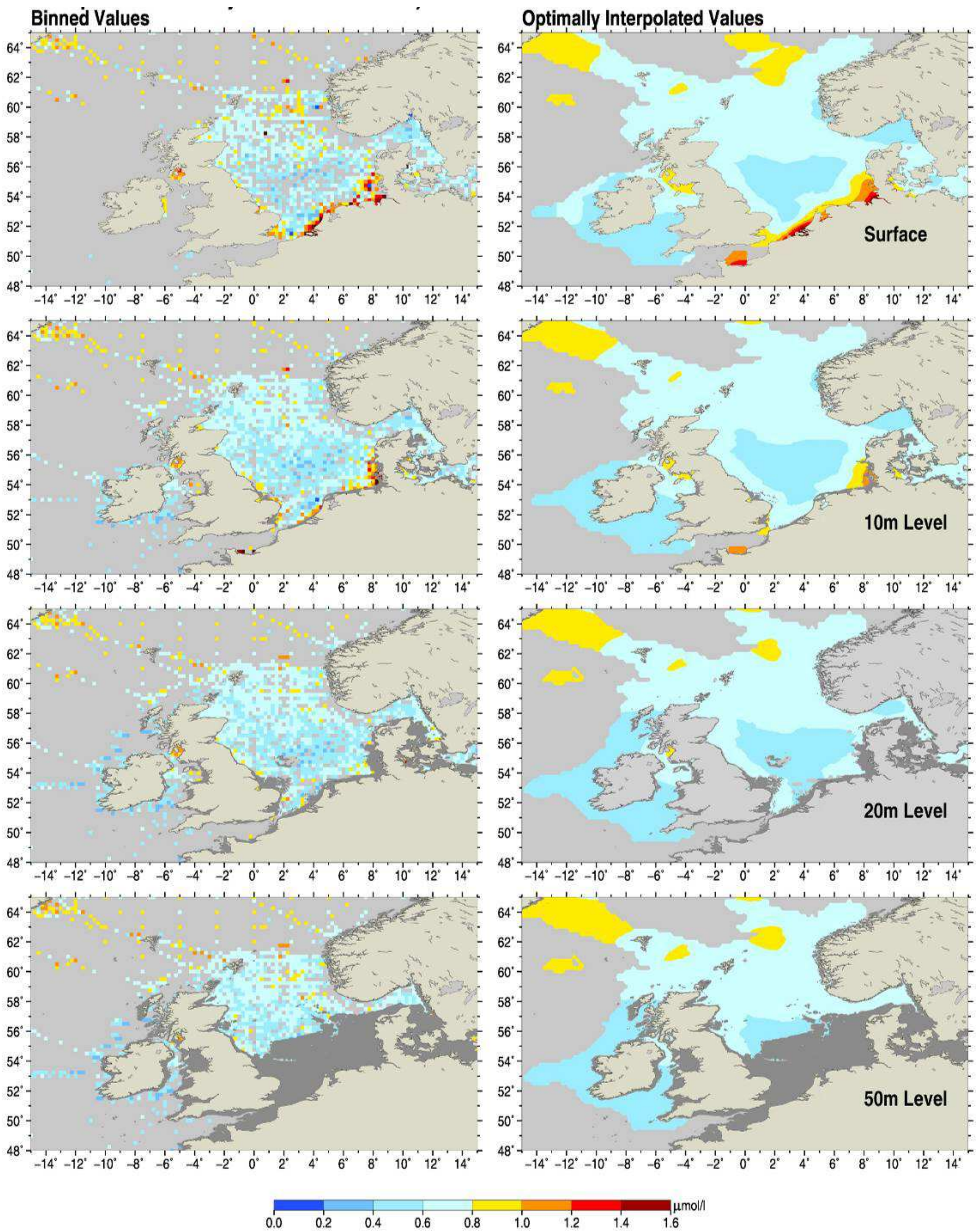

Fig. A6.6: Climatological phosphate distributions at four selected levels in February

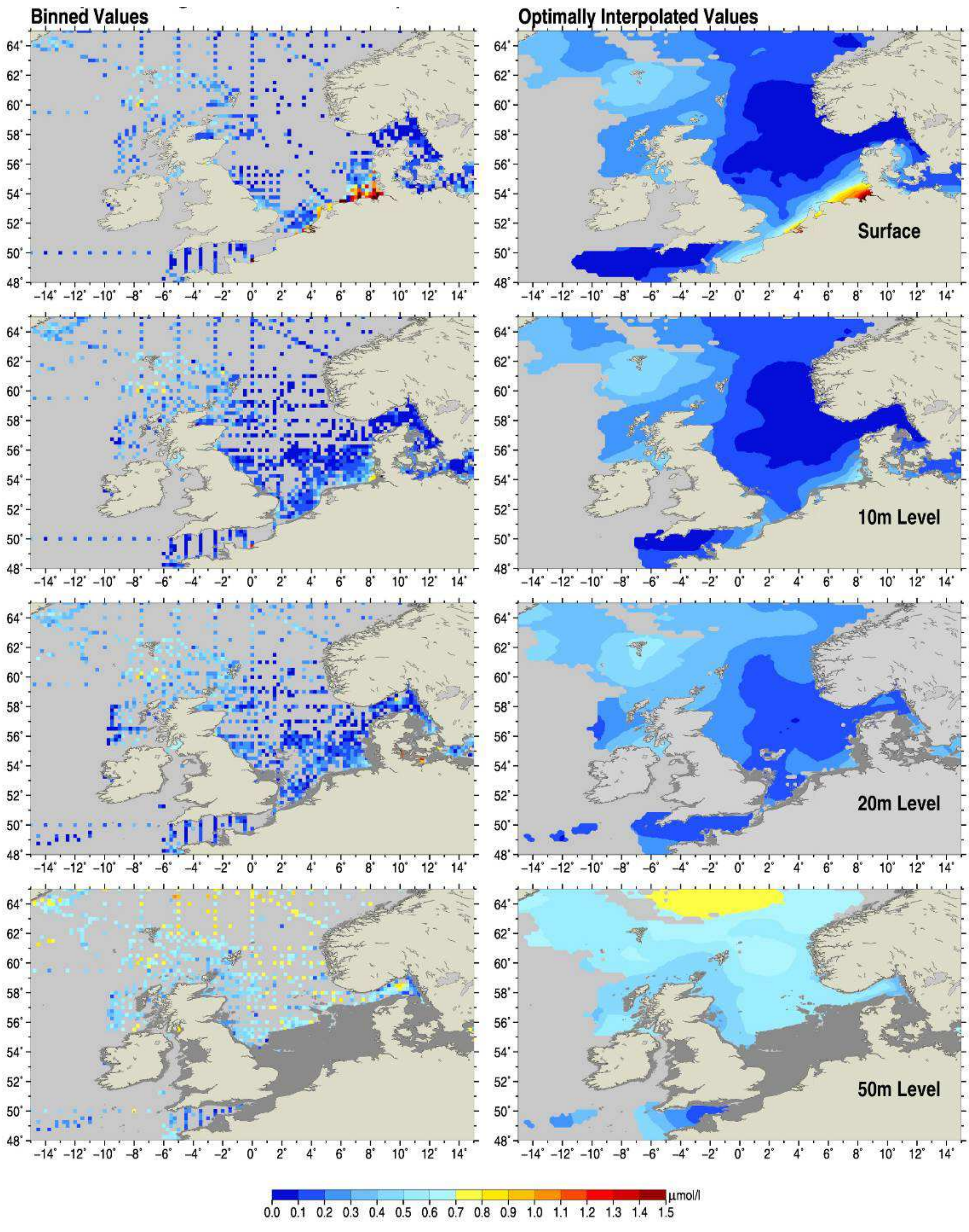

Fig. A6.7: Climatological phosphate distributions at four selected levels in August

Appendix 7 (Silicate)

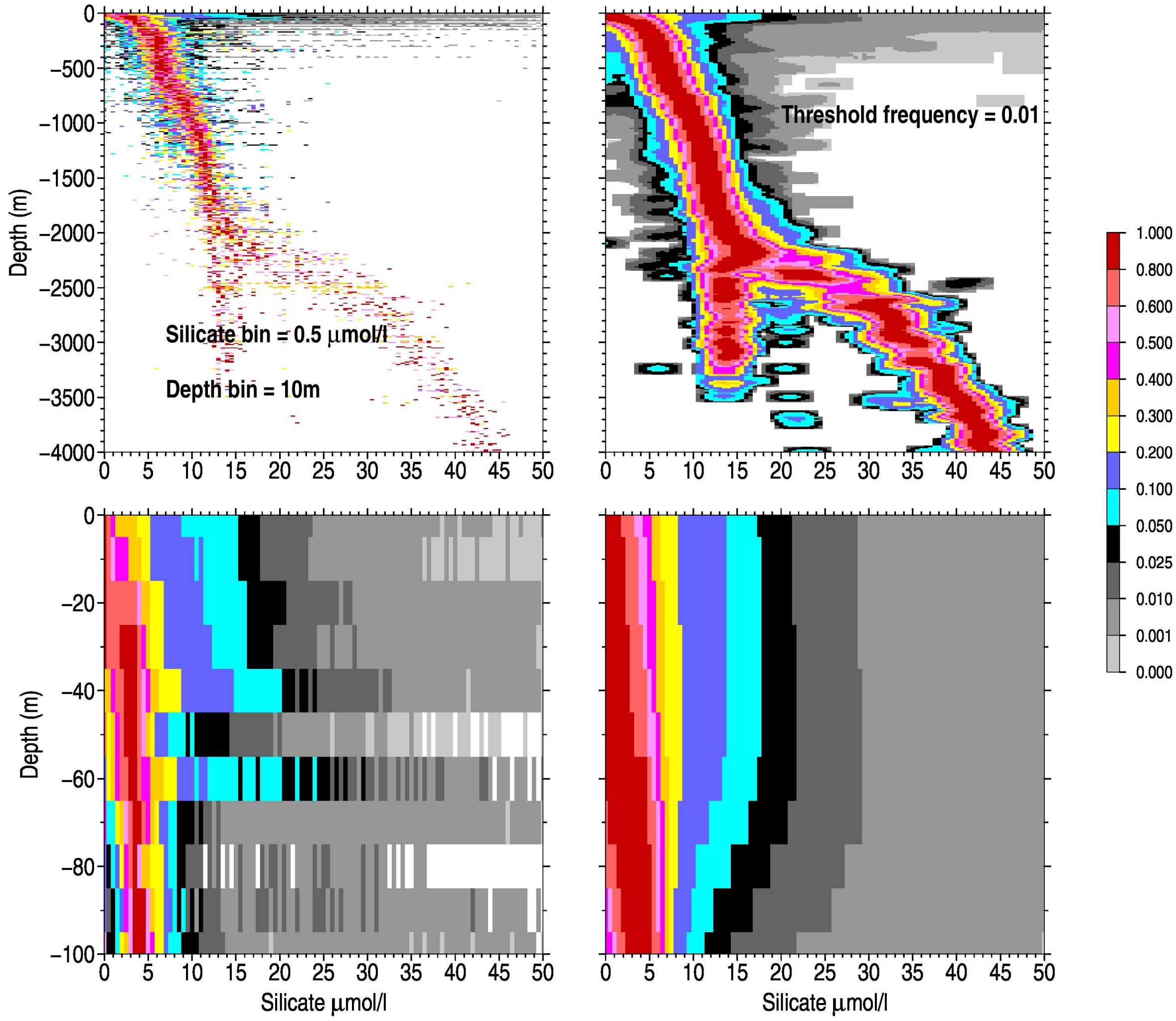

Fig. A 7.1: Normalized silicate depth histogram. For each level the number of observations in each bin is divided by the value for the most populated bin of the same level. Left; unsmoothed histogram, right: histograms smoothed with 11x11 point kernel

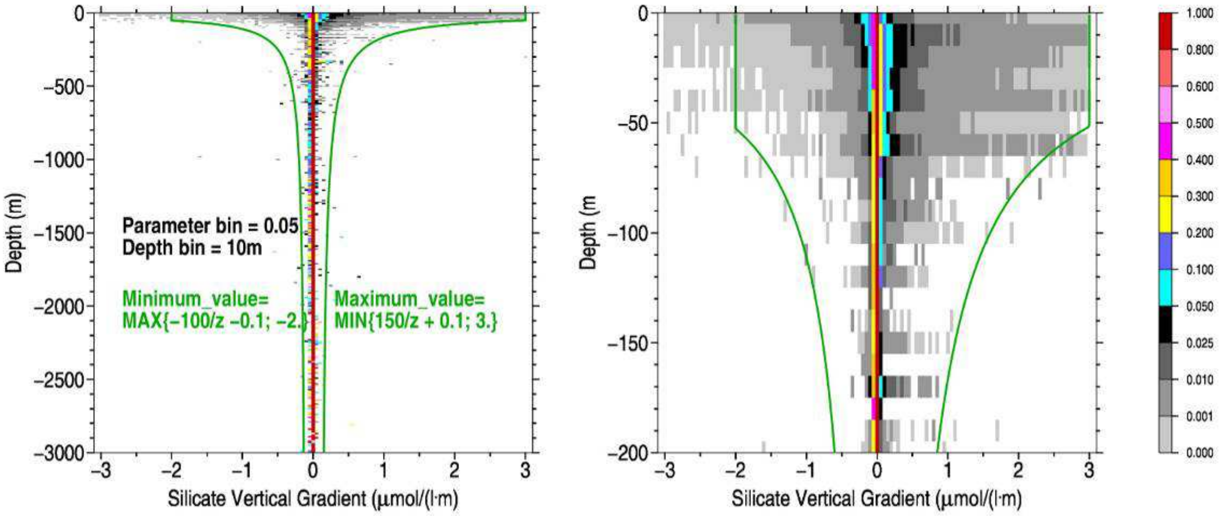

Fig. A7.2: Normalized silicate vertical gradient histogram. For each level the original number of the data in each bin is divided by the value for the most populated bin. The min-max vertical gradient limits shown in green are approximated by the reciprocal function of depth

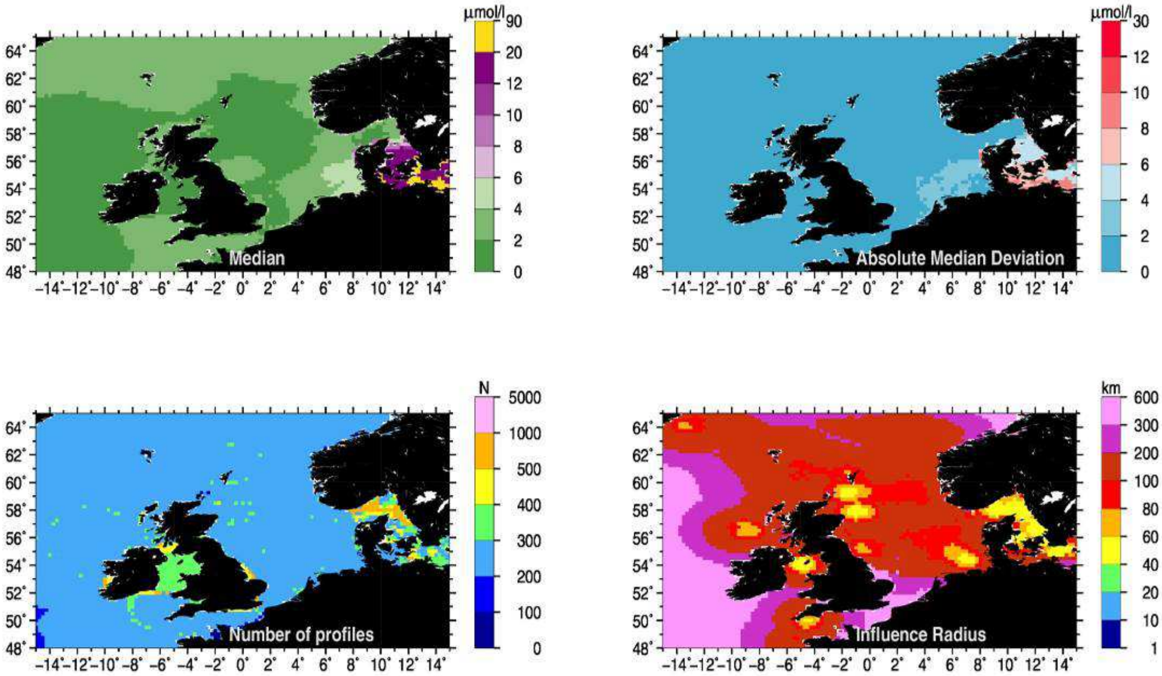

Fig. A7.3: Median silicate (Silmed), absolute median deviation (Silamd), number of profiles, influence radius at 15 m depth for January. Climatological salinity limits are defined as (Silmed – 2*Silamd; Silmed + 2Silamd)

