Product Information Document (PIDoc)

SeaDataCloud Temperature and Salinity Climatology for the North Sea (Version 1)

SDC_NS_CLIM_TS_V1

HORIZON 2020

sdn-userdesk@seadatanet.org – www.seadatanet.org

SeaDataCloud - Further developing the pan-European infrastructure for marine and ocean data management

Grant Agreement Number: 730960

Product Name

SDC_N_CLIM_TS_V1

Extended name

SeaDataCloud Temperature and Salinity Climatologies for the North Sea (Version 1)

Product DOI

Short description

The SDC_NS_CLIM_TS_V1 product contains Temperature and Salinity Climatologies for the North Sea including annual, seasonal and monthly fields covering the time periods 1955-2014 and seasonal fields for 6 decades starting from 1955 to 2014 (1955-1964, 1965-1974, 1975-1984, 1985-1994, 1995-2004, 2005-2014). The climatological fields were computed with a dataset that combines data extracted from 2 major sources: 1) the SeaDataNet infrastructure and 2) the World Ocean Database 2018. The computation was done with the DIVAnd (Data-Interpolating Variational Analysis in n dimensions), version 2.3.1.

Authors

Charles Troupin, Serge Scory

Dissemination

Public

Copyright terms

How to Cite

History

Version	**Authors**	**Date**	**Comments**
1.0	Ch. Troupin, S. Scory	05/07/2019	First version
1.1	S. Scory	18/07/2019	Full update
1.2	Ch. Troupin	19/07/2019	Final profreading
1.3	S. Simoncelli	23/07/2019	review

Table of contents

Abstract

The SDC_NS_CLIM_TS_V1 product contains Temperature and Salinity Climatologies for the North Sea including annual, seasonal and monthly fields covering the time periods 1955-2014 and seasonal fields for 6 decades starting from 1955 to 2014 (1955-1964, 1965-1974, 1975-1984,1985-1994, 1995-2004, 2005-2014). The climatological fields were computed with a dataset that combines data extracted from 2 major sources: 1) the SeaDataNet infrastructure and 2) the World Ocean Database 2018. The computation was done with the DIVAnd (Data-Interpolating Variational Analysis in n dimensions), version 5.1.7.

1. Data

The input dataset for computation of the North Sea Temperature and Salinity climatological fields includes data retrieved from the SeaDataNet [1] internal data source – the SeaDataNet infrastructure – that were integrated with data from the World Ocean Database:

1. SeaDataCloud (SDC) Temperature and Salinity Historical Data Collection for the North Sea (Version 1) - SDC_NS_DATA_TS_V1_DISCRETE, that contains unrestricted data, excluding, underway data [2].
2. Data extracted from the World Ocean Database 2018 - WOD18 [3].

1.1. Source datasets

1.1.1. SeaDataCloud Temperature and Salinity Historical Data Collection for the North Sea

The SeaDataCloud Temperature and Salinity Historical Data Collection for the North Sea contains temperature and salinity data of the water body (profiles and other discrete samples) retrieved from the SeaDataNet infrastructure at the end of 2017. The detailed description of the collection is provided in [4].

All data in the collection have been quality controlled using the ODV software [5] and according to procedures described in [4]. Bad profiles (*e.g.* stations on land, empty depth levels and empty profiles) were excluded from the collection. The collection covers period 1893 – 2017.

Table 1.1 Data Statistics: total numbers.

	Stations	Values
All samples	162 452	
Temperature	158 622	7 817 193
Salinity	157 545	7 707 384

Spatial and temporal distributions of the considered data are presented at Figure 1-1 and Figure 1-2. The data availability shows high densities in certain areas, due to intensive monitoring or research programmes (Figure 1-1): Belgian coastal zone and Rhine/Meuse Delta, Danish coast, Skagerrak, Firth of Forth and two transects at the Northern boundary.

Although the collection spans from 1893 till 2017, most of the measurements were made during the last 30 years: 115415 discrete and profile stations (out of 162452) were performed after 1985. The coverage over the year is rather uniform (Figure 1-2).