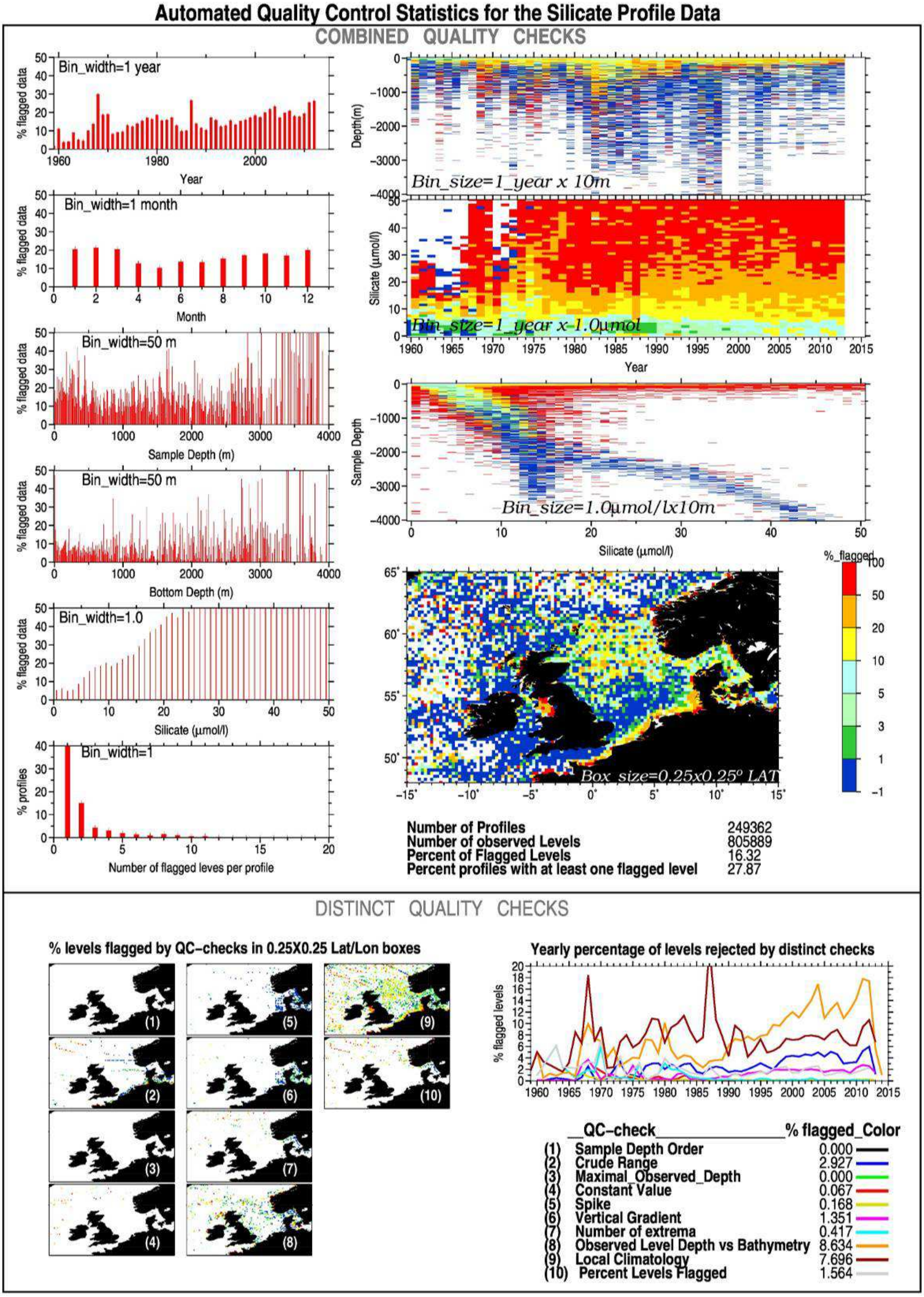

Fig. A7.4: Automated Quality Control Statistics for Silicate

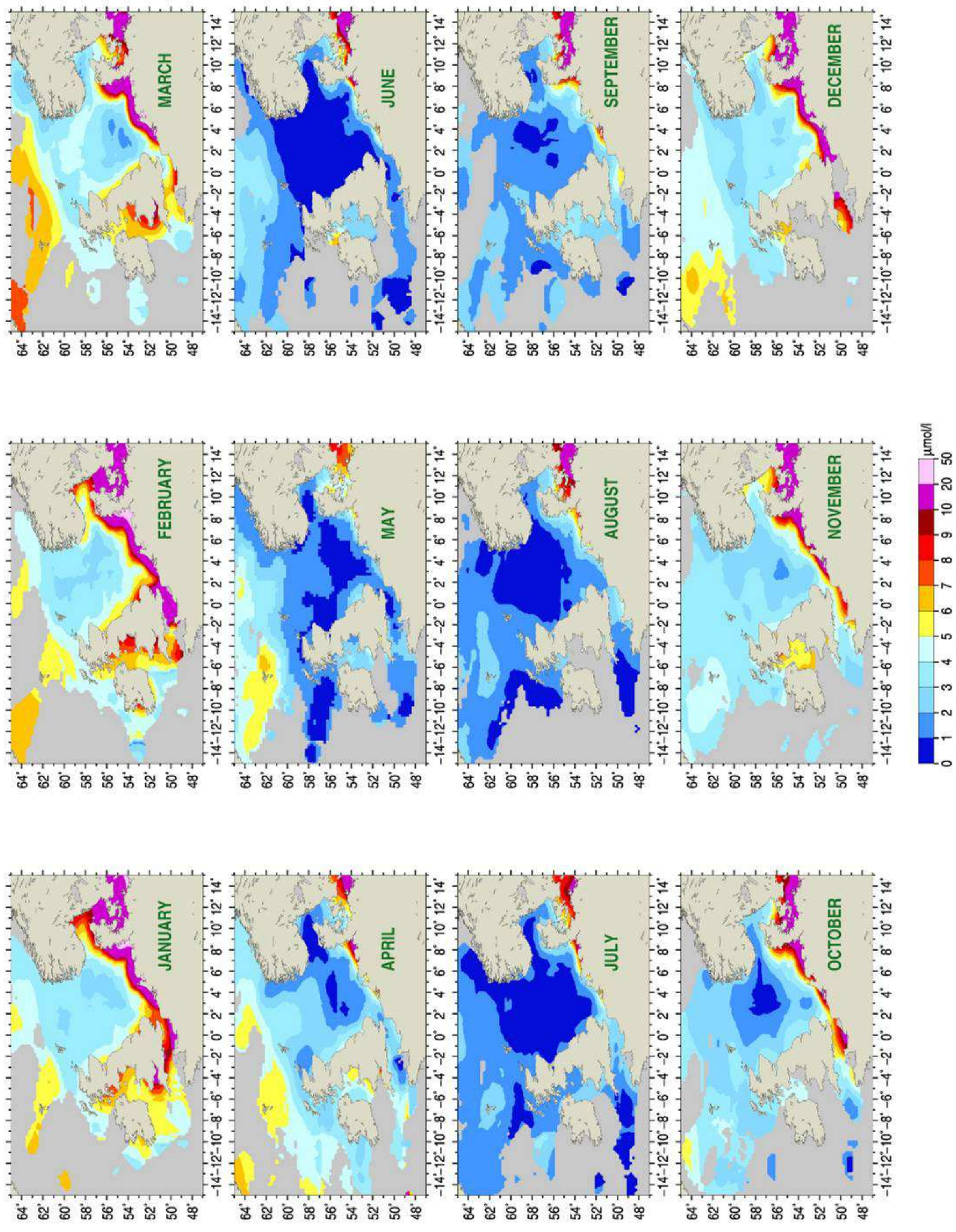

Fig. A7.5: Climatological monthly mean surface silicate

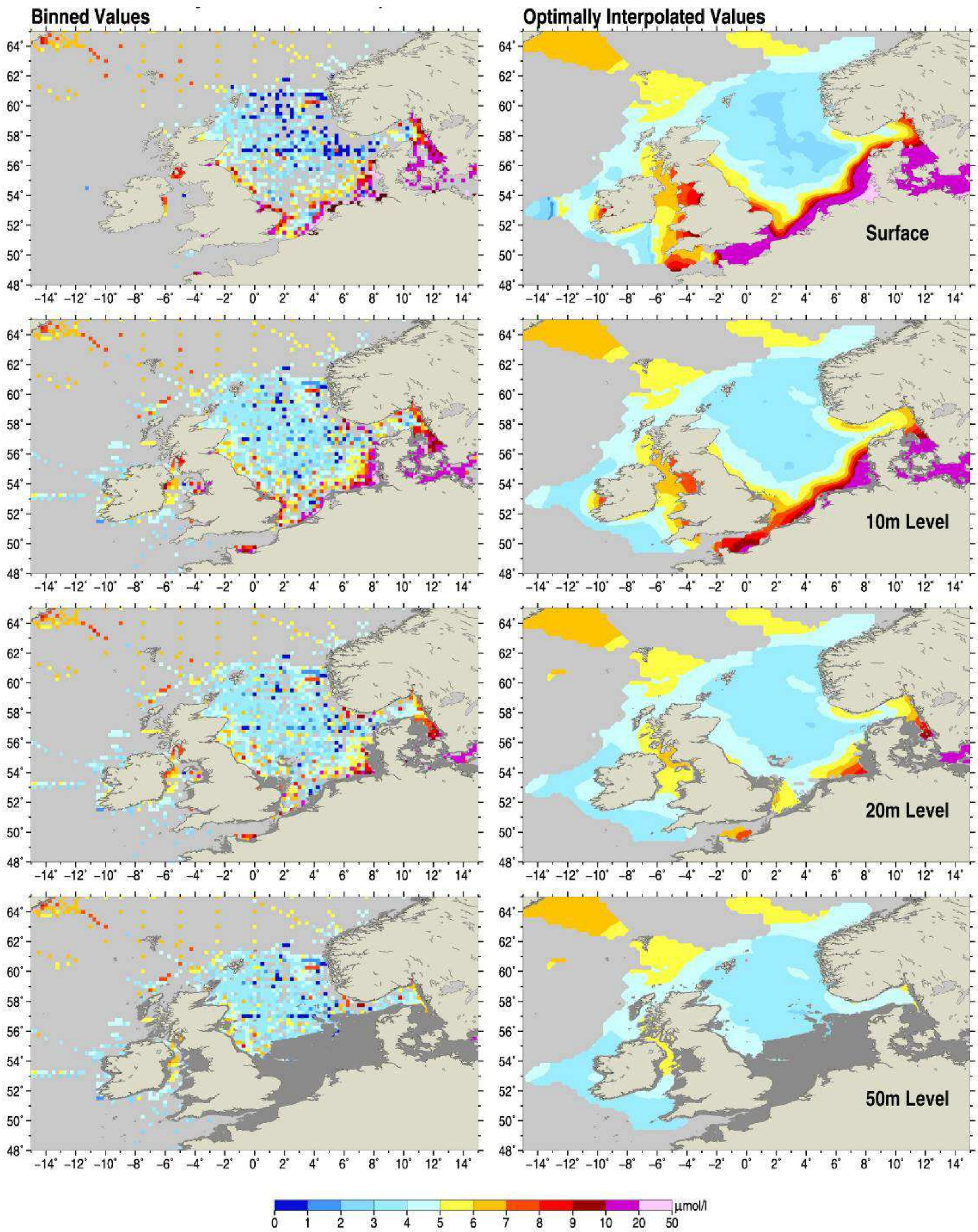

Fig. A7.6: Climatological silicate distributions at four selected levels in February

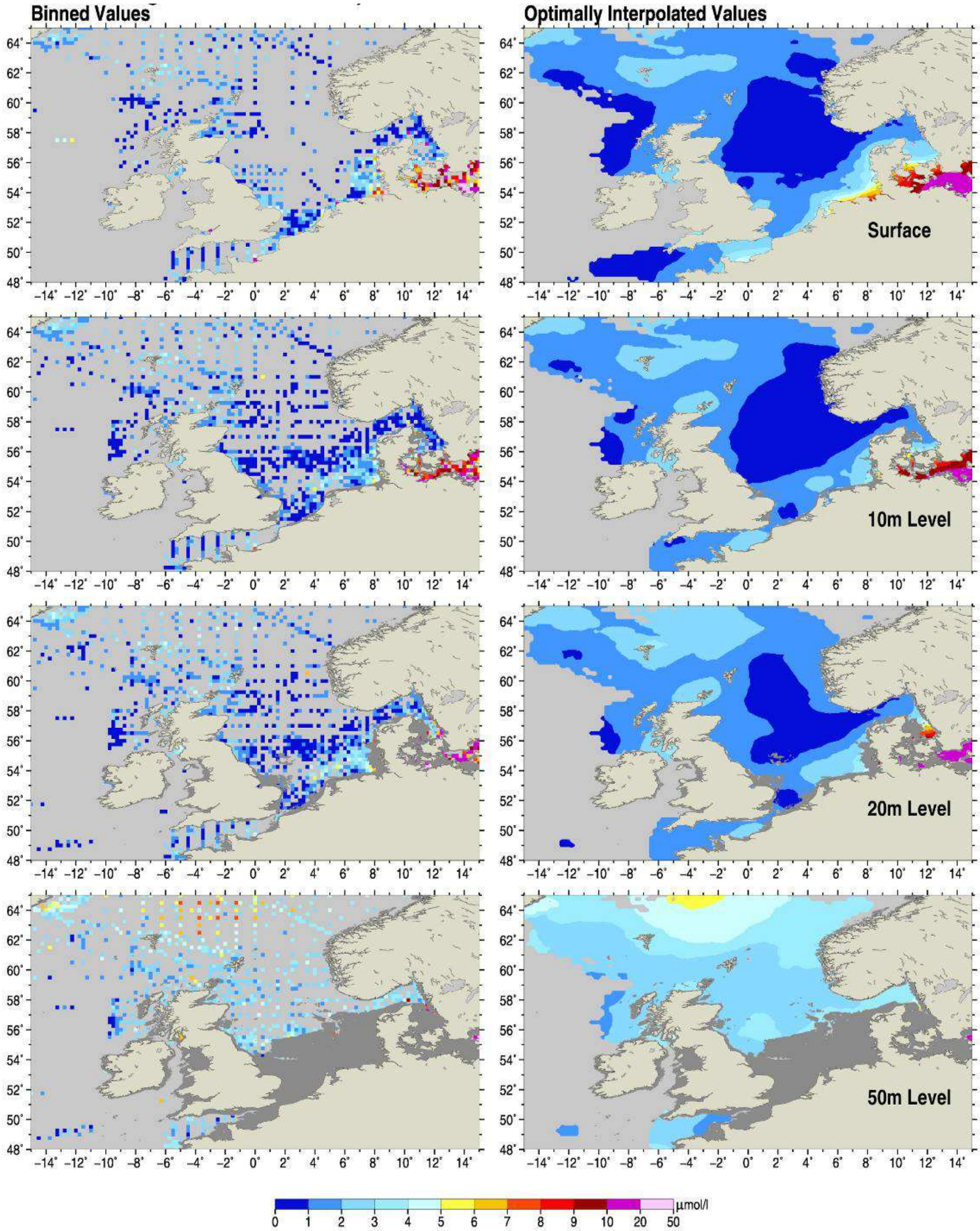

Fig. A7.7: Climatological silicate distributions at four selected levels in August

Appendix 8 (Ammonium)

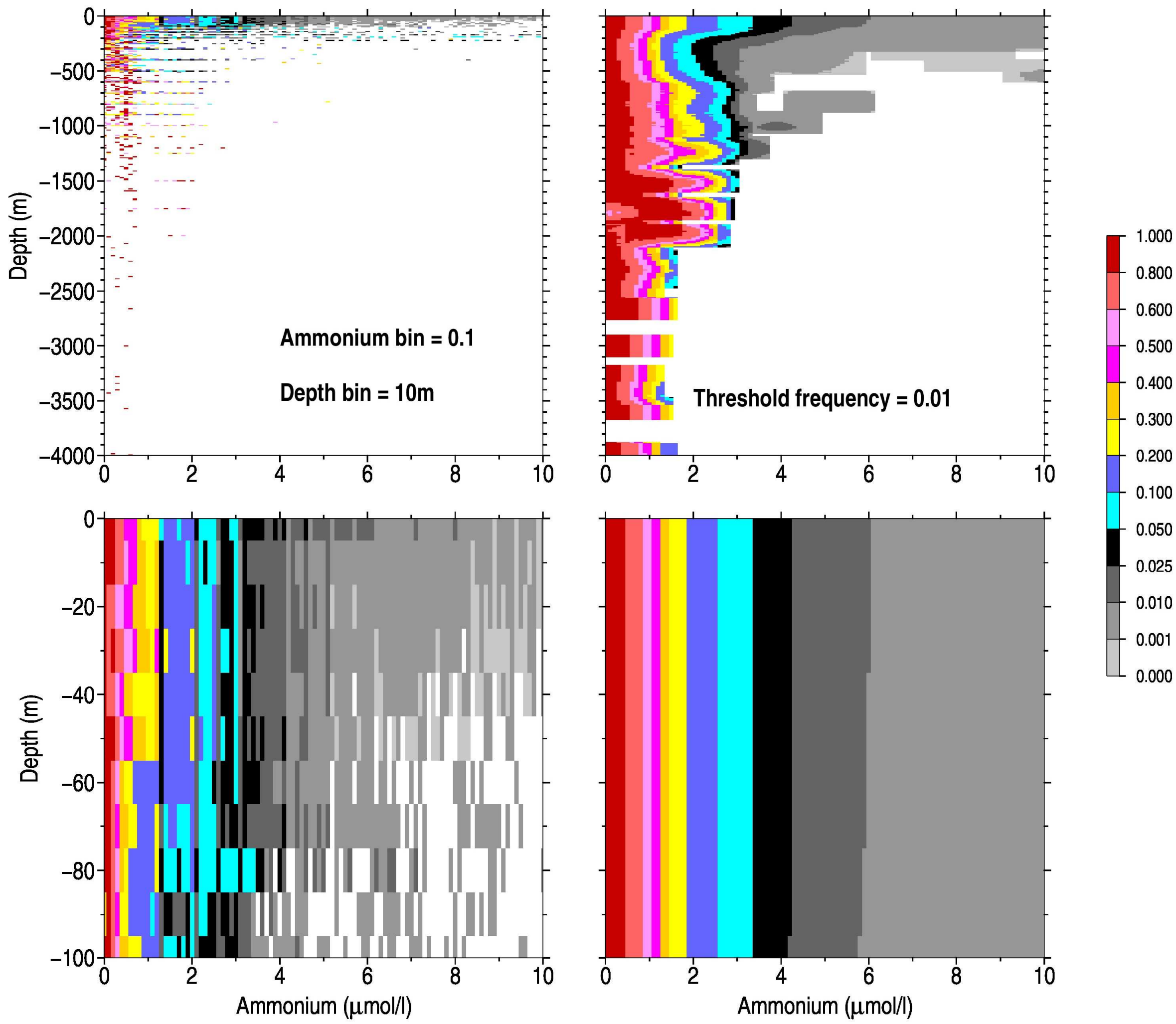

Fig. A8.1: Normalized ammonium depth histogram. For each level the number of observations in each bin is divided by the value for the most populated bin of the same level. Left; unsmoothed histogram, right: histograms smoothed with 11x11 point kernel

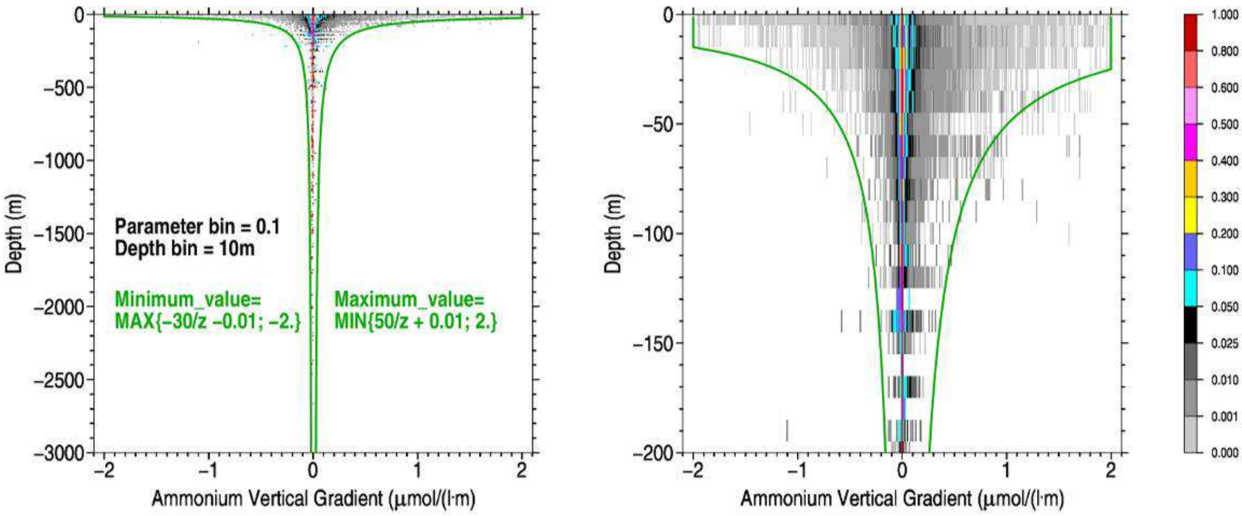

Fig. A8.2: Normalized ammonium vertical gradient histogram. For each level the original number of the data in each bin is divided by the value for the most populated bin. The min-max vertical gradient limits shown in green are approximated by the reciprocal function of depth

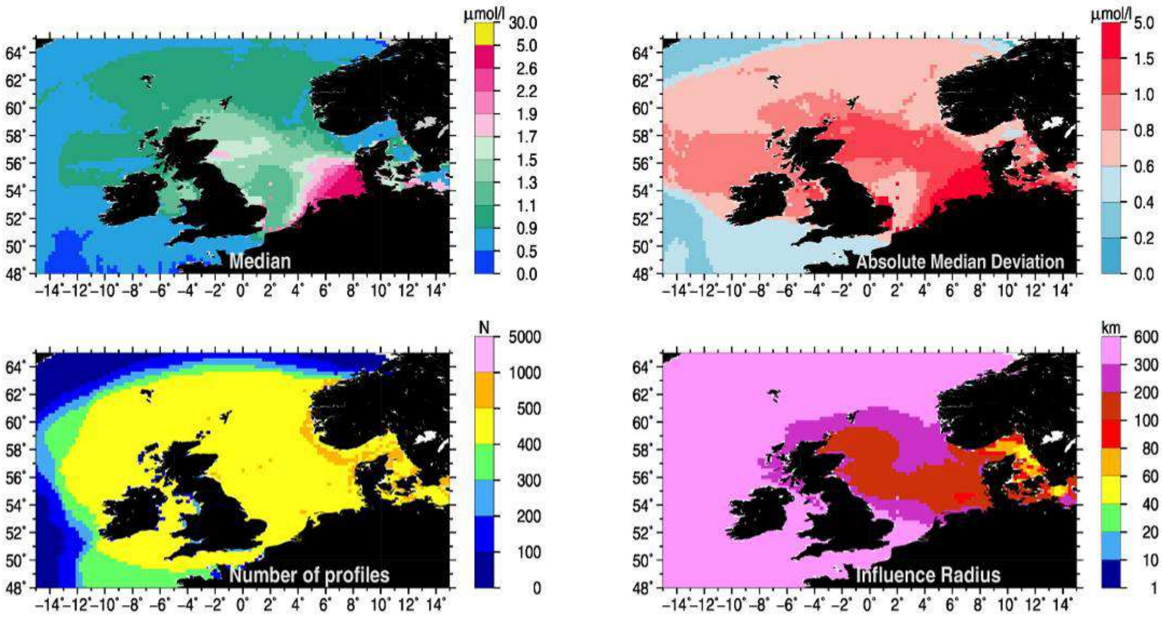

Fig. A8.3: Median ammonium (AMMmed), absolute median deviation (AMMamd), number of profiles, influence radius at 15 m depth for January. Climatological salinity limits are defined as (AMMmed – 2*AMMamd; AMMmed + 2AMMamd)

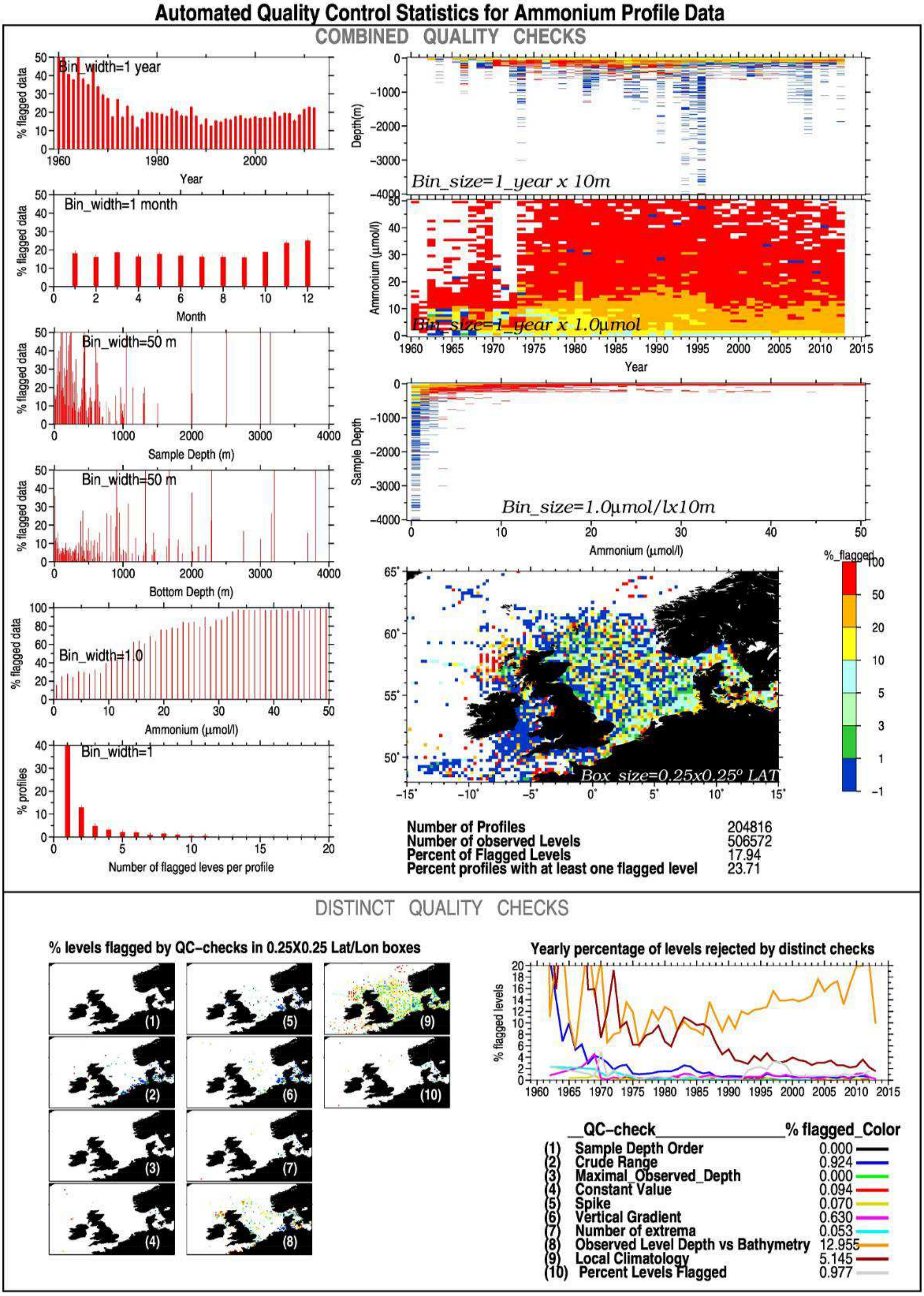

Fig. A 8.4: Automated Quality Control Statistics for Ammonium

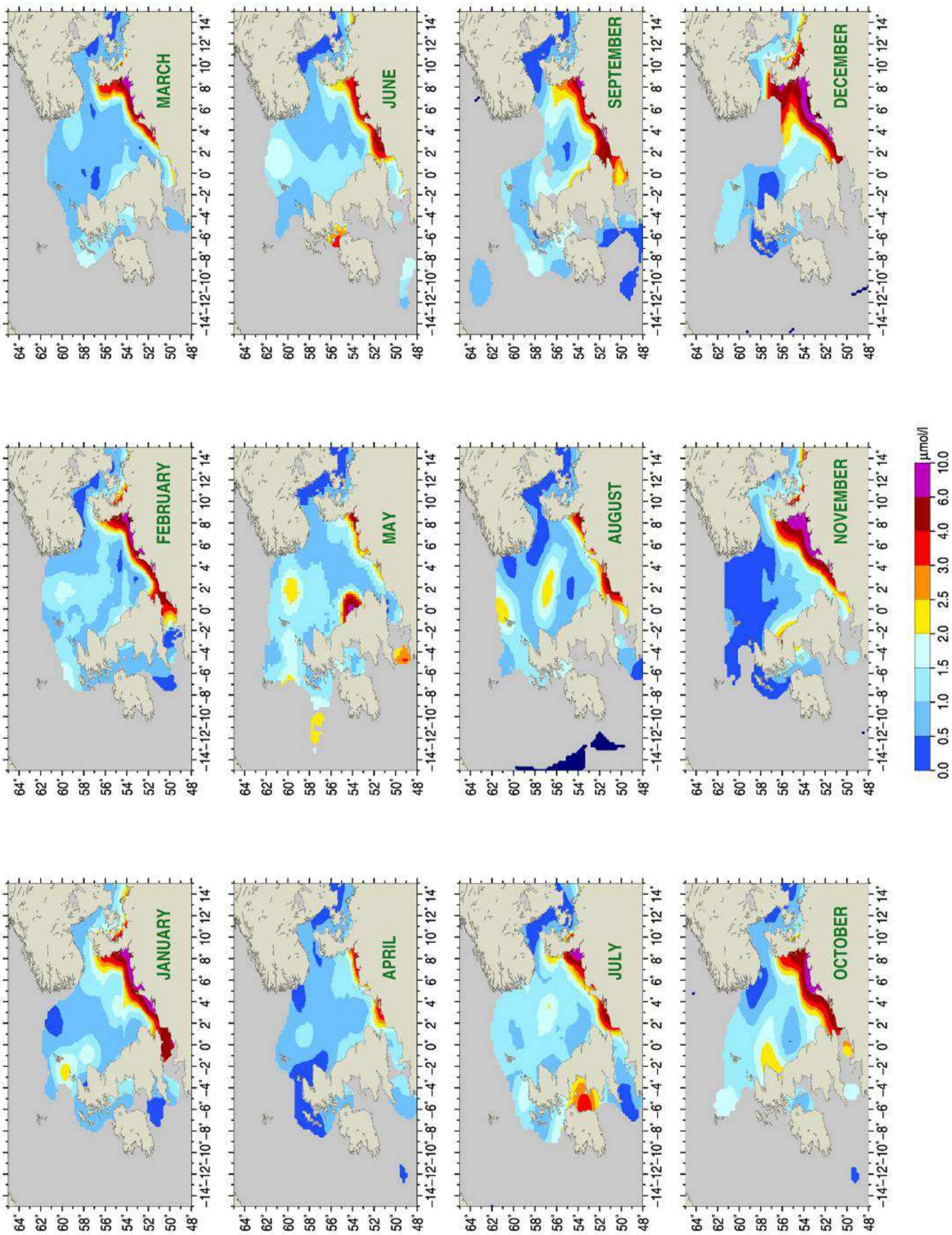

Fig. A8.5: Climatological monthly mean surface Ammonium

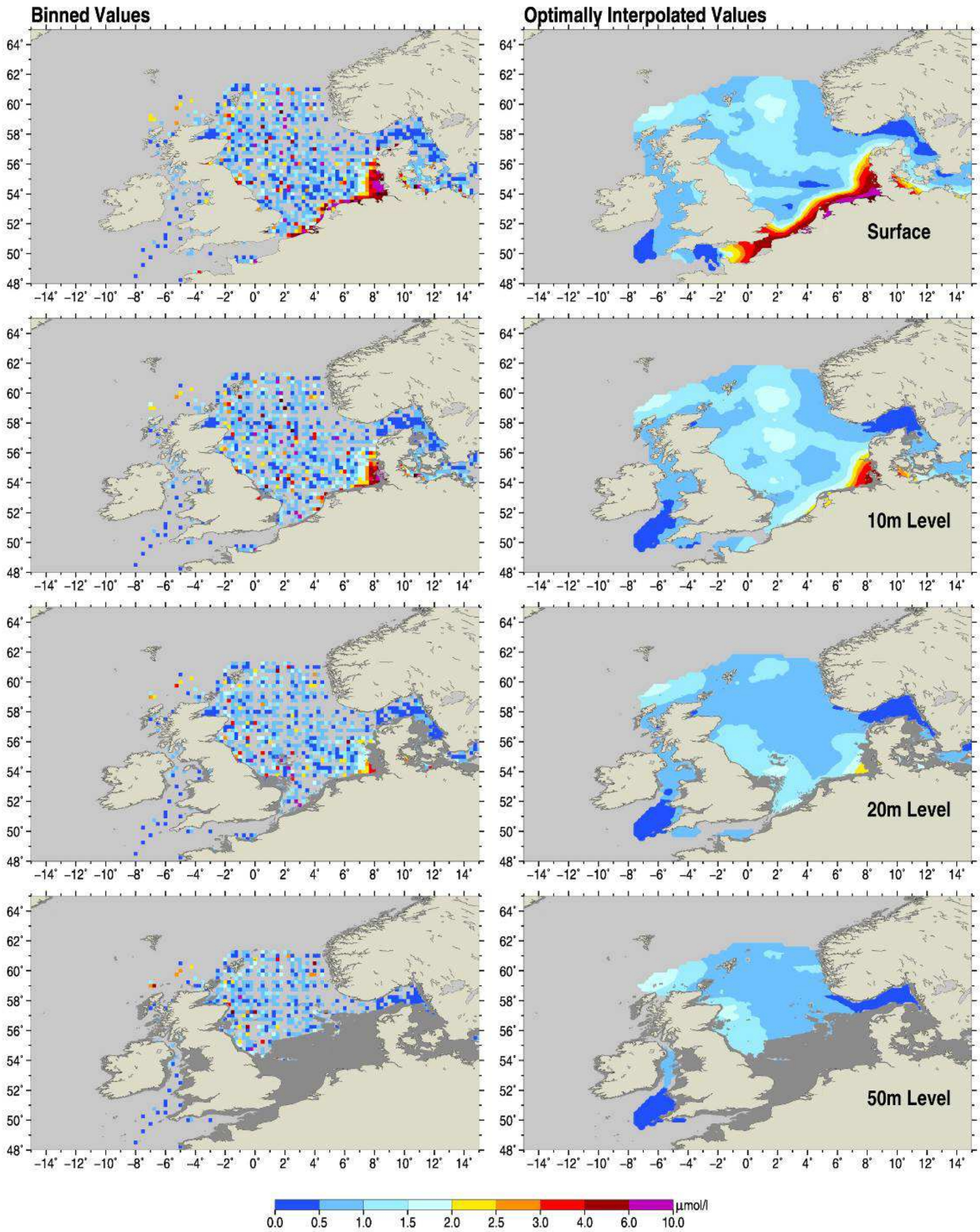

Fig. A8.6: Climatological ammonium distributions at four selected levels in February

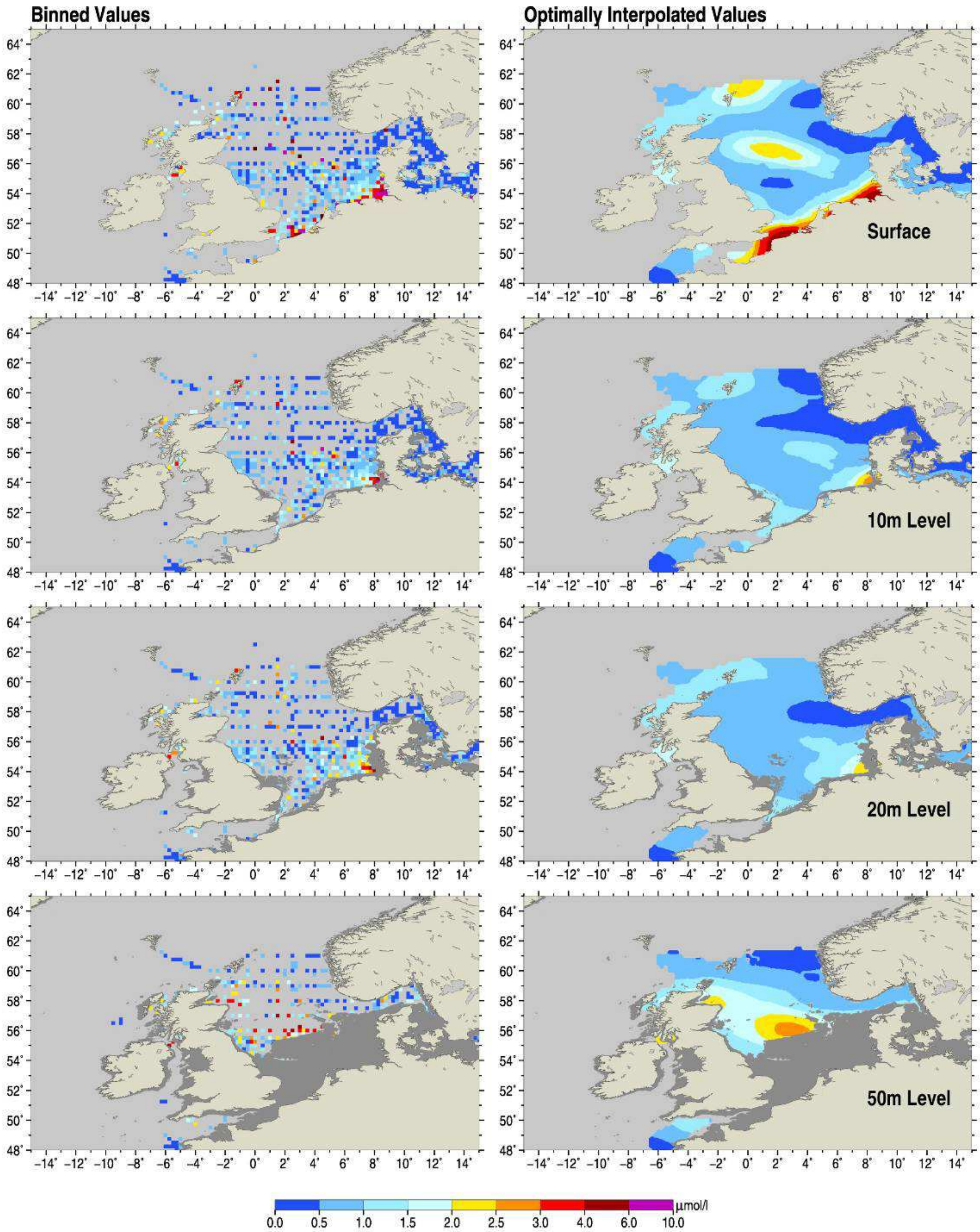

Fig. A8.7: Climatological ammonium distributions at four selected levels in August

Appendix 9 (Chlorophyll-a)

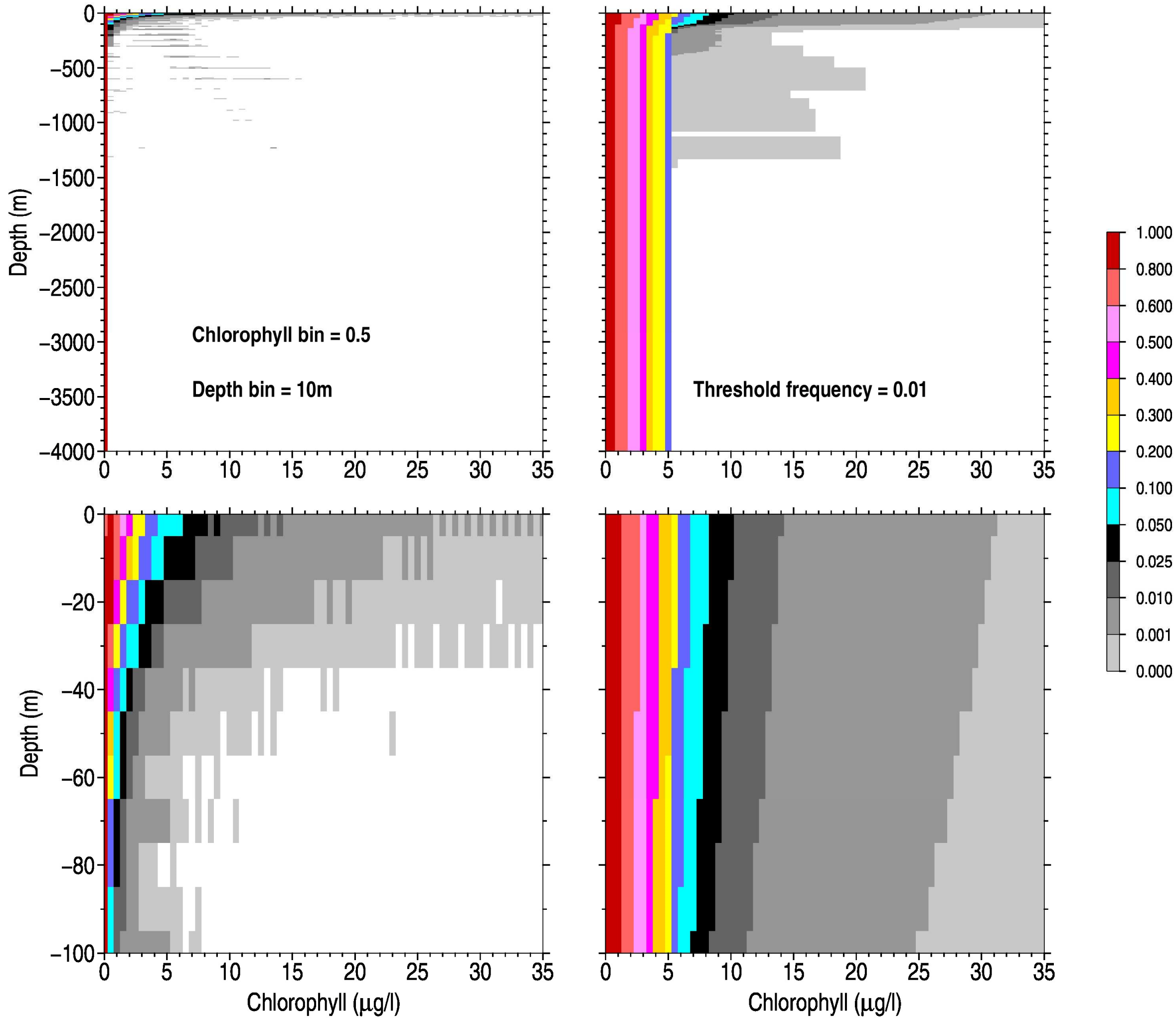

Fig. A9.1: Normalized chlorophyll depth histogram. For each level the number of observations in each bin is divided by the value for the most populated bin of the same level. Left; unsmoothed histogram, right: histograms smoothed with 11x11 point kernel