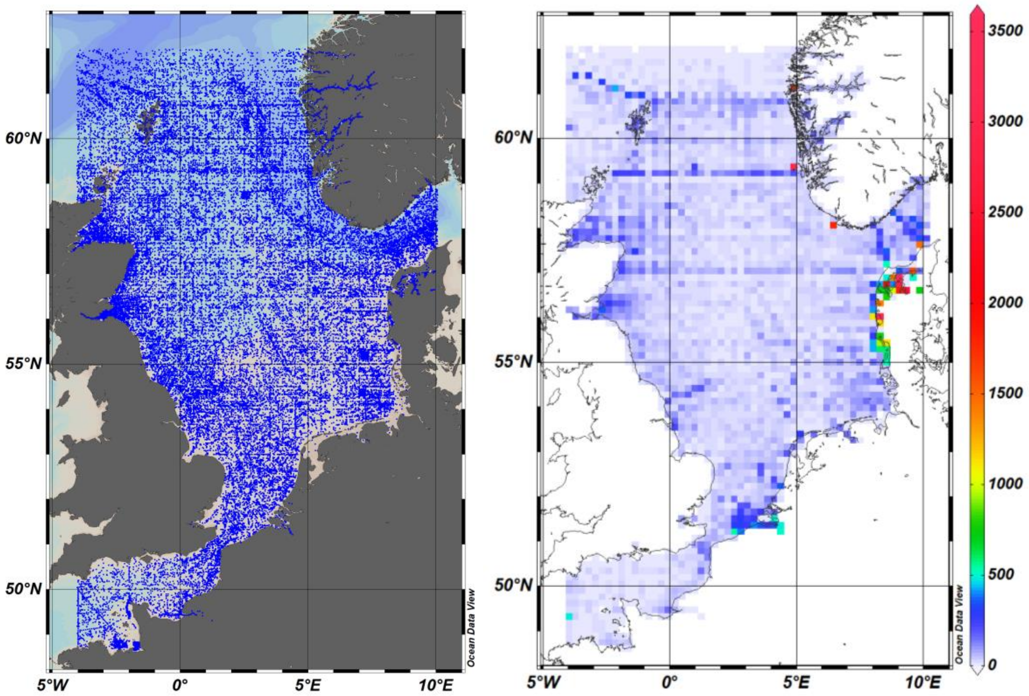


Figure 1-1 Spatial distribution and density of profiles and discrete observations (whole collection).

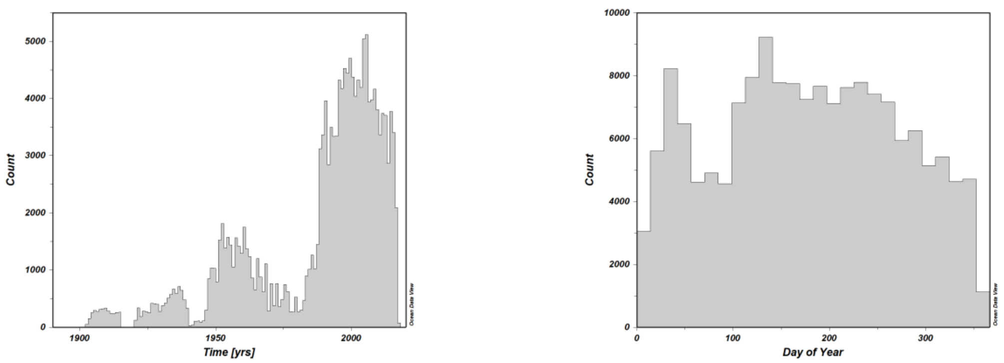


Figure 1-2 Distribution of the measurements (stations) over time (left) and seasonal distribution (right), for the whole collection.

1.1.2. World Ocean Database 2018

North Sea Temperature and Salinity data were downloaded from the WOD18 website (https://www.nodc.noaa.gov/OC5/WOD/pr_wod.html). In order to be consistent with the selected SeaDataCloud data, only the following families of instruments have been selected:

- Ocean Station Data (OSD) [Bottle, low resolution CTD/XCTD, plankton data]
- Profiling floats (PFL)

at native measurement levels and imported to ODV (4) collection for quality check. NB: Only the data for the period 1955-2014 were considered.

The same QC procedure than the one used for checking the data extracted from the SeaDataNet infrastructure was used [4].

Table 1.2 WOD2018 Data Statistics

	Stations	Values
All samples	168 197	
Temperature	161 900	1 108 850
Salinity	158 435	1 076 178

The spatial and temporal distributions of data are presented in Figure 1-3 and Figure 1-4. This dataset also shows zones of active monitoring activities, but it seems that the German and the southern Dutch zones are more present in the WOD dataset while the contrary applies for the Danish area. The seasonal repartitions are similar. In the number of stations reported, a relative shift seems to occur around 1990: there are more stations in SeaDataNet than in WOD after 1990, while it as the contrary before 1990. (Figure 1-5).