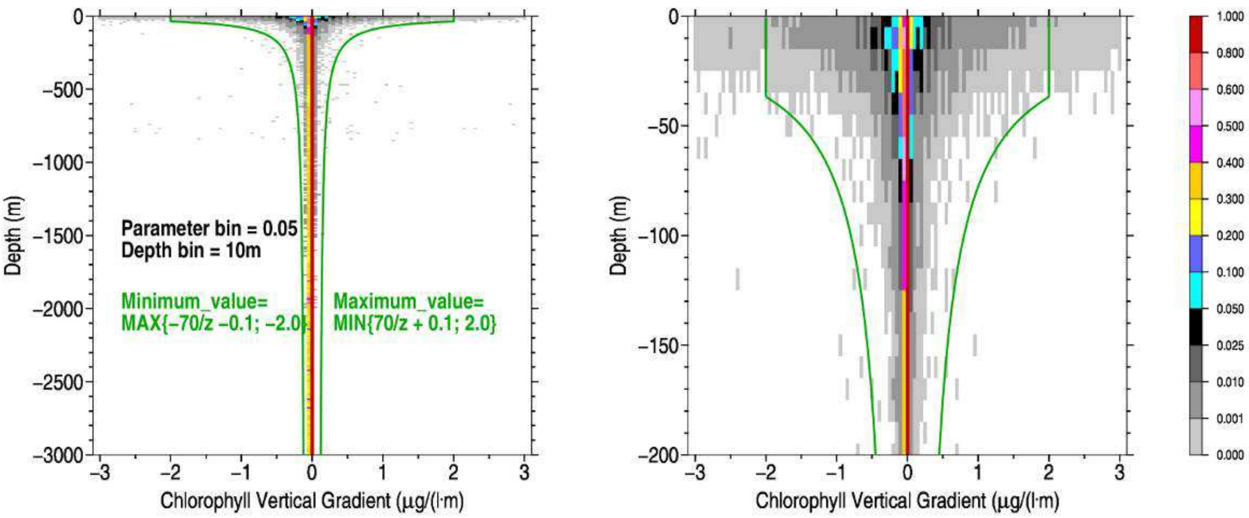

Fig. A9.2: Normalized chlorophyll vertical gradient histogram. For each level the original number of the data in each bin is divided by the value for the most populated bin. The min-max vertical gradient limits shown in green are approximated by the reciprocal function of depth

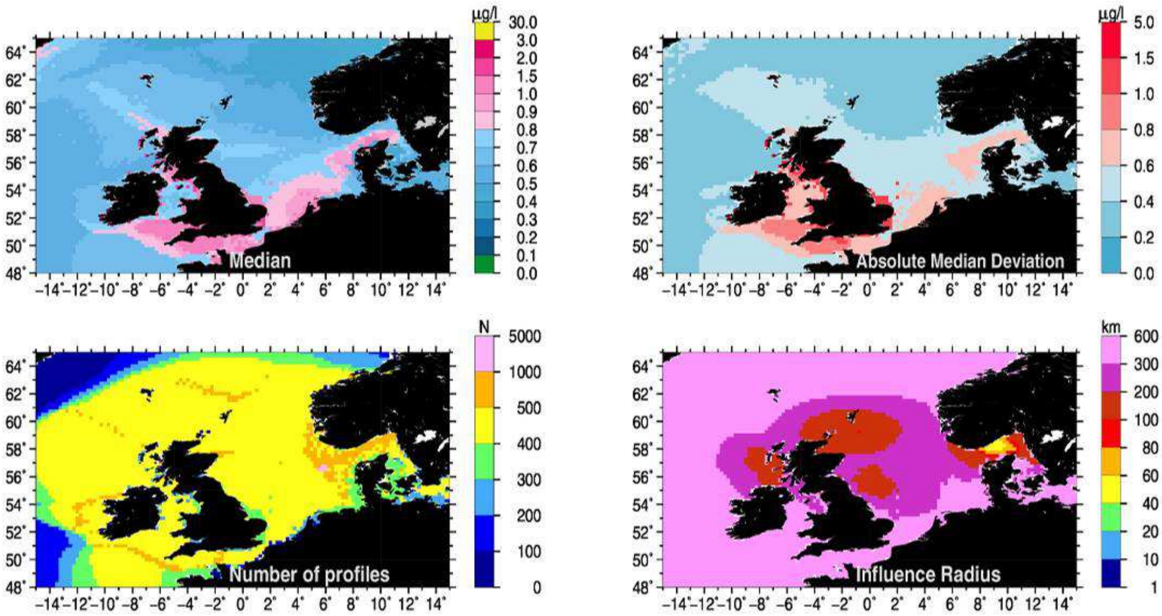

Fig. A9.3: Median chlorophyll (CHmed), absolute median deviation (CHamd), number of profiles, influence radius at 15 m depth for January. Climatological salinity limits are defined as (CHmed – 2*CHamd; CHmed + 2CHamd)

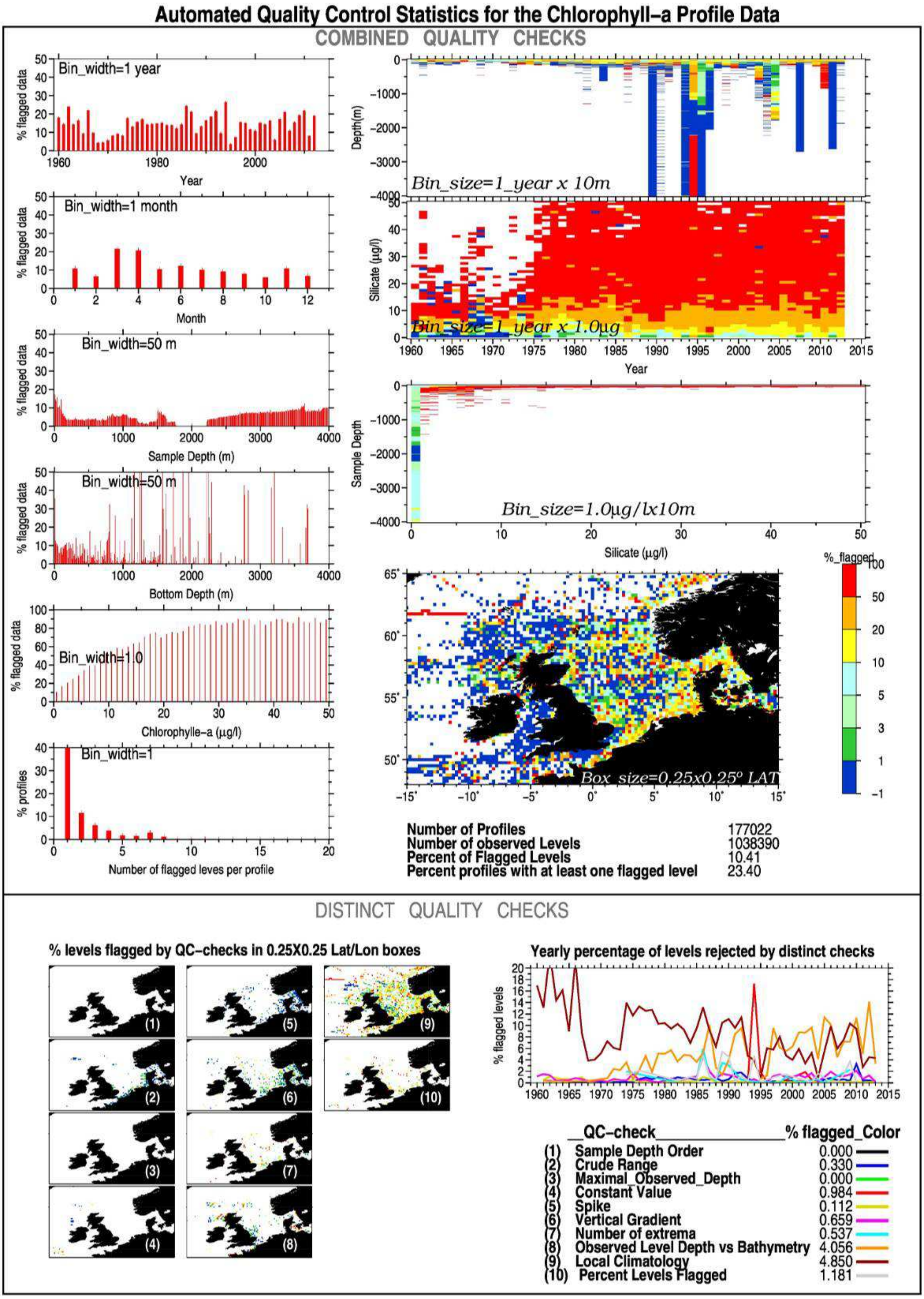

Fig. A9.4: Automated Quality Control Statistics for Chlorophyll

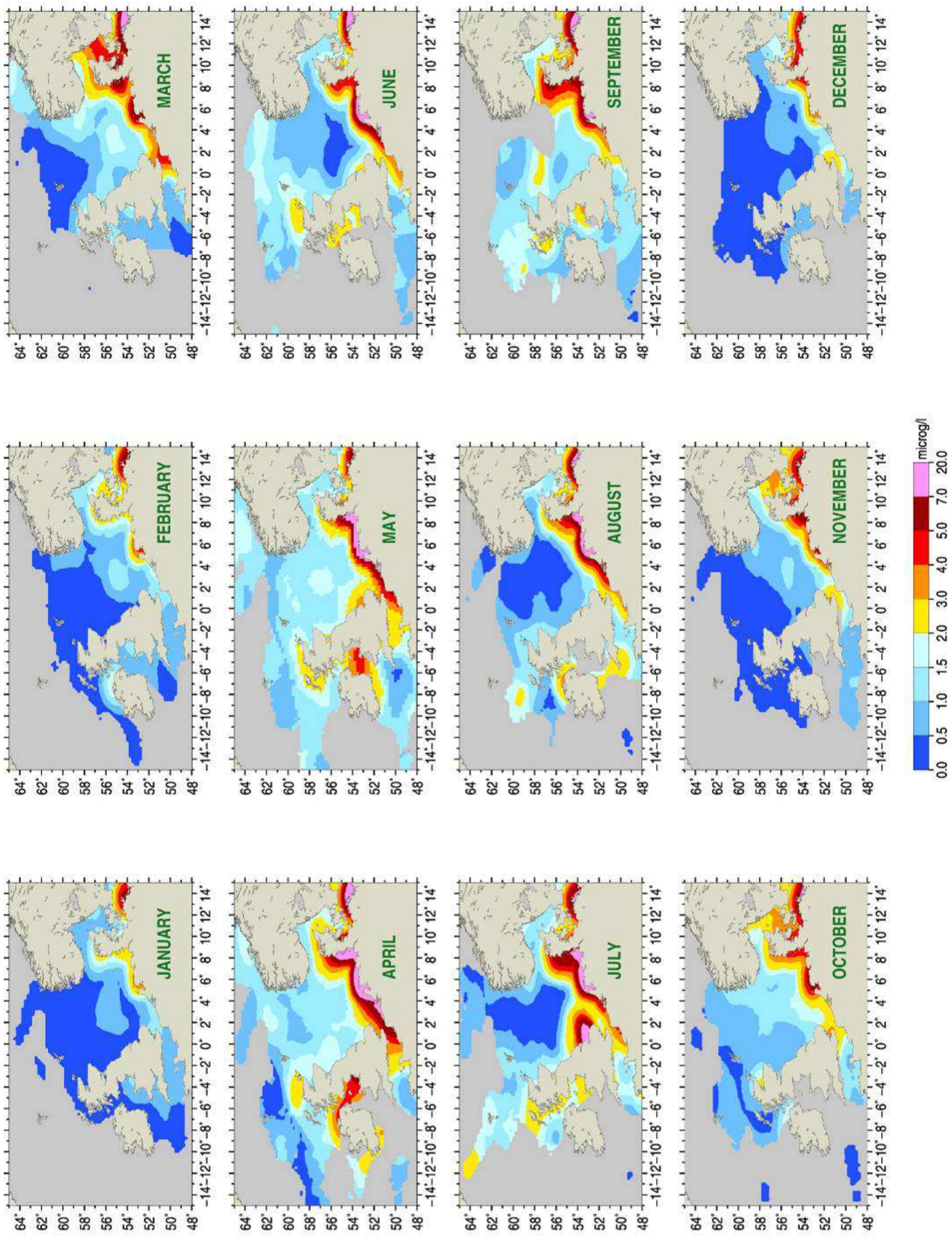

Fig. A9.5: Climatological monthly mean surface chlorophyll

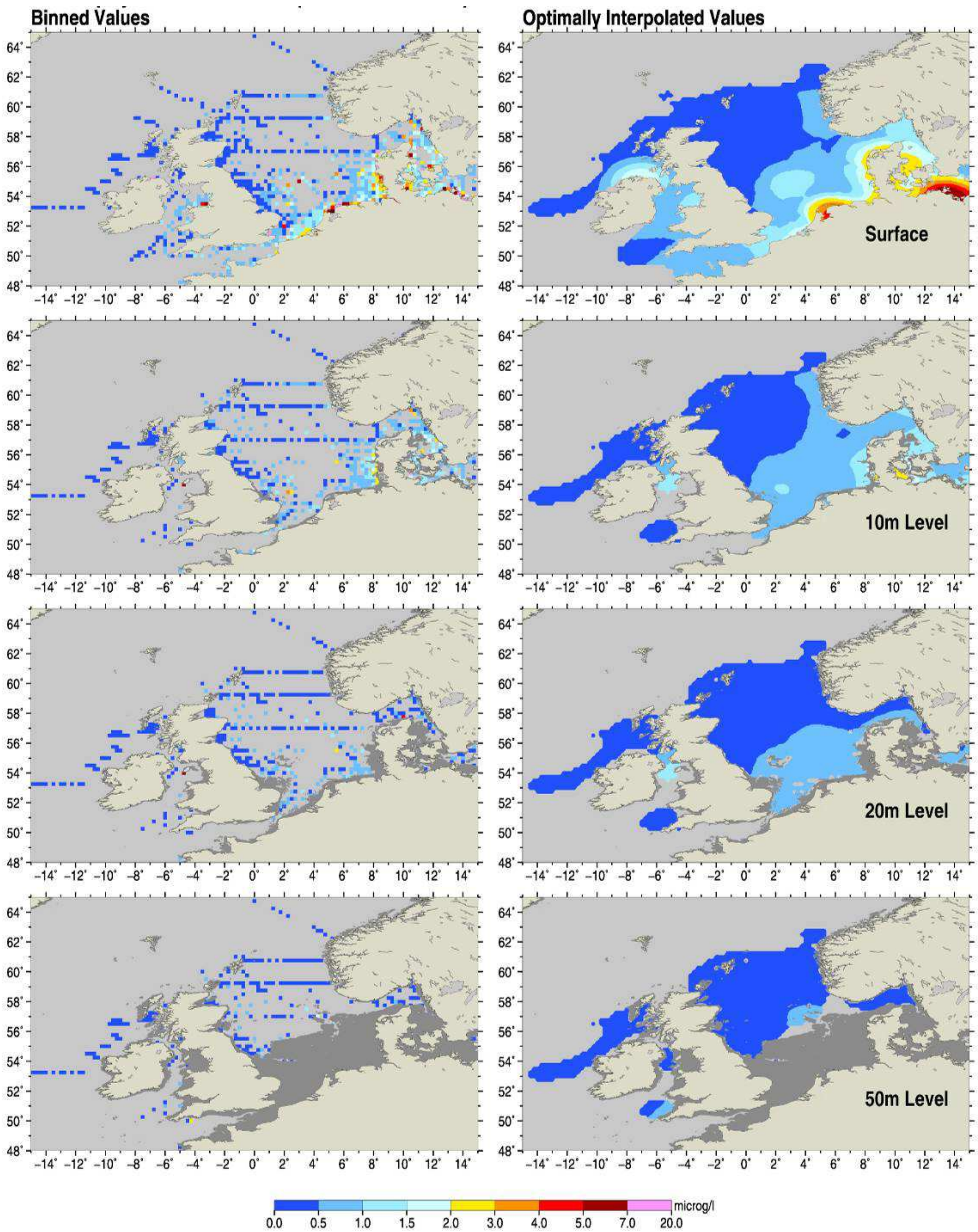

Fig. A9.6: Climatological chlorophyll distributions at four selected levels in February

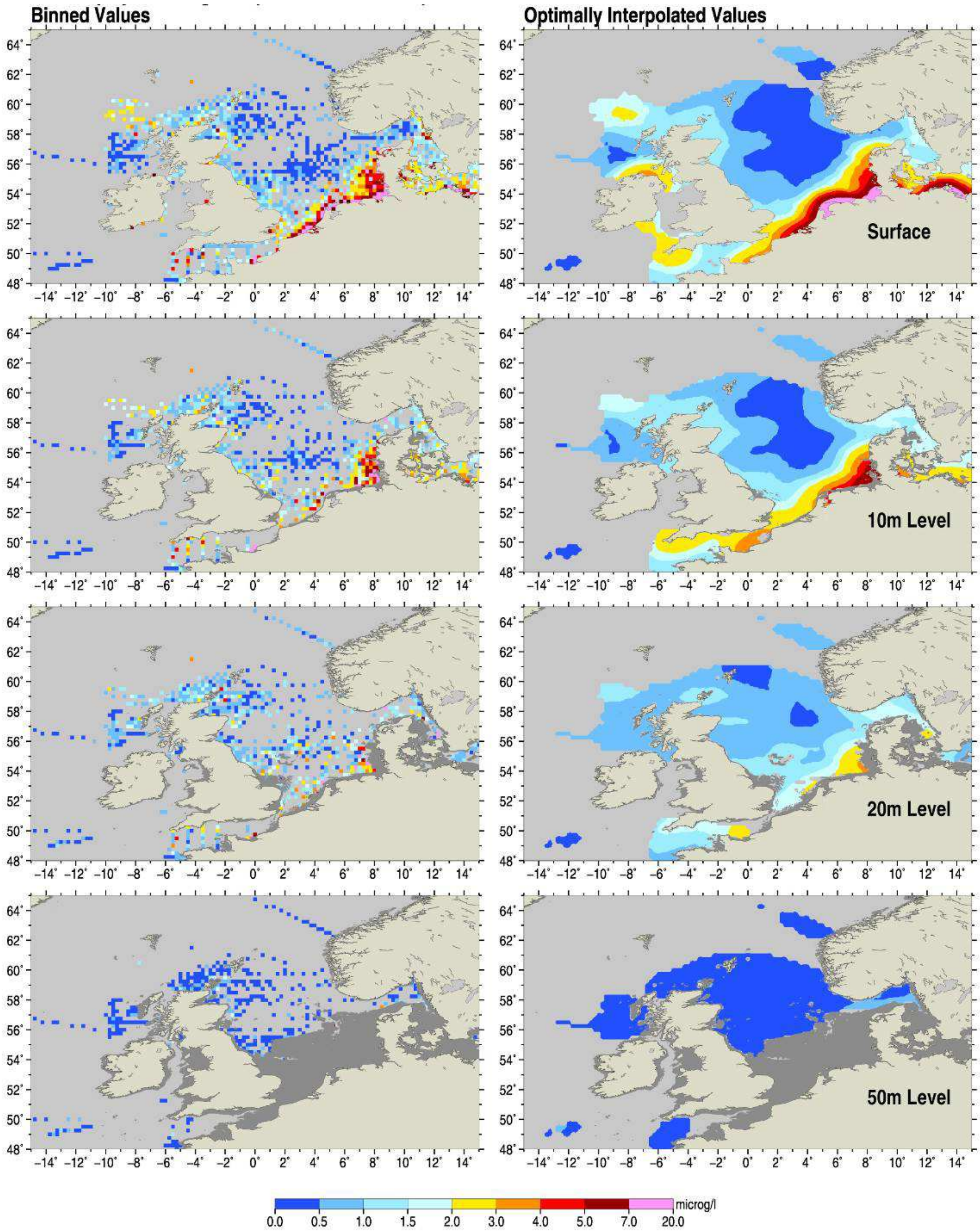

Fig. A9.7: Climatological chlorophyll distributions at four selected levels in August

Appendix 10 (Near bottom distributions)

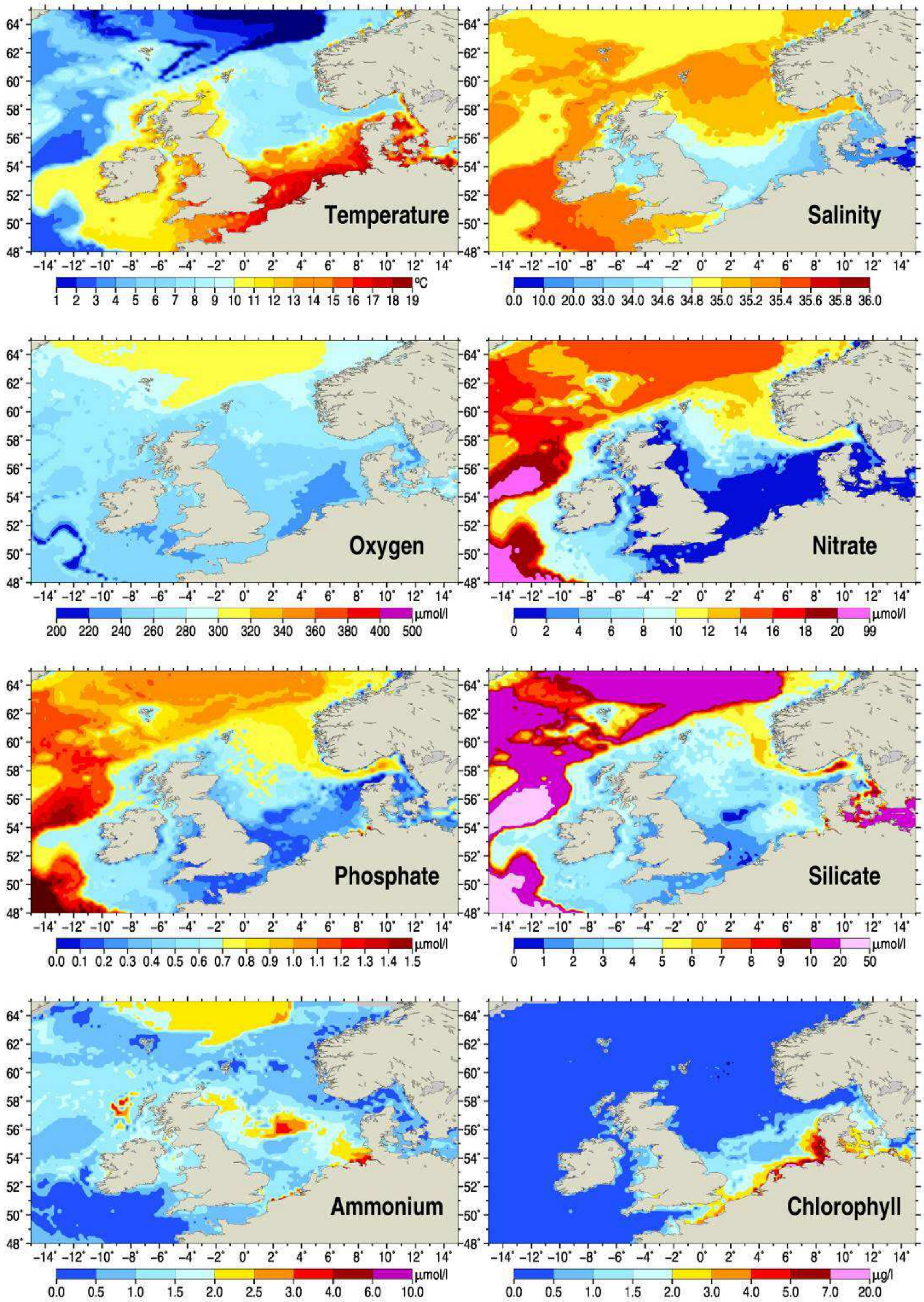

Fig. A10.1: Parameter near-bottom distributions. The values on the standard level nearest to the bottom are used to produce the maps. Above 100 m the August values are taken, the annual mean values are used for the deeper levels.

Appendix 11   (Time series numerical values)

Table A11.1:Monthly time series of the averaged parameter values. Averaging is done over the area [2W-10E; 51-65N] and is based on the optimally interpolated fields

1	2	3	4	5	6	7	8	9	10
Level (m)	**Month**	**Temperature**	**Salinity**	**Oxygen**	**Nitrate**	**Phosphate**	**Silicate**	**Ammonium**	**Chlorophyll**
0.	1	6.643	34.064	300.354	10.776	0.702	6.033	2.099	0.761
0.	2	5.678	34.032	299.768	11.338	0.706	6.529	1.872	0.923
0.	3	5.481	33.952	314.570	10.592	0.646	5.562	1.532	1.795
0.	4	6.799	33.815	325.142	7.289	0.423	2.582	1.071	2.772
0.	5	9.122	33.622	304.551	3.454	0.251	1.460	1.427	2.559
0.	6	12.346	33.499	285.838	1.406	0.210	1.281	1.483	1.867
0.	7	14.456	33.512	270.770	0.825	0.241	1.548	1.672	2.368
0.	8	15.902	33.676	260.360	0.827	0.232	1.582	1.278	1.775
0.	9	14.286	33.845	257.319	1.439	0.296	2.221	1.779	2.260
0.	10	12.606	33.845	261.478	3.075	0.403	3.399	2.089	1.699
0.	11	9.845	33.968	271.118	5.776	0.549	4.424	1.974	1.225
0.	12	8.321	34.082	285.410	8.524	0.661	5.372	2.685	0.823
20.	1	7.047	34.664	296.808	7.200	0.593	3.957	1.247	0.443
20.	2	6.164	34.673	295.535	7.718	0.612	4.358	0.957	0.549
20.	3	5.785	34.677	310.470	7.228	0.584	3.670	0.832	1.148
20.	4	6.552	34.625	322.888	4.765	0.389	2.004	0.765	1.886
20.	5	8.010	34.547	304.574	1.988	0.231	1.216	1.209	1.926
20.	6	10.364	34.497	287.144	0.935	0.177	0.911	1.252	1.503
20.	7	12.339	34.466	273.799	0.618	0.168	1.183	1.278	1.319
20.	8	14.222	34.485	261.756	0.473	0.150	1.288	0.814	1.154
20.	9	13.773	34.492	254.790	1.011	0.217	1.813	1.288	1.481
20.	10	12.399	34.554	261.004	2.216	0.301	2.322	1.315	1.002
20.	11	10.038	34.600	268.976	4.145	0.456	3.022	0.944	0.646
20.	12	8.913	34.600	282.569	5.975	0.570	3.495	1.414	0.420
50.	1	7.492	34.925	288.178	7.324	0.613	3.684	1.029	0.320
50.	2	6.793	34.945	289.575	7.712	0.630	3.781	0.855	0.369
50.	3	5.995	34.931	306.748	7.319	0.609	3.871	0.724	0.590
50.	4	6.446	34.923	311.811	6.232	0.535	2.814	0.718	0.884
50.	5	6.701	34.897	291.089	4.709	0.485	2.220	1.928	1.079
50.	6	7.517	34.912	283.544	3.982	0.505	1.966	2.399	1.079
50.	7	7.918	34.956	274.124	4.113	0.504	2.606	2.117	0.407
50.	8	8.664	34.959	257.663	4.291	0.511	2.848	1.373	0.310
50.	9	9.487	34.960	251.524	5.065	0.479	2.735	1.241	0.620
50.	10	9.780	34.966	257.796	5.214	0.465	2.833	1.171	0.442
50.	11	9.498	34.912	267.621	5.619	0.498	3.094	0.293	0.387
50.	12	8.823	34.909	273.109	6.877	0.580	3.199	0.630	0.225
78.	1	7.788	35.033	286.139	8.042	0.638	3.618	1.008	0.284
78.	2	7.163	35.050	284.379	8.476	0.656	3.818	0.820	0.267
78.	3	6.280	35.019	303.934	8.122	0.616	4.016	0.627	0.419
78.	4	6.520	35.035	303.115	7.883	0.600	3.456	0.804	0.546
78.	5	6.607	35.015	285.517	7.020	0.595	3.112	1.764	0.589
78.	6	7.172	35.067	280.022	6.802	0.651	2.741	2.306	1.349
78.	7	7.334	35.089	272.831	7.345	0.666	3.675	1.926	0.275
78.	8	7.982	35.094	259.883	7.578	0.665	3.752	1.144	0.144
78.	9	8.483	35.114	252.045	8.347	0.626	3.294	1.094	0.396
78.	10	8.801	35.118	252.578	8.458	0.645	3.973	1.073	0.307
78.	11	9.019	35.077	257.414	7.984	0.620	3.904	0.189	0.230
78.	12	8.805	35.065	271.133	8.217	0.627	3.240	0.638	0.147
98.	1	7.894	35.059	284.950	8.462	0.666	3.693	0.746	0.257
98.	2	7.290	35.087	281.196	8.953	0.677	3.887	0.726	0.226
98.	3	6.432	35.051	300.023	8.394	0.628	4.042	0.622	0.349
98.	4	6.592	35.077	301.208	8.574	0.631	3.851	0.792	0.421
98.	5	6.713	35.067	282.364	8.152	0.638	3.630	1.600	0.446
98.	6	7.126	35.129	278.731	8.133	0.712	3.099	1.691	1.204
98.	7	7.208	35.140	272.220	8.820	0.723	4.172	1.657	0.278
98.	8	7.714	35.160	261.784	9.560	0.734	4.361	0.908	0.131
98.	9	8.023	35.169	253.245	9.919	0.687	3.703	1.053	0.412
98.	10	8.525	35.175	256.896	9.775	0.725	4.584	0.897	0.279
98.	11	8.592	35.146	253.143	9.949	0.726	4.637	0.188	0.153
98.	12	8.737	35.126	268.644	9.012	0.671	3.436	0.616	0.133

Table A11.2: Yearly time series for the extended North Sea Region. For each of the eight parameters (abbreviated T, S, OX, NI, PH, SI, AM, CL) both unsmoothed (columns 3, 5, 7, 9, 11, 13, 15, 17) and smoothed (columns 4, 6, 8, 10, 12, 14, 16, 18) yearly anomaly values Δ are given. Parameter units like everywhere in the text. Anomalies are relative to the year 2005. Dummy values are represented by 99.000.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18-
Level(m)	**Year**	**ΔT1**	**ΔT2**	**ΔS1**	**ΔS2**	**ΔOX1**	**ΔOX2**	**ΔNI1**	**ΔNI2**	**ΔPH1**	**ΔPH2**	**ΔSI1**	**ΔSI2**	**ΔAM1**	**ΔAM2**	**ΔCL1**	**ΔCL2**
0	1960	-0.125	99.000	0.150	99.000	-11.2	99.0	-0.214	99.000	-0.022	99.000	0.463	99.000	99.000	99.000	-0.107	99.000
0	1961	-0.048	99.000	0.154	99.000	99.0	99.0	-0.355	99.000	-0.087	99.000	-0.252	99.000	99.000	99.000	-0.041	99.000
0	1962	-0.567	99.000	0.153	99.000	99.0	99.0	-0.256	99.000	-0.051	99.000	-0.239	99.000	99.000	99.000	0.394	99.000
0	1963	-0.539	99.000	0.093	99.000	-0.2	99.0	-0.088	99.000	-0.016	99.000	0.418	99.000	99.000	99.000	-0.099	99.000
0	1964	-0.513	99.000	0.123	99.000	-4.4	99.0	99.000	99.000	-0.129	99.000	99.000	99.000	99.000	99.000	0.055	99.000
0	1965	-0.507	-0.452	0.075	0.108	-5.2	-5.8	-0.083	-0.152	0.014	-0.038	0.015	0.019	99.000	99.000	-0.135	-0.069
0	1966	-0.263	-0.427	0.095	0.113	-9.3	-7.0	99.000	99.000	-0.015	-0.031	-0.227	0.010	99.000	99.000	-0.106	-0.113
0	1967	-0.521	-0.414	0.158	0.120	-6.7	-7.8	-0.237	-0.211	-0.048	-0.029	0.123	0.034	99.000	99.000	-0.195	-0.144
0	1968	-0.309	-0.415	0.124	0.123	-10.8	-7.9	-0.340	-0.210	-0.018	-0.027	0.127	0.072	99.000	99.000	-0.112	-0.164
0	1969	-0.476	-0.421	0.125	0.122	-8.4	-7.1	-0.078	-0.186	-0.053	-0.022	0.126	0.103	0.313	0.281	-0.228	-0.170
0	1970	-0.491	-0.419	0.116	0.120	-5.8	-6.0	99.000	99.000	0.009	-0.012	99.000	99.000	99.000	99.000	-0.215	-0.158
0	1971	-0.315	-0.408	0.092	0.121	0.5	-5.2	-0.137	-0.139	-0.013	0.004	0.071	0.108	0.188	0.264	-0.140	-0.129
0	1972	-0.485	-0.393	0.140	0.124	-8.0	-4.8	-0.110	-0.143	0.009	0.026	0.294	0.077	0.356	0.252	-0.041	-0.098
0	1973	-0.274	-0.383	0.152	0.122	-6.7	-4.2	-0.144	-0.159	0.026	0.052	-0.122	0.032	99.000	99.000	-0.020	-0.082
0	1974	-0.451	-0.381	0.128	0.112	-3.7	-2.9	-0.205	-0.175	0.143	0.073	0.063	-0.015	0.161	0.199	-0.107	-0.080
0	1975	-0.324	-0.395	0.067	0.096	0.8	-1.0	-0.182	-0.181	0.113	0.083	-0.170	-0.045	0.172	0.184	-0.127	-0.080
0	1976	-0.374	-0.431	0.094	0.078	0.2	1.0	-0.266	-0.161	0.032	0.080	-0.035	-0.047	0.167	0.180	-0.072	-0.072
0	1977	-0.481	-0.482	0.059	0.064	3.4	2.8	-0.150	-0.116	0.102	0.072	-0.114	-0.020	0.244	0.178	-0.053	-0.057
0	1978	-0.578	-0.527	0.029	0.056	4.1	4.2	0.050	-0.060	0.080	0.064	0.094	0.020	0.120	0.176	0.002	-0.045
0	1979	-0.688	-0.539	0.038	0.056	7.5	4.5	-0.044	-0.011	-0.001	0.061	0.090	0.056	0.141	0.177	-0.070	-0.040
0	1980	-0.492	-0.512	0.071	0.061	10.2	3.2	0.036	0.024	0.078	0.064	0.063	0.085	0.269	0.182	-0.033	-0.040
0	1981	-0.493	-0.465	0.100	0.065	-4.8	0.7	0.120	0.047	0.091	0.069	0.108	0.113	0.094	0.182	-0.005	-0.043
0	1982	-0.255	-0.433	0.036	0.066	-2.3	-1.7	-0.051	0.065	0.058	0.074	99.000	99.000	0.293	0.170	-0.116	-0.050
0	1983	-0.471	-0.433	0.067	0.065	-4.8	-3.2	0.194	0.080	0.089	0.076	0.307	0.142	0.135	0.149	0.039	-0.059
0	1984	-0.441	-0.457	0.083	0.064	-5.6	-3.8	0.031	0.090	0.081	0.073	-0.048	0.124	0.064	0.131	-0.152	-0.066
0	1985	-0.484	-0.478	0.051	0.061	-0.8	-4.3	0.121	0.088	0.072	0.067	0.271	0.091	0.039	0.129	-0.075	-0.067
0	1986	-0.587	-0.464	0.075	0.059	-6.2	-5.5	0.169	0.066	0.046	0.059	-0.031	0.046	0.276	0.138	-0.028	-0.065
0	1987	-0.558	-0.398	0.026	0.062	-1.0	-8.0	-0.014	0.024	0.069	0.055	0.071	-0.001	0.126	0.147	-0.059	-0.063
0	1988	-0.227	-0.298	0.038	0.075	-14.0	-10.9	-0.025	-0.026	0.005	0.056	-0.194	-0.031	0.058	0.157	-0.076	-0.061
0	1989	-0.085	-0.212	0.130	0.093	99.0	99.0	-0.098	-0.064	0.083	0.063	-0.085	-0.027	0.227	0.164	-0.101	-0.052
0	1990	0.006	-0.179	0.136	0.106	-18.4	-12.1	-0.165	-0.073	0.090	0.071	0.150	0.009	0.257	0.164	-0.014	-0.036
0	1991	-0.330	-0.198	0.102	0.105	-0.6	-9.8	-0.065	-0.048	0.071	0.074	-0.232	0.065	0.091	0.155	0.011	-0.021
0	1992	-0.136	-0.233	0.129	0.091	-12.6	-7.2	-0.027	-0.005	0.068	0.073	0.420	0.113	0.084	0.147	-0.007	-0.016
0	1993	-0.440	-0.250	0.067	0.068	0.4	-5.1	0.104	0.025	0.084	0.066	0.161	0.128	0.212	0.142	-0.018	-0.022
0	1994	-0.294	-0.242	0.020	0.046	-6.5	-3.0	0.180	0.015	0.085	0.049	0.099	0.103	0.140	0.134	-0.020	-0.034
0	1995	0.077	-0.220	0.007	0.034	-5.4	-0.3	-0.038	-0.034	0.015	0.023	0.006	0.054	0.128	0.113	-0.059	-0.043
0	1996	-0.521	-0.188	0.004	0.036	5.7	2.3	-0.202	-0.084	-0.001	-0.003	0.105	0.004	0.115	0.082	-0.114	-0.039
0	1997	-0.074	-0.138	0.075	0.041	15.1	3.5	-0.249	-0.092	-0.089	-0.019	-0.165	-0.025	-0.007	0.050	-0.001	-0.025
0	1998	-0.076	-0.076	0.092	0.039	-3.1	2.7	-0.062	-0.053	-0.025	-0.019	-0.161	-0.024	0.016	0.024	0.049	-0.009
0	1999	0.097	-0.025	0.012	0.023	5.4	1.0	0.116	-0.008	0.020	-0.010	0.154	-0.007	0.016	0.008	-0.040	-0.001
0	2000	0.014	0.000	-0.006	0.000	-9.8	0.0	0.138	0.000	-0.003	0.000	0.040	0.000	-0.013	0.000	0.032	0.000
0	2001	-0.082	0.009	-0.022	-0.020	0.4	0.5	-0.040	-0.036	0.016	0.008	0.016	-0.010	-0.012	-0.002	-0.006	-0.005
0	2002	0.099	0.016	-0.088	-0.028	5.0	1.8	-0.199	-0.091	-0.024	0.016	-0.169	-0.018	-0.016	0.002	-0.018	-0.014
0	2003	-0.041	0.026	-0.001	-0.025	6.5	2.7	-0.080	-0.133	0.056	0.030	-0.019	-0.003	0.026	0.010	-0.003	-0.025
0	2004	0.079	0.038	-0.028	-0.018	-0.8	3.0	-0.267	-0.147	0.026	0.046	0.091	0.030	0.034	0.017	-0.060	-0.034
0	2005	0.046	0.053	0.018	-0.015	0.7	2.6	-0.138	-0.140	0.074	0.063	0.084	0.069	0.002	0.027	-0.067	-0.035
0	2006	0.014	0.071	0.001	-0.021	15.4	1.8	-0.064	-0.126	0.080	0.078	0.012	0.109	-0.000	0.038	-0.015	-0.031
0	2007	0.134	0.081	-0.054	-0.027	-13.2	1.7	-0.088	-0.116	0.099	0.087	0.184	0.137	0.111	0.045	-0.006	-0.026
0	2008	0.170	0.064	-0.096	-0.027	-2.1	3.5	-0.171	-0.108	0.101	0.086	0.315	0.133	0.095	0.037	-0.034	-0.027
0	2009	0.098	0.015	0.057	-0.019	7.9	6.7	-0.155	-0.096	0.127	0.075	0.164	0.100	-0.019	0.016	-0.020	-0.036
0	2010	-0.173	-0.043	-0.043	-0.009	99.0	99.0	0.014	-0.090	-0.004	0.063	-0.175	0.079	-0.031	-0.007	-0.023	-0.054
0	2011	-0.233	99.000	0.004	99.000	7.1	99.0	0.018	99.000	0.030	99.000	-0.133	99.000	-0.045	99.000	-0.086	99.000
0	2012	0.068	99.000	0.052	99.000	-0.3	99.0	-0.229	99.000	0.064	99.000	0.404	99.000	-0.000	99.000	-0.141	99.000
0	2013	-0.150	99.000	-0.078	99.000	1.3	99.0	-0.294	99.000	0.138	99.000	0.509	99.000	-0.047	99.000	-0.114	99.000
0	2014	99.000	99.000	99.000	99.000	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000
0	2015	99.000	99.000	99.000	99.000	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000
35	1960	-0.144	99.000	0.059	99.000	-1.5	99.0	-0.193	99.000	-0.021	99.000	0.021	99.000	99.000	99.000	-0.035	99.000
35	1961	0.130	99.000	0.029	99.000	9.1	99.0	-0.310	99.000	0.023	99.000	-0.167	99.000	99.000	99.000	0.008	99.000
35	1962	-0.169	99.000	0.043	99.000	-0.9	99.0	-0.047	99.000	0.028	99.000	0.188	99.000	99.000	99.000	-0.022	99.000
35	1963	-0.357	99.000	0.009	99.000	4.3	99.0	-0.107	99.000	0.018	99.000	0.045	99.000	99.000	99.000	-0.020	99.000
35	1964	-0.248	99.000	0.024	99.000	10.3	99.0	99.000	99.000	-0.061	99.000	99.000	99.000	99.000	99.000	-0.198	99.000
35	1965	-0.361	-0.321	0.020	0.027	4.4	4.2	-0.225	-0.183	-0.014	-0.014	-0.268	-0.015	99.000	99.000	0.029	-0.037
35	1966	-0.356	-0.340	0.026	0.032	-1.0	3.4	-0.249	-0.178	0.004	-0.014	0.067	0.017	99.000	99.000	0.045	-0.029
35	1967	-0.349	-0.350	0.051	0.035	3.2	2.7	-0.144	-0.155	-0.022	-0.014	0.273	0.049	99.000	99.000	-0.061	-0.036
35	1968	-0.343	-0.354	0.051	0.034	6.0	1.9	-0.076	-0.131	-0.005	-0.014	-0.118	0.058	0.183	0.087	-0.006	-0.055
35	1969	-0.371	-0.353	0.026	0.028	-0.2	1.2	-0.093	-0.115	-0.031	-0.013	0.170	0.044	-0.017	0.071	-0.188	-0.071
35	1970	-0.381	-0.345	0.010	0.021	-4.5	0.7	-0.169	-0.105	-0.012	-0.008	0.047	0.016	99.000	99.000	-0.021	-0.079
35	1971	-0.310	-0.331	0.018	0.013	4.2	0.8	-0.074	-0.095	0.003	0.001	-0.116	-0.005	-0.001	0.082	-0.069	-0.082
35	1972	-0.306	-0.317	0.007	0.004	0.1	1.6	-0.052	-0.090	0.009	0.010	-0.018	0.007	0.235	0.092	-0.136	-0.086

35	1973	-0.301	-0.309	0.003	-0.006	0.2	2.7	-0.098	-0.098	0.021	0.017	-0.167	0.055	99.000	99.000	-0.016	-0.088
35	1974	-0.294	-0.311	-0.022	-0.020	6.7	3.8	-0.047	-0.119	0.033	0.019	0.390	0.106	-0.004	0.060	-0.192	-0.087
35	1975	-0.299	-0.323	-0.031	-0.035	6.4	4.4	-0.196	-0.136	0.056	0.014	0.265	0.120	0.085	0.049	-0.011	-0.080
35	1976	-0.373	-0.342	-0.054	-0.048	3.6	4.3	-0.296	-0.127	-0.070	0.010	-0.059	0.088	0.022	0.056	-0.107	-0.070
35	1977	-0.329	-0.361	-0.078	-0.055	5.1	3.7	-0.029	-0.086	0.032	0.011	0.113	0.042	-0.035	0.077	-0.043	-0.056
35	1978	-0.412	-0.376	-0.062	-0.056	0.8	3.1	-0.018	-0.029	0.036	0.018	-0.134	0.008	0.235	0.098	-0.050	-0.037
35	1979	-0.422	-0.384	-0.053	-0.050	3.8	2.8	0.087	0.025	-0.005	0.026	0.067	-0.011	0.197	0.104	-0.067	-0.011
35	1980	-0.320	-0.388	-0.034	-0.042	1.7	2.9	-0.014	0.075	0.054	0.034	-0.034	-0.030	-0.031	0.099	0.097	0.020
35	1981	-0.433	-0.389	-0.032	-0.034	2.3	3.2	0.136	0.122	0.050	0.040	0.089	-0.047	0.031	0.091	-0.001	0.048
35	1982	-0.406	-0.388	-0.030	-0.027	6.2	3.6	0.236	0.156	0.020	0.044	-0.433	-0.043	0.278	0.072	0.109	0.069
35	1983	-0.352	-0.388	-0.033	-0.020	2.7	3.6	0.237	0.166	0.087	0.045	0.190	-0.007	0.045	0.032	0.108	0.079
35	1984	-0.381	-0.389	-0.000	-0.015	4.2	3.4	0.108	0.150	0.020	0.041	-0.017	0.039	-0.094	-0.014	0.074	0.082
35	1985	-0.407	-0.387	0.012	-0.014	1.6	3.0	0.142	0.120	0.047	0.037	0.233	0.062	-0.188	-0.039	0.063	0.084
35	1986	-0.428	-0.366	-0.025	-0.019	4.1	2.4	0.085	0.084	0.016	0.033	0.013	0.041	0.018	-0.031	0.070	0.093
35	1987	-0.363	-0.312	-0.039	-0.022	4.5	1.3	0.047	0.043	0.041	0.031	0.117	-0.012	0.064	-0.006	0.104	0.104
35	1988	-0.331	-0.226	-0.050	-0.016	-4.7	0.3	0.026	-0.001	0.012	0.032	-0.264	-0.065	-0.079	0.015	0.196	0.108
35	1989	-0.010	-0.138	0.000	-0.002	-0.5	0.1	-0.047	-0.034	0.057	0.033	-0.108	-0.093	0.122	0.024	0.081	0.100
35	1990	0.092	-0.087	0.048	0.012	-0.5	0.9	-0.230	-0.034	0.029	0.034	-0.064	-0.087	0.065	0.024	0.037	0.085
35	1991	-0.140	-0.094	0.018	0.019	2.2	2.5	0.021	0.009	0.017	0.037	-0.146	-0.061	-0.122	0.026	0.129	0.072
35	1992	-0.016	-0.147	0.040	0.013	3.6	4.2	0.057	0.068	0.040	0.042	0.042	-0.029	0.080	0.031	0.020	0.063
35	1993	-0.321	-0.210	0.013	-0.001	10.0	5.1	0.340	0.101	0.070	0.043	0.012	-0.010	0.136	0.031	0.032	0.057
35	1994	-0.331	-0.246	-0.048	-0.015	7.0	4.8	0.064	0.078	0.070	0.036	0.036	-0.016	-0.029	0.019	0.140	0.050
35	1995	-0.338	-0.236	-0.051	-0.021	2.2	3.6	0.064	0.007	-0.000	0.021	-0.020	-0.049	-0.004	-0.001	-0.029	0.041
35	1996	-0.131	-0.190	-0.008	-0.016	0.0	2.6	-0.078	-0.075	0.007	0.005	-0.047	-0.092	-0.027	-0.016	0.037	0.033
35	1997	-0.164	-0.134	-0.009	-0.007	0.9	2.1	-0.321	-0.119	-0.038	-0.004	-0.314	-0.110	-0.054	-0.021	0.026	0.026
35	1998	0.041	-0.085	0.023	0.001	3.3	2.0	-0.255	-0.101	-0.004	-0.005	-0.174	-0.084	-0.020	-0.015	0.060	0.018
35	1999	-0.154	-0.044	0.001	0.003	5.1	1.4	0.052	-0.045	-0.001	-0.002	0.044	-0.033	0.046	-0.006	-0.022	0.008
35	2000	-0.007	0.000	0.008	0.000	0.1	0.0	0.202	0.000	0.033	0.000	0.185	0.000	-0.098	0.000	-0.005	0.000
35	2001	0.071	0.046	0.008	-0.004	-4.4	-1.4	-0.021	0.003	-0.021	-0.002	-0.017	-0.009	0.161	-0.002	-0.033	0.000
35	2002	0.161	0.086	-0.054	-0.003	-4.5	-2.0	-0.100	-0.024	-0.012	-0.005	-0.108	-0.048	-0.101	-0.014	0.022	0.007
35	2003	0.052	0.119	-0.004	0.006	-1.5	-1.6	0.069	-0.055	0.005	-0.005	-0.024	-0.087	-0.042	-0.031	0.036	0.014
35	2004	0.161	0.152	0.056	0.018	-0.7	-0.9	-0.286	-0.072	-0.026	-0.004	-0.255	-0.102	0.031	-0.048	0.003	0.020
35	2005	0.159	0.186	0.031	0.026	2.2	-0.6	0.051	-0.075	0.027	-0.003	-0.101	-0.089	-0.146	-0.060	0.017	0.025

Table A11.3: Yearly time series for the North Sea Region For each of the eight parameters (abbreviated T, S, OX, NI, PH, SI, AM, CL) both unsmoothed (columns 3, 5, 7, 9, 11, 13, 15, 17) and smoothed (columns 4, 6, 8, 10, 12, 14, 16, 18) yearly anomaly values Δ are given. Parameter units like everywhere in the text. Anomalies are relative to the year 2005. Dummy values are represented by 99.000.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Level(m)	**Year**	**ΔT1**	**ΔT2**	**ΔS1**	**ΔS2**	**ΔOX1**	**ΔOX2**	**ΔNI1**	**ΔNI2**	**ΔPH1**	**ΔPH2**	**ΔSI1**	**ΔSI2**	**ΔAM1**	**ΔAM2**	**ΔCL1**	**ΔCL2**
0	1960	-0.230	99.000	0.133	99.000	99.0	99.0	-0.148	99.000	-0.025	99.000	0.668	99.000	99.000	99.000	-0.054	99.000
0	1961	0.041	99.000	0.142	99.000	99.0	99.0	-0.346	99.000	-0.075	99.000	-0.306	99.000	99.000	99.000	-0.045	99.000
0	1962	-0.718	99.000	0.145	99.000	99.0	99.0	-0.231	99.000	-0.017	99.000	-0.288	99.000	99.000	99.000	0.358	99.000
0	1963	-0.547	99.000	0.138	99.000	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	-0.106	99.000
0	1964	-0.604	99.000	0.138	99.000	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	0.063	99.000
0	1965	-0.496	-0.487	0.019	0.101	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	-0.097	-0.059
0	1966	-0.260	-0.476	0.077	0.106	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	-0.094	-0.108
0	1967	-0.492	-0.497	0.168	0.120	99.0	99.0	-0.207	-0.257	-0.086	-0.034	99.000	99.000	99.000	99.000	-0.223	-0.152
0	1968	-0.638	-0.531	0.157	0.130	99.0	99.0	-0.328	-0.251	0.033	-0.027	0.056	0.052	99.000	99.000	99.000	99.000
0	1969	-0.622	-0.539	0.120	0.136	99.0	99.0	99.000	99.000	-0.040	-0.022	0.049	0.043	99.000	99.000	-0.225	-0.176
0	1970	-0.554	-0.508	0.121	0.148	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	-0.229	-0.139
0	1971	-0.398	-0.450	0.085	0.171	99.0	99.0	-0.030	-0.115	99.000	99.000	99.000	99.000	99.000	99.000	-0.081	-0.089
0	1972	-0.396	-0.391	0.318	0.194	99.0	99.0	99.000	99.000	-0.017	0.033	99.000	99.000	99.000	99.000	0.066	-0.047
0	1973	-0.308	-0.350	0.231	0.201	99.0	99.0	-0.107	-0.192	0.025	0.057	-0.331	-0.305	99.000	99.000	0.007	-0.027
0	1974	-0.269	-0.341	0.208	0.193	99.0	99.0	-0.346	-0.225	0.158	0.076	-0.331	-0.287	99.000	99.000	-0.070	-0.027
0	1975	-0.305	-0.370	0.072	0.185	99.0	99.0	-0.248	-0.229	0.081	0.086	-0.305	-0.252	99.000	99.000	-0.057	-0.032
0	1976	-0.425	-0.429	0.186	0.183	99.0	99.0	-0.221	-0.201	0.056	0.085	-0.150	-0.208	0.175	0.333	0.020	-0.037
0	1977	-0.529	-0.494	0.336	0.171	99.0	99.0	-0.229	-0.138	0.158	0.075	-0.179	-0.168	99.000	99.000	-0.073	-0.044
0	1978	-0.607	-0.536	0.109	0.140	99.0	99.0	-0.068	-0.049	0.011	0.063	-0.038	-0.136	0.315	0.347	-0.041	-0.057
0	1979	-0.624	-0.533	0.057	0.098	99.0	99.0	0.082	0.043	0.004	0.057	99.000	99.000	0.617	0.333	-0.033	-0.073
0	1980	-0.526	-0.484	0.005	0.062	5.3	-1.8	0.281	0.109	0.087	0.057	-0.331	-0.043	0.195	0.292	-0.176	-0.085
0	1981	-0.483	-0.420	0.116	0.038	-5.7	-5.2	0.101	0.141	0.118	0.057	0.279	0.024	0.084	0.244	-0.060	-0.085
0	1982	-0.043	-0.386	-0.033	0.024	-17.9	-8.3	0.097	0.152	-0.007	0.053	99.000	99.000	0.344	0.206	-0.129	-0.075
0	1983	-0.420	-0.408	-0.031	0.023	-6.1	-10.4	0.241	0.155	0.058	0.049	0.276	0.031	0.148	0.178	0.040	-0.064
0	1984	-0.545	-0.466	0.068	0.034	-13.7	-11.3	0.112	0.153	0.043	0.049	-0.310	-0.013	0.137	0.158	-0.136	-0.054
0	1985	-0.553	-0.507	0.039	0.049	-12.4	-11.8	0.147	0.138	0.058	0.052	0.050	-0.043	0.049	0.148	-0.013	-0.047
0	1986	-0.606	-0.485	0.109	0.061	-11.3	-12.7	0.246	0.097	0.040	0.053	-0.103	-0.060	0.244	0.149	-0.048	-0.038
0	1987	-0.630	-0.381	0.020	0.074	-7.1	-14.6	-0.005	0.034	0.105	0.051	0.080	-0.079	0.178	0.154	-0.024	-0.027
0	1988	-0.153	-0.233	0.064	0.094	99.0	99.0	-0.084	-0.034	-0.011	0.049	-0.232	-0.098	0.030	0.161	-0.015	-0.012
0	1989	0.163	-0.115	0.143	0.121	99.0	99.0	-0.119	-0.084	0.057	0.050	-0.216	-0.097	0.234	0.170	-0.050	0.009
0	1990	0.145	-0.086	0.172	0.143	99.0	99.0	-0.160	-0.098	0.054	0.055	0.062	-0.060	0.257	0.173	0.092	0.031
0	1991	-0.316	-0.142	0.168	0.148	-16.0	-15.9	-0.134	-0.076	0.085	0.059	-0.271	0.005	0.136	0.168	0.049	0.041
0	1992	-0.086	-0.223	0.201	0.129	-15.0	-12.3	-0.030	-0.035	0.043	0.061	0.370	0.064	0.060	0.160	0.104	0.030

0	1993	-0.575	-0.272	0.091	0.093	0.9	-9.1	0.068	-0.004	0.054	0.057	0.135	0.085	0.258	0.150	-0.007	-0.001
0	1994	-0.337	-0.274	-0.004	0.059	-13.6	-6.8	0.147	-0.007	0.110	0.046	0.052	0.060	0.172	0.130	-0.048	-0.038
0	1995	0.094	-0.247	-0.015	0.045	0.0	-4.8	-0.129	-0.042	0.000	0.029	-0.055	0.004	0.075	0.098	-0.125	-0.060
0	1996	-0.576	-0.204	0.053	0.052	-11.8	-2.8	-0.072	-0.079	-0.010	0.014	0.140	-0.065	0.013	0.066	-0.140	-0.057
0	1997	-0.052	-0.147	0.086	0.064	10.5	-1.0	-0.258	-0.084	-0.030	0.008	-0.331	-0.117	0.050	0.042	0.041	-0.035
0	1998	-0.072	-0.084	0.150	0.061	-3.1	-0.1	-0.037	-0.054	0.060	0.005	-0.291	-0.124	0.048	0.024	0.003	-0.013
0	1999	0.077	-0.033	0.034	0.036	2.2	-0.1	0.031	-0.014	0.016	0.002	-0.026	-0.077	-0.002	0.009	-0.014	-0.001
0	2000	-0.014	0.000	-0.030	0.000	-4.7	0.0	0.130	0.000	-0.054	0.000	-0.022	0.000	-0.034	0.000	0.033	0.000
0	2001	-0.103	0.027	-0.025	-0.030	0.9	0.5	0.026	-0.023	-0.011	0.008	0.169	0.072	0.009	0.001	-0.005	-0.008
0	2002	0.179	0.055	-0.130	-0.040	3.7	1.2	-0.205	-0.066	0.015	0.027	0.108	0.116	-0.051	0.011	-0.030	-0.023
0	2003	0.054	0.078	-0.028	-0.030	2.5	1.9	-0.023	-0.103	0.088	0.047	0.198	0.125	0.100	0.023	-0.004	-0.041
0	2004	0.152	0.091	0.025	-0.014	-2.8	2.5	-0.220	-0.119	0.091	0.058	0.200	0.110	0.048	0.030	-0.123	-0.053
0	2005	0.024	0.100	0.017	-0.007	5.8	2.7	-0.141	-0.118	0.029	0.059	-0.085	0.094	-0.028	0.037	-0.069	-0.057
0	2006	0.079	0.110	0.021	-0.014	14.3	2.3	-0.036	-0.111	0.074	0.054	0.070	0.092	0.011	0.049	-0.012	-0.055
0	2007	0.232	0.108	-0.061	-0.023	-14.4	2.2	-0.086	-0.104	0.041	0.048	0.166	0.088	0.155	0.062	-0.060	-0.053
0	2008	0.111	0.070	-0.127	-0.020	0.5	4.0	-0.192	-0.086	0.036	0.043	0.269	0.054	0.079	0.064	-0.081	-0.054
0	2009	0.138	-0.006	0.094	-0.004	8.3	7.0	-0.155	-0.055	0.034	0.039	-0.081	-0.013	0.022	0.050	-0.019	-0.061
0	2010	-0.252	-0.085	-0.003	0.018	99.0	99.0	0.183	-0.030	99.000	99.000	-0.331	-0.094	0.088	0.027	-0.043	-0.079
0	2011	-0.383	99.000	0.002	99.000	3.2	99.0	0.116	99.000	99.000	99.000	99.000	99.000	-0.069	99.000	-0.108	99.000
0	2012	0.068	99.000	0.131	99.000	0.2	99.0	-0.326	99.000	99.000	99.000	99.000	99.000	0.018	99.000	-0.218	99.000
0	2013	99.000	99.000	99.000	99.000	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	-0.069	99.000	-0.080	99.000
0	2014	99.000	99.000	99.000	99.000	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000
0	2015	99.000	99.000	99.000	99.000	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000
35	1960	-0.133	99.000	0.075	99.000	99.0	99.0	-0.178	99.000	-0.018	99.000	0.008	99.000	99.000	99.000	-0.048	99.000
35	1961	0.070	99.000	0.038	99.000	99.0	99.0	-0.307	99.000	0.044	99.000	-0.103	99.000	99.000	99.000	0.024	99.000
35	1962	-0.075	99.000	0.062	99.000	99.0	99.0	-0.060	99.000	0.067	99.000	0.202	99.000	99.000	99.000	0.067	99.000
35	1963	-0.304	99.000	0.070	99.000	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	-0.001	99.000
35	1964	-0.276	99.000	0.050	99.000	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	-0.158	99.000
35	1965	-0.316	-0.306	0.021	0.038	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	0.071	0.018
35	1966	-0.405	-0.324	0.025	0.034	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	0.058	0.041
35	1967	-0.283	-0.327	0.018	0.033	99.0	99.0	-0.139	-0.100	-0.061	0.000	99.000	99.000	99.000	99.000	0.161	0.039
35	1968	-0.312	-0.326	0.076	0.034	99.0	99.0	-0.045	-0.091	0.024	0.017	-0.205	-0.003	99.000	99.000	99.000	99.000
35	1969	-0.342	-0.328	0.009	0.032	99.0	99.0	-0.129	-0.080	0.086	0.031	0.242	0.029	99.000	99.000	-0.181	-0.042
35	1970	-0.324	-0.331	0.024	0.031	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	-0.004	-0.062
35	1971	-0.335	-0.329	0.034	0.030	99.0	99.0	0.098	-0.087	99.000	99.000	99.000	99.000	99.000	99.000	-0.054	-0.065
35	1972	-0.397	-0.316	0.042	0.027	99.0	99.0	-0.262	-0.108	0.018	0.019	99.000	99.000	99.000	99.000	-0.076	-0.066
35	1973	-0.225	-0.295	0.013	0.021	99.0	99.0	-0.168	-0.130	-0.013	0.017	-0.439	0.017	99.000	99.000	-0.057	-0.062
35	1974	-0.294	-0.279	0.038	0.008	99.0	99.0	0.044	-0.152	0.043	0.017	0.405	0.097	99.000	99.000	-0.170	-0.047
35	1975	-0.208	-0.278	-0.017	-0.010	99.0	99.0	-0.289	-0.168	0.056	0.014	0.232	0.148	99.000	99.000	0.095	-0.025
35	1976	-0.303	-0.294	-0.036	-0.027	99.0	99.0	-0.307	-0.158	-0.059	0.010	0.066	0.152	-0.128	-0.029	-0.024	-0.007
35	1977	-0.311	-0.316	-0.060	-0.040	99.0	99.0	-0.096	-0.106	0.036	0.008	0.355	0.111	99.000	99.000	0.035	0.004
35	1978	-0.383	-0.332	-0.049	-0.047	99.0	99.0	-0.048	-0.023	0.011	0.014	-0.065	0.053	99.000	99.000	-0.049	0.014
35	1979	-0.387	-0.337	-0.040	-0.049	99.0	99.0	0.101	0.065	-0.035	0.024	-0.141	0.016	0.521	0.239	0.013	0.033
35	1980	-0.219	-0.341	-0.067	-0.047	-7.4	0.7	0.230	0.134	0.102	0.034	-0.069	0.027	-0.050	0.230	0.118	0.057
35	1981	-0.386	-0.353	-0.036	-0.042	5.7	1.7	0.164	0.177	0.066	0.039	0.242	0.079	0.258	0.208	0.038	0.082
35	1982	-0.394	-0.370	-0.038	-0.032	6.3	2.1	0.198	0.197	-0.028	0.039	99.000	99.000	0.361	0.171	0.134	0.101
35	1983	-0.378	-0.386	-0.044	-0.019	-0.6	1.9	0.258	0.200	0.078	0.038	0.235	0.163	0.102	0.112	0.113	0.111
35	1984	-0.410	-0.397	0.021	-0.008	1.6	1.5	0.182	0.184	0.027	0.037	0.095	0.158	-0.052	0.053	0.170	0.113
35	1985	-0.388	-0.398	0.029	-0.004	-1.1	1.2	0.203	0.148	0.050	0.035	0.186	0.134	-0.130	0.025	0.044	0.116
35	1986	-0.447	-0.374	-0.010	-0.007	2.5	1.0	0.095	0.096	0.011	0.033	0.126	0.086	0.093	0.034	0.077	0.129
35	1987	-0.415	-0.304	-0.043	-0.008	5.0	0.4	0.022	0.035	0.047	0.032	0.185	0.010	0.153	0.055	0.207	0.147
35	1988	-0.322	-0.187	-0.035	0.002	-4.6	-0.4	-0.010	-0.023	0.010	0.032	-0.286	-0.072	-0.032	0.067	0.217	0.155
35	1989	0.101	-0.064	0.026	0.023	-1.2	-0.7	-0.113	-0.058	0.067	0.031	-0.191	-0.125	0.158	0.066	0.128	0.149
35	1990	0.276	0.004	0.094	0.045	-5.6	0.2	-0.219	-0.052	0.007	0.030	-0.145	-0.130	0.066	0.061	0.101	0.133
35	1991	-0.031	-0.014	0.042	0.056	5.8	2.1	0.035	-0.007	0.015	0.033	-0.185	-0.095	-0.079	0.064	0.179	0.117
35	1992	0.008	-0.099	0.096	0.051	3.3	4.0	0.025	0.050	0.040	0.039	0.056	-0.048	0.165	0.075	0.040	0.101
35	1993	-0.321	-0.196	0.058	0.032	10.6	4.9	0.298	0.081	0.062	0.043	-0.009	-0.015	0.104	0.087	0.094	0.087
35	1994	-0.396	-0.254	-0.020	0.007	3.5	4.4	0.027	0.062	0.080	0.039	0.046	-0.013	0.086	0.088	0.140	0.072
35	1995	-0.301	-0.253	-0.052	-0.011	4.0	3.2	0.098	-0.002	-0.003	0.027	0.026	-0.045	0.120	0.080	-0.027	0.059
35	1996	-0.211	-0.206	-0.019	-0.016	-1.1	2.3	-0.097	-0.075	0.023	0.014	-0.064	-0.094	-0.019	0.070	0.058	0.053
35	1997	-0.163	-0.141	-0.028	-0.010	-0.8	2.2	-0.337	-0.111	-0.018	0.004	-0.335	-0.119	0.137	0.060	0.049	0.050
35	1998	0.065	-0.085	0.021	-0.001	6.0	2.3	-0.200	-0.088	-0.004	0.001	-0.190	-0.096	0.016	0.046	0.114	0.041
35	1999	-0.123	-0.042	0.011	0.003	5.6	1.7	0.071	-0.033	-0.000	0.001	0.016	-0.041	0.101	0.025	-0.005	0.022
35	2000	-0.037	0.000	0.024	0.000	0.1	0.0	0.205	0.000	0.033	0.000	0.205	0.000	-0.118	0.000	-0.004	0.000
35	2001	0.035	0.044	-0.016	-0.006	-4.3	-1.9	-0.012	-0.016	-0.035	-0.002	-0.018	-0.001	0.103	-0.027	-0.059	-0.014
35	2002	0.233	0.082	-0.053	-0.004	-6.9	-2.9	-0.145	-0.062	0.002	-0.003	-0.086	-0.036	-0.153	-0.054	-0.017	-0.015
35	2003	0.005	0.113	-0.017	0.011	-3.8	-2.6	-0.073	-0.097	0.002	-0.002	0.003	-0.078	-0.040	-0.080	0.013	-0.006
35	2004	0.115	0.145	0.078	0.032	0.7	-1.8	-0.322	-0.097	-0.018	0.000	-0.235	-0.104	-0.089	-0.101	-0.026	0.007
35	2005	0.203	0.179	0.060	0.046	1.5	-1.6	0.095	-0.078	0.045	-0.001	-0.148	-0.103	-0.184	-0.109	0.018	0.021
35	2006	0.307	0.200	0.071	0.046	-0.3	-2.2	-0.044	-0.069	-0.026	-0.005	-0.051	-0.080	-0.134	-0.096	0.110	0.031
35	2007	0.179	0.193	0.046	0.033	-9.4	-3.1	0.019	-0.086	-0.018	-0.011	-0.034	-0.050	-0.078	-0.070	-0.036	0.039
35	2008	0.220	0.151	-0.010	0.014	-1.7	-3.3	-0.265	-0.110	-0.003	-0.019	0.010	-0.025	0.034	-0.052	0.055	0.046
35	2009	0.112	0.080	0.010	-0.002	-4.3	-2.8	-0.158	-0.111	-0.027	-0.027	-0.083	-0.005	0.039	-0.059	0.080	0.053
35	2010	0.023	0.005	-0.043	-0.010	-1.3	-2.2	-0.114	-0.080	-0.030	-0.035	0.113	0.012	-0.137	-0.085	0.063	0.056
35	2011	-0.248	99.000	-0.034	99.000	2.4	99.0	0.035	99.000	-0.078	99.000	-0.048	99.000	-0.244	99.000	0.064	99.000
35	2012	-0.104	99.000	0.058	99.000	-6.8	99.0	-0.036	99.000	-0.023	99.000	0.033	99.000	99.000	99.000	-0.003	99.000
35	2013	-0.058	99.000	-0.076	99.000	4.1	99.0	0.209	99.000	-0.043	99.000	0.177	99.000	0.060	99.000	0.097	99.000
35	2014	0.542	99.000	0.057	99.000	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000
35	2015	99.000	99.000	99.000	99.000	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000

Table A11.4: Yearly time series for the northern North Sea. For each of the eight parameters (abbreviated T, S, OX, NI, PH, SI, AM, CL) both unsmoothed (columns 3, 5, 7, 9, 11, 13, 15, 17) and smoothed (columns 4, 6, 8, 10, 12, 14, 16, 18) yearly anomaly values Δ are given. Parameter units like everywhere in the text. Anomalies are relative to the year 2005. Dummy values are represented by 99.000.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Level(m)	**Year**	**ΔT1**	**ΔT2**	**ΔS1**	**ΔS2**	**ΔOX1**	**ΔOX2**	**ΔNI1**	**ΔNI2**	**ΔPH1**	**ΔPH2**	**ΔSI1**	**ΔSI2**	**ΔAM1**	**ΔAM2**	**ΔCL1**	**ΔCL2**
0	1960	-0.037	99.000	0.109	99.000	99.0	99.0	99.000	99.000	-0.006	99.000	99.000	99.000	99.000	99.000	-0.144	99.000
0	1961	0.089	99.000	0.112	99.000	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	-0.135	99.000
0	1962	-0.558	99.000	0.171	99.000	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	0.269	99.000
0	1963	-0.410	99.000	0.175	99.000	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	-0.196	99.000
0	1964	-0.377	99.000	0.141	99.000	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	-0.027	99.000
0	1965	-0.273	-0.334	0.022	0.109	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	-0.178	-0.146
0	1966	-0.155	-0.349	0.067	0.113	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	-0.186	-0.195
0	1967	-0.519	-0.392	0.184	0.128	99.0	99.0	-0.136	-0.136	99.000	99.000	99.000	99.000	99.000	99.000	-0.313	-0.240
0	1968	-0.437	-0.433	0.191	0.138	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000
0	1969	-0.566	-0.438	0.109	0.139	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	-0.311	-0.262
0	1970	-0.463	-0.397	0.126	0.138	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	-0.314	-0.225
0	1971	-0.265	-0.329	0.086	0.143	99.0	99.0	-0.117	-0.173	99.000	99.000	99.000	99.000	99.000	99.000	-0.160	-0.178
0	1972	-0.228	-0.266	0.231	0.147	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	-0.018	-0.143
0	1973	-0.192	-0.234	0.172	0.139	99.0	99.0	-0.194	-0.259	-0.010	-0.008	-0.388	-0.362	99.000	99.000	-0.083	-0.130
0	1974	-0.131	-0.246	0.108	0.121	99.0	99.0	-0.433	-0.287	99.000	99.000	99.000	99.000	99.000	99.000	-0.290	-0.131
0	1975	-0.285	-0.297	0.043	0.106	99.0	99.0	99.000	99.000	0.029	-0.005	99.000	99.000	99.000	99.000	-0.034	-0.125
0	1976	-0.390	-0.365	0.089	0.100	99.0	99.0	-0.153	-0.297	-0.124	0.002	99.000	99.000	99.000	99.000	-0.105	-0.097
0	1977	-0.520	-0.428	0.157	0.096	99.0	99.0	-0.433	-0.279	0.141	0.014	0.265	0.120	99.000	99.000	-0.269	-0.043
0	1978	-0.382	-0.469	0.111	0.084	99.0	99.0	99.000	99.000	-0.022	0.029	-0.033	0.111	99.000	99.000	0.109	0.020
0	1979	-0.604	-0.472	0.038	0.068	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	0.394	0.052
0	1980	-0.579	-0.419	-0.030	0.055	99.0	99.0	0.033	0.091	0.070	0.054	99.000	99.000	99.000	99.000	-0.130	0.038
0	1981	-0.431	-0.329	0.173	0.051	99.0	99.0	0.133	0.156	0.079	0.057	0.202	0.198	0.239	0.394	0.002	-0.003
0	1982	0.196	-0.260	-0.057	0.054	99.0	99.0	0.306	0.187	0.046	0.056	99.000	99.000	0.695	0.381	-0.084	-0.040
0	1983	-0.253	-0.256	0.090	0.064	99.0	99.0	0.210	0.194	0.018	0.058	0.245	0.254	0.257	0.342	0.008	-0.060
0	1984	-0.415	-0.304	0.079	0.079	99.0	99.0	0.161	0.179	0.085	0.063	99.000	99.000	0.285	0.288	-0.204	-0.063
0	1985	-0.357	-0.344	0.083	0.093	99.0	99.0	0.142	0.143	0.097	0.066	0.514	0.115	0.141	0.237	0.018	-0.051
0	1986	-0.464	-0.320	0.187	0.098	99.0	99.0	0.254	0.078	0.041	0.061	-0.132	-0.015	0.299	0.202	-0.108	-0.034
0	1987	-0.474	-0.212	0.025	0.102	99.0	99.0	-0.061	-0.016	0.116	0.048	-0.227	-0.123	0.124	0.188	0.139	-0.032
0	1988	0.033	-0.057	0.068	0.112	-14.9	-16.9	-0.134	-0.117	-0.059	0.037	-0.345	-0.176	0.012	0.194	-0.079	-0.054
0	1989	0.365	0.068	0.178	0.129	99.0	99.0	-0.315	-0.187	0.054	0.032	-0.236	-0.162	0.408	0.203	-0.125	-0.093
0	1990	0.309	0.098	0.153	0.145	-17.8	-17.9	-0.290	-0.198	0.036	0.034	0.081	-0.101	0.287	0.193	-0.094	-0.134
0	1991	-0.126	0.027	0.154	0.148	99.0	99.0	-0.227	-0.152	0.041	0.041	-0.326	-0.024	0.079	0.165	-0.217	-0.163
0	1992	0.188	-0.098	0.199	0.133	-11.7	-13.7	-0.058	-0.080	0.031	0.049	0.340	0.045	-0.016	0.141	-0.262	-0.170
0	1993	-0.518	-0.216	0.102	0.108	-1.4	-11.5	0.134	-0.035	0.062	0.054	0.104	0.081	0.306	0.126	-0.120	-0.159
0	1994	-0.478	-0.283	0.020	0.087	-12.6	-10.5	0.126	-0.052	0.119	0.049	0.052	0.076	0.069	0.105	-0.104	-0.141
0	1995	-0.062	-0.285	0.050	0.087	-11.5	-10.1	-0.217	-0.117	0.012	0.033	0.086	0.027	99.000	99.000	-0.124	-0.118
0	1996	-0.551	-0.237	0.059	0.106	-16.3	-8.9	-0.236	-0.179	0.003	0.015	0.158	-0.052	-0.006	0.023	-0.222	-0.085
0	1997	-0.026	-0.166	0.226	0.116	-2.9	-6.6	-0.362	-0.184	-0.051	0.005	-0.388	-0.124	-0.021	0.004	0.029	-0.043
0	1998	-0.062	-0.098	0.234	0.094	0.1	-4.1	-0.238	-0.123	0.043	0.001	-0.334	-0.141	0.033	0.000	0.086	-0.007
0	1999	0.051	-0.048	-0.006	0.045	-4.8	-1.9	0.078	-0.039	0.026	-0.000	-0.095	-0.087	-0.014	0.000	-0.045	0.007
0	2000	-0.127	0.000	-0.185	0.000	-3.2	0.0	0.262	0.000	-0.058	0.000	0.062	0.000	-0.032	0.000	0.084	0.000
0	2001	-0.113	0.067	0.121	-0.016	9.2	1.6	0.026	-0.037	0.005	0.006	0.222	0.070	0.083	-0.003	-0.043	-0.022
0	2002	0.395	0.147	-0.206	-0.003	-0.7	2.5	-0.185	-0.120	0.029	0.016	0.051	0.097	-0.079	-0.008	-0.076	-0.051
0	2003	0.191	0.212	0.164	0.015	5.4	2.5	-0.335	-0.188	0.028	0.026	0.141	0.087	0.010	-0.013	-0.026	-0.079
0	2004	0.287	0.248	0.089	0.015	2.5	1.4	-0.319	-0.205	0.056	0.031	0.142	0.059	-0.023	-0.013	-0.163	-0.098
0	2005	0.247	0.265	-0.047	-0.016	0.2	-0.8	-0.119	-0.188	0.016	0.027	-0.142	0.038	-0.021	-0.005	-0.161	-0.102
0	2006	0.243	0.277	-0.003	-0.066	1.3	-3.3	-0.016	-0.174	0.040	0.017	0.012	0.035	-0.003	0.016	-0.054	-0.093
0	2007	0.332	0.276	-0.144	-0.107	-16.5	-4.9	-0.245	-0.169	0.006	0.005	0.109	0.031	99.000	99.000	-0.057	-0.080
0	2008	0.365	0.242	-0.378	-0.110	-9.8	-4.7	-0.296	-0.140	-0.045	-0.005	0.211	-0.003	0.158	0.072	-0.097	-0.067
0	2009	0.221	0.167	0.057	-0.071	8.3	-3.0	-0.210	-0.064	-0.001	-0.011	-0.139	-0.071	0.036	0.081	-0.056	-0.057
0	2010	0.080	0.066	-0.035	-0.013	99.0	99.0	0.161	0.046	99.000	99.000	-0.388	-0.152	99.000	99.000	-0.042	-0.052
0	2011	-0.345	99.000	0.182	99.000	99.0	99.0	0.425	99.000	99.000	99.000	99.000	99.000	99.000	99.000	0.050	99.000
0	2012	99.000	99.000	99.000	99.000	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	-0.207	99.000
0	2013	99.000	99.000	99.000	99.000	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	-0.016	99.000
0	2014	99.000	99.000	99.000	99.000	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000
0	2015	99.000	99.000	99.000	99.000	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000
35	1960	-0.195	99.000	0.084	99.000	99.0	99.0	99.000	99.000	-0.006	99.000	99.000	99.000	99.000	99.000	-0.034	99.000
35	1961	-0.015	99.000	0.031	99.000	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	0.038	99.000
35	1962	-0.225	99.000	0.089	99.000	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	0.081	99.000
35	1963	-0.403	99.000	0.099	99.000	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	0.013	99.000
35	1964	-0.278	99.000	0.066	99.000	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	-0.144	99.000
35	1965	-0.292	-0.322	0.014	0.050	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	0.113	0.020
35	1966	-0.419	-0.332	0.035	0.046	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	0.073	0.026
35	1967	-0.248	-0.339	0.050	0.045	99.0	99.0	-0.196	-0.185	-0.148	-0.147	99.000	99.000	99.000	99.000	99.000	99.000
35	1968	-0.379	-0.346	0.093	0.044	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000
35	1969	-0.401	-0.347	-0.008	0.040	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	-0.188	-0.068
35	1970	-0.310	-0.339	0.032	0.038	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	0.032	-0.063
35	1971	-0.332	-0.317	0.054	0.038	99.0	99.0	0.070	-0.027	99.000	99.000	99.000	99.000	99.000	99.000	-0.057	-0.058
35	1972	-0.375	-0.283	0.047	0.038	99.0	99.0	99.000	99.000	-0.005	-0.008	99.000	99.000	99.000	99.000	-0.064	-0.056

35	1973	-0.123	-0.245	0.028	0.031	99.0	99.0	-0.101	-0.150	-0.025	-0.001	-0.429	-0.391	99.000	99.000	-0.053	-0.052
35	1974	-0.289	-0.219	0.053	0.017	99.0	99.0	-0.339	-0.186	99.000	99.000	99.000	99.000	99.000	99.000	-0.155	-0.038
35	1975	-0.090	-0.219	-0.016	-0.002	99.0	99.0	99.000	99.000	0.073	0.019	99.000	99.000	99.000	99.000	0.136	-0.017
35	1976	-0.162	-0.250	-0.032	-0.018	99.0	99.0	-0.145	-0.157	-0.082	0.028	99.000	99.000	99.000	99.000	-0.089	0.003
35	1977	-0.428	-0.291	-0.060	-0.026	99.0	99.0	-0.098	-0.104	0.128	0.034	0.570	0.523	99.000	99.000	0.092	0.021
35	1978	-0.385	-0.315	-0.014	-0.027	99.0	99.0	99.000	99.000	0.032	0.033	99.000	99.000	99.000	99.000	-0.065	0.038
35	1979	-0.286	-0.316	-0.001	-0.025	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	0.164	0.059
35	1980	-0.269	-0.308	-0.061	-0.022	99.0	99.0	0.172	0.289	-0.025	0.017	99.000	99.000	99.000	99.000	-0.002	0.078
35	1981	-0.296	-0.311	0.013	-0.018	99.0	99.0	0.378	0.348	0.007	0.022	0.302	0.274	0.284	0.137	0.164	0.094
35	1982	-0.324	-0.327	-0.041	-0.009	99.0	99.0	0.561	0.362	0.054	0.033	99.000	99.000	0.003	0.105	0.073	0.104
35	1983	-0.342	-0.349	-0.010	0.005	99.0	99.0	0.295	0.342	0.065	0.042	0.235	0.235	0.116	0.075	0.126	0.111
35	1984	-0.417	-0.365	0.043	0.019	99.0	99.0	0.281	0.300	0.015	0.046	0.127	0.222	0.038	0.050	0.150	0.120
35	1985	-0.342	-0.366	0.061	0.023	99.0	99.0	0.256	0.246	0.082	0.045	0.429	0.189	-0.015	0.037	0.019	0.142
35	1986	-0.427	-0.331	0.035	0.017	6.6	4.2	0.220	0.181	0.031	0.040	0.072	0.119	0.033	0.040	0.181	0.177
35	1987	-0.364	-0.243	-0.035	0.011	7.4	2.8	0.187	0.100	0.053	0.031	0.180	0.020	0.070	0.057	0.316	0.212
35	1988	-0.249	-0.105	-0.039	0.018	-4.8	1.6	-0.067	0.016	-0.021	0.021	-0.379	-0.069	-0.028	0.079	0.252	0.229
35	1989	0.261	0.027	0.046	0.039	1.6	1.3	-0.126	-0.041	0.041	0.015	-0.126	-0.114	0.309	0.086	0.175	0.224
35	1990	0.390	0.085	0.120	0.062	-1.3	2.2	-0.188	-0.047	-0.007	0.015	-0.062	-0.111	0.051	0.069	0.294	0.197
35	1991	0.035	0.039	0.069	0.070	4.4	4.1	0.037	-0.010	0.009	0.021	-0.197	-0.077	-0.056	0.038	0.189	0.157
35	1992	-0.024	-0.073	0.102	0.059	7.4	6.2	0.046	0.033	0.029	0.029	0.044	-0.037	0.061	0.011	0.012	0.116
35	1993	-0.340	-0.184	0.058	0.030	10.0	7.5	0.186	0.044	0.053	0.033	0.018	-0.010	-0.061	-0.005	0.066	0.090
35	1994	-0.404	-0.238	-0.040	-0.004	9.4	7.2	0.126	0.004	0.077	0.028	0.060	-0.016	0.005	-0.007	0.072	0.078
35	1995	-0.221	-0.222	-0.066	-0.027	10.7	5.3	-0.204	-0.069	-0.021	0.016	-0.002	-0.062	99.000	99.000	0.169	0.072
35	1996	-0.219	-0.157	-0.065	-0.031	-1.0	2.8	-0.116	-0.136	0.005	0.003	-0.081	-0.123	-0.092	0.047	-0.030	0.064
35	1997	-0.063	-0.083	-0.027	-0.018	-7.1	1.0	-0.289	-0.159	-0.036	-0.003	-0.409	-0.155	0.217	0.075	0.043	0.055
35	1998	0.189	-0.035	0.032	-0.002	5.5	0.4	-0.240	-0.123	0.017	-0.002	-0.247	-0.126	0.120	0.075	0.139	0.043
35	1999	-0.087	-0.016	0.039	0.004	0.8	0.3	-0.111	-0.053	-0.019	0.001	-0.021	-0.056	0.074	0.047	-0.003	0.023
35	2000	-0.101	0.000	0.011	0.000	-0.0	0.0	0.364	0.000	0.059	0.000	0.299	0.000	-0.029	0.000	0.002	0.000
35	2001	-0.053	0.033	-0.063	-0.002	-1.9	-0.3	-0.071	-0.002	-0.052	-0.004	-0.069	0.005	-0.028	-0.044	-0.095	-0.014
35	2002	0.299	0.075	-0.019	0.009	-1.1	-0.5	0.009	-0.047	0.004	-0.008	-0.018	-0.029	-0.192	-0.072	0.011	-0.014
35	2003	-0.009	0.110	0.032	0.033	0.3	-0.6	-0.184	-0.087	-0.013	-0.010	-0.082	-0.068	-0.059	-0.084	0.014	-0.005
35	2004	0.161	0.134	0.089	0.058	2.0	-1.1	-0.339	-0.089	-0.023	-0.011	-0.158	-0.087	0.025	-0.088	-0.014	0.007
35	2005	0.150	0.149	0.110	0.071	-4.1	-2.3	0.143	-0.069	0.025	-0.014	-0.141	-0.078	-0.222	-0.082	-0.009	0.019
35	2006	0.230	0.153	0.080	0.065	-1.9	-3.9	0.097	-0.067	-0.045	-0.018	0.004	-0.046	-0.133	-0.059	0.099	0.032
35	2007	0.117	0.137	0.063	0.047	-8.4	-5.4	-0.177	-0.091	-0.034	-0.021	-0.028	-0.005	0.025	-0.029	-0.005	0.044
35	2008	0.147	0.097	-0.017	0.026	-4.8	-6.2	-0.267	-0.104	-0.012	-0.025	0.041	0.034	0.224	-0.013	0.065	0.053
35	2009	0.075	0.035	0.013	0.012	-11.9	-5.6	-0.108	-0.069	0.004	-0.035	0.098	0.063	-0.222	-0.022	0.088	0.059
35	2010	-0.012	-0.033	0.002	0.005	99.0	99.0	-0.047	0.014	-0.042	-0.050	0.096	0.079	99.000	99.000	0.045	0.059
35	2011	-0.263	99.000	-0.025	99.000	7.3	99.0	0.166	99.000	-0.139	99.000	0.163	99.000	99.000	99.000	0.081	99.000
35	2012	-0.074	99.000	0.053	99.000	99.0	99.0	0.350	99.000	-0.047	99.000	-0.161	99.000	99.000	99.000	0.009	99.000
35	2013	-0.308	99.000	-0.028	99.000	99.0	99.0	0.234	99.000	99.000	99.000	0.377	99.000	99.000	99.000	0.079	99.000
35	2014	0.561	99.000	99.000	99.000	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000
35	2015	99.000	99.000	99.000	99.000	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000

Table A11.5: Yearly time series for the southern North Sea. For each of the eight parameters (abbreviated T, S, OX, NI, PH, SI, AM, CL) both unsmoothed (columns 3, 5, 7, 9, 11, 13, 15, 17) and smoothed (columns 4, 6, 8, 10, 12, 14, 16, 18) yearly anomaly values Δ are given. Parameter units like everywhere in the text. Anomalies are relative to the year 2005. Dummy values are represented by 99.000.

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
Level(m)	**Year**	**ΔT1**	**ΔT2**	**ΔS1**	**ΔS2**	**ΔOX1**	**ΔOX2**	**ΔNI1**	**ΔNI2**	**ΔPH1**	**ΔPH2**	**ΔSI1**	**ΔSI2**	**ΔAM1**	**ΔAM2**	**ΔCL1**	**ΔCL2**
0	1987	-0.682	-0.454	0.044	0.060	-6.9	-13.0	0.029	0.018	0.079	0.070	0.590	0.142	0.183	0.123	-0.024	0.045
0	1988	-0.222	-0.302	0.086	0.091	99.0	99.0	-0.073	-0.011	0.115	0.079	0.121	0.110	0.029	0.118	0.072	0.073
0	1989	0.077	-0.181	0.116	0.124	99.0	99.0	0.003	-0.033	0.101	0.081	-0.134	0.037	0.105	0.120	0.054	0.120
0	1990	0.084	-0.146	0.190	0.149	99.0	99.0	-0.058	-0.049	0.041	0.077	-0.154	-0.027	0.117	0.141	0.188	0.177
0	1991	-0.349	-0.179	0.189	0.154	-12.5	-13.6	-0.087	-0.063	99.000	99.000	99.000	99.000	0.156	0.172	0.309	0.215
0	1992	-0.218	-0.215	0.213	0.132	-16.3	-10.6	-0.051	-0.074	99.000	99.000	99.000	99.000	0.266	0.195	0.353	0.210
0	1993	-0.497	-0.208	0.073	0.090	2.6	-7.4	-0.081	-0.078	0.073	0.083	0.144	0.051	0.290	0.193	0.144	0.160
0	1994	-0.006	-0.172	-0.014	0.051	-14.6	-4.2	-0.150	-0.071	0.108	0.086	0.020	0.049	0.093	0.172	0.064	0.090
0	1995	0.182	-0.147	-0.044	0.032	8.3	-1.4	-0.064	-0.054	0.073	0.086	0.000	0.037	0.159	0.146	-0.038	0.028
0	1996	-0.538	-0.137	0.096	0.033	-7.0	0.9	0.124	-0.038	99.000	99.000	99.000	99.000	0.075	0.121	-0.034	-0.010
0	1997	-0.065	-0.114	0.018	0.042	15.3	2.0	-0.204	-0.027	99.000	99.000	99.000	99.000	0.199	0.093	0.005	-0.027
0	1998	-0.058	-0.069	0.069	0.043	-6.1	1.8	0.091	-0.016	99.000	99.000	99.000	99.000	0.045	0.057	-0.106	-0.029
0	1999	0.054	-0.024	0.061	0.029	7.1	0.7	-0.072	-0.005	99.000	99.000	99.000	99.000	-0.042	0.021	0.005	-0.019
0	2000	0.059	0.000	0.052	0.000	-5.3	0.0	0.051	0.000	-0.000	0.000	99.000	99.000	-0.042	0.000	-0.012	0.000
0	2001	-0.102	0.009	-0.101	-0.032	-4.7	0.2	0.079	-0.007	99.000	99.000	99.000	99.000	0.033	-0.005	-0.001	0.023
0	2002	0.086	0.014	-0.088	-0.048	6.5	1.2	-0.181	-0.027	99.000	99.000	99.000	99.000	-0.036	-0.000	0.085	0.042
0	2003	-0.020	0.021	-0.101	-0.040	3.9	2.7	0.148	-0.059	99.000	99.000	99.000	99.000	0.028	0.006	0.106	0.049
0	2004	0.085	0.029	0.023	-0.015	-5.0	4.2	-0.207	-0.094	99.000	99.000	99.000	99.000	0.018	0.010	-0.016	0.043
0	2005	-0.029	0.039	0.044	0.009	11.4	5.2	-0.141	-0.118	99.000	99.000	99.000	99.000	99.000	99.000	0.074	0.027
0	2006	0.026	0.051	0.045	0.023	99.0	99.0	-0.236	-0.120	99.000	99.000	99.000	99.000	99.000	99.000	0.031	0.005
0	2007	0.192	0.046	-0.010	0.031	-14.3	4.9	0.064	-0.101	99.000	99.000	99.000	99.000	99.000	99.000	-0.070	-0.013

0	2008	-0.013	0.003	0.014	0.039	3.2	6.3	-0.205	-0.066	99.000	99.000	99.000	99.000	-0.042	-0.040	-0.063	-0.022
0	2009	0.159	-0.077	0.142	0.045	8.2	9.2	-0.106	-0.026	99.000	99.000	99.000	99.000	99.000	99.000	0.021	-0.027
0	2010	-0.440	-0.158	0.004	0.047	99.0	99.0	0.231	0.001	99.000	99.000	99.000	99.000	99.000	99.000	0.003	-0.035
0	2011	-0.380	99.000	-0.016	99.000	4.2	99.0	0.090	99.000	99.000	99.000	99.000	99.000	-0.042	99.000	-0.060	99.000
0	2012	-0.022	99.000	0.141	99.000	2.7	99.0	-0.244	99.000	99.000	99.000	99.000	99.000	99.000	99.000	-0.129	99.000
0	2013	99.000	99.000	99.000	99.000	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	-0.042	99.000	-0.055	99.000
0	2014	99.000	99.000	99.000	99.000	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000
0	2015	99.000	99.000	99.000	99.000	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000
35	1960	-0.106	99.000	0.071	99.000	99.0	99.0	-0.064	99.000	0.009	99.000	0.230	99.000	99.000	99.000	99.000	99.000
35	1961	0.264	99.000	0.055	99.000	99.0	99.0	-0.294	99.000	0.068	99.000	-0.083	99.000	99.000	99.000	99.000	99.000
35	1962	0.097	99.000	0.033	99.000	99.0	99.0	-0.150	99.000	0.100	99.000	0.324	99.000	99.000	99.000	99.000	99.000
35	1963	-0.054	99.000	0.032	99.000	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000
35	1964	-0.161	99.000	0.009	99.000	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000
35	1965	-0.278	-0.221	0.037	0.019	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000
35	1966	-0.329	-0.272	0.005	0.019	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000
35	1967	-0.307	-0.291	-0.018	0.023	99.0	99.0	-0.100	-0.051	-0.004	0.042	99.000	99.000	99.000	99.000	99.000	99.000
35	1968	-0.333	-0.289	0.068	0.029	99.0	99.0	0.047	-0.050	0.058	0.055	-0.119	0.054	99.000	99.000	99.000	99.000
35	1969	-0.204	-0.283	0.057	0.030	99.0	99.0	-0.117	-0.054	0.109	0.068	0.262	0.090	99.000	99.000	99.000	99.000
35	1970	-0.308	-0.286	99.000	99.000	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000
35	1971	-0.225	-0.304	-0.034	0.009	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000
35	1972	-0.399	-0.328	0.038	0.001	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000
35	1973	-0.371	-0.349	-0.013	-0.006	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000
35	1974	-0.304	-0.362	0.011	-0.018	99.0	99.0	0.240	-0.042	0.119	0.072	0.425	0.254	99.000	99.000	99.000	99.000
35	1975	-0.438	-0.367	-0.048	-0.034	99.0	99.0	-0.227	-0.094	0.091	0.051	0.160	0.214	99.000	99.000	99.000	99.000
35	1976	-0.377	-0.366	-0.058	-0.049	99.0	99.0	-0.304	-0.116	-0.044	0.033	0.051	0.178	-0.090	-0.004	99.000	99.000
35	1977	-0.290	-0.360	-0.074	-0.059	99.0	99.0	-0.062	-0.098	0.039	0.024	0.331	0.141	99.000	99.000	99.000	99.000
35	1978	-0.418	-0.350	-0.067	-0.062	99.0	99.0	-0.050	-0.050	0.004	0.030	-0.011	0.090	99.000	99.000	99.000	99.000
35	1979	-0.410	-0.339	-0.060	-0.061	99.0	99.0	0.016	0.004	-0.034	0.049	99.000	99.000	0.467	0.356	99.000	99.000
35	1980	-0.098	-0.342	-0.054	-0.057	-9.5	-0.1	0.103	0.051	0.198	0.066	-0.112	-0.012	99.000	99.000	0.164	0.054
35	1981	-0.458	-0.360	-0.064	-0.053	7.5	1.5	0.040	0.094	0.121	0.069	0.029	-0.022	0.258	0.310	-0.055	0.093
35	1982	-0.454	-0.383	-0.034	-0.047	6.1	2.4	0.083	0.136	-0.067	0.062	99.000	99.000	0.507	0.236	0.295	0.122
35	1983	-0.374	-0.398	-0.068	-0.040	-0.8	2.6	0.317	0.162	0.110	0.056	99.000	99.000	0.107	0.150	0.093	0.133
35	1984	-0.367	-0.406	-0.005	-0.034	3.9	2.4	0.196	0.152	0.066	0.053	0.011	0.073	-0.093	0.082	0.183	0.125
35	1985	-0.431	-0.411	-0.019	-0.032	1.2	2.1	0.198	0.105	0.045	0.051	0.026	0.103	-0.115	0.064	0.068	0.113
35	1986	-0.453	-0.396	-0.044	-0.032	1.2	1.7	-0.116	0.049	0.021	0.051	0.272	0.107	0.181	0.089	0.044	0.109
35	1987	-0.448	-0.340	-0.051	-0.028	5.7	0.8	-0.053	0.009	0.056	0.056	0.242	0.067	0.301	0.116	0.148	0.113
35	1988	-0.369	-0.239	-0.031	-0.017	-3.1	-0.4	0.117	-0.014	0.070	0.062	-0.103	-0.007	0.005	0.117	0.175	0.114
35	1989	0.035	-0.128	-0.001	-0.001	-1.6	-1.3	-0.033	-0.027	0.111	0.063	-0.177	-0.068	0.138	0.100	0.111	0.104
35	1990	0.149	-0.058	0.063	0.014	-8.8	-1.0	-0.223	-0.017	0.027	0.058	-0.243	-0.070	0.074	0.087	0.012	0.089
35	1991	-0.130	-0.057	-0.018	0.022	6.8	0.4	0.054	0.027	0.038	0.055	-0.071	-0.015	0.012	0.090	0.137	0.079
35	1992	0.077	-0.116	0.064	0.023	-1.9	1.8	0.031	0.090	0.049	0.057	0.300	0.049	0.108	0.106	0.025	0.076
35	1993	-0.292	-0.198	0.030	0.018	9.9	2.2	0.468	0.137	0.081	0.061	0.078	0.076	0.191	0.119	0.077	0.072
35	1994	-0.373	-0.257	-0.008	0.011	1.6	1.5	-0.168	0.139	0.082	0.060	0.085	0.049	0.138	0.107	0.178	0.061
35	1995	-0.413	-0.265	-0.029	0.006	-5.0	0.8	0.500	0.089	0.028	0.052	0.061	-0.015	0.197	0.071	-0.100	0.046
35	1996	-0.145	-0.225	0.060	0.003	-1.2	1.2	-0.041	0.010	0.082	0.039	-0.117	-0.082	-0.190	0.031	0.113	0.034
35	1997	-0.180	-0.167	-0.032	0.002	4.1	2.5	-0.346	-0.047	0.005	0.023	-0.314	-0.114	0.032	0.007	-0.030	0.025
35	1998	-0.049	-0.110	0.004	0.002	6.2	3.3	-0.214	-0.046	-0.021	0.010	-0.198	-0.092	0.045	-0.002	0.078	0.019
35	1999	-0.151	-0.055	-0.024	0.003	7.7	2.4	0.281	-0.011	0.018	0.002	0.097	-0.039	0.037	-0.003	-0.040	0.010
35	2000	0.026	0.000	0.056	0.000	-0.0	0.0	0.034	0.000	-0.009	0.000	0.088	0.000	-0.194	0.000	0.036	0.000
35	2001	0.108	0.046	0.026	-0.011	-6.5	-2.6	0.068	-0.035	-0.006	0.002	0.043	0.002	0.183	-0.001	-0.018	-0.008
35	2002	0.150	0.079	-0.092	-0.024	-7.2	-3.9	-0.301	-0.087	-0.002	0.006	-0.118	-0.026	0.002	-0.019	-0.054	-0.011
35	2003	-0.012	0.114	-0.080	-0.026	-6.5	-3.4	-0.035	-0.118	0.035	0.013	0.112	-0.061	-0.002	-0.060	0.016	-0.005
35	2004	0.061	0.171	0.054	-0.017	-0.4	-1.9	-0.293	-0.110	-0.022	0.022	-0.343	-0.080	-0.243	-0.107	-0.027	0.010
35	2005	0.348	0.242	-0.046	-0.004	3.4	-0.9	0.051	-0.075	0.071	0.029	-0.011	-0.078	-0.164	-0.132	0.036	0.028
35	2006	0.397	0.297	0.039	0.004	2.6	-1.1	-0.178	-0.040	0.042	0.028	-0.044	-0.067	99.000	99.000	0.104	0.043
35	2007	0.330	0.308	0.011	0.004	-9.3	-1.8	0.293	-0.028	0.033	0.015	0.004	-0.064	-0.147	-0.062	0.006	0.052
35	2008	0.354	0.265	0.006	-0.006	0.4	-2.2	-0.177	-0.044	0.016	-0.004	-0.030	-0.064	-0.040	-0.022	0.064	0.058
35	2009	0.222	0.179	0.007	-0.021	-3.3	-2.2	-0.135	-0.067	-0.100	-0.018	-0.419	-0.043	0.297	-0.018	0.076	0.059
35	2010	0.115	0.074	-0.096	-0.035	-1.9	-1.9	-0.089	-0.081	-0.007	-0.020	0.354	0.005	-0.173	-0.039	0.085	0.055
35	2011	-0.223	99.000	-0.066	99.000	1.3	99.0	0.024	99.000	-0.026	99.000	-0.157	99.000	-0.243	99.000	0.038	99.000
35	2012	-0.105	99.000	0.041	99.000	-7.5	99.0	-0.190	99.000	0.044	99.000	0.264	99.000	99.000	99.000	-0.025	99.000
35	2013	-0.059	99.000	-0.121	99.000	4.1	99.0	99.000	99.000	-0.037	99.000	0.194	99.000	0.211	99.000	0.097	99.000
35	2014	99.000	99.000	99.000	99.000	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000
35	2015	99.000	99.000	99.000	99.000	99.0	99.0	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000	99.000

List of Figures

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