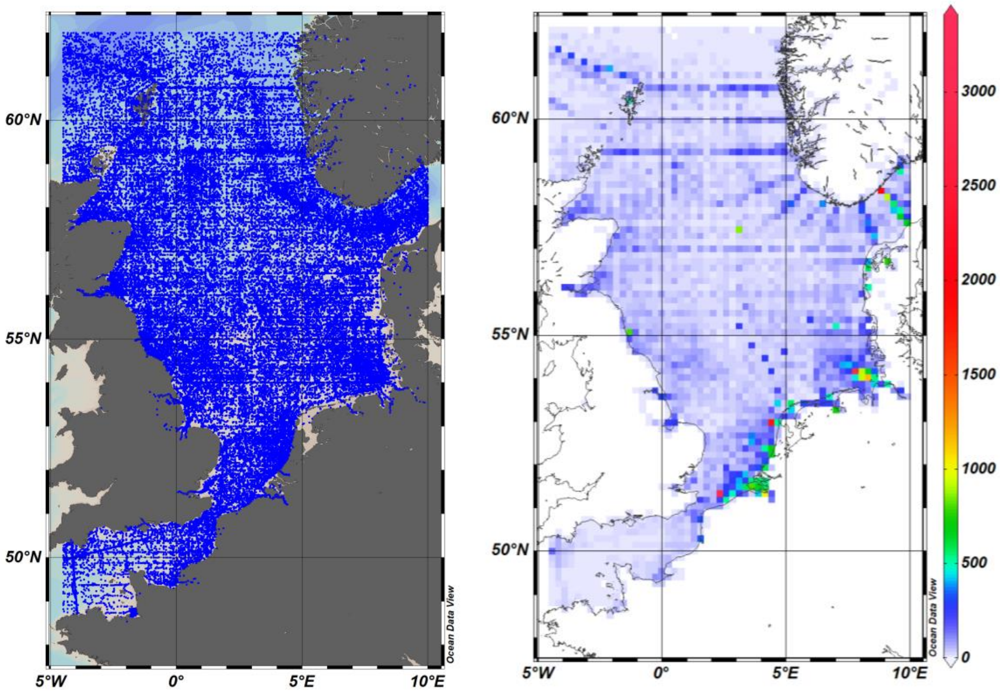


Figure 1-3 Spatial distribution of the stations (left) and density (right) of WOD18 observations, for the period 1955-2014.

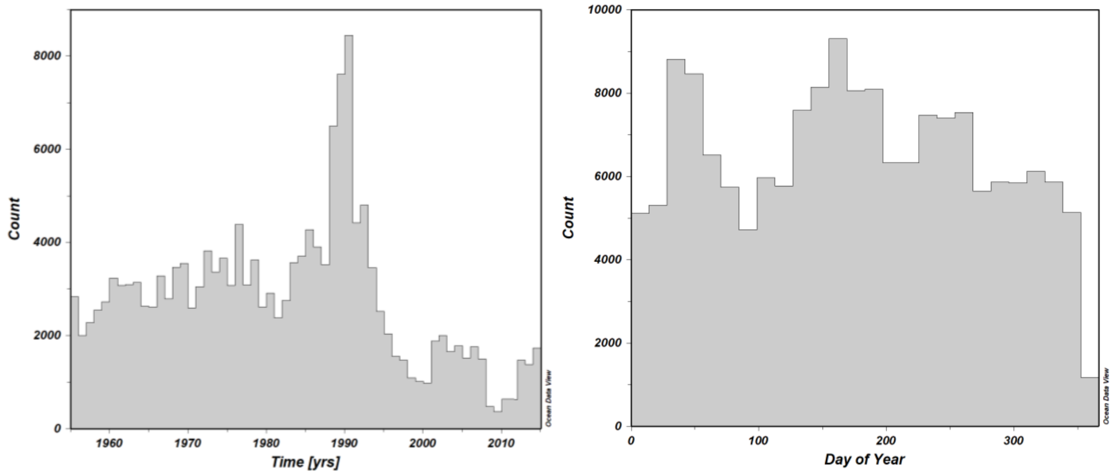


Figure 1-4 Time distribution (left) and seasonal distribution (right) of WOD18 observations for the period 1955-2014.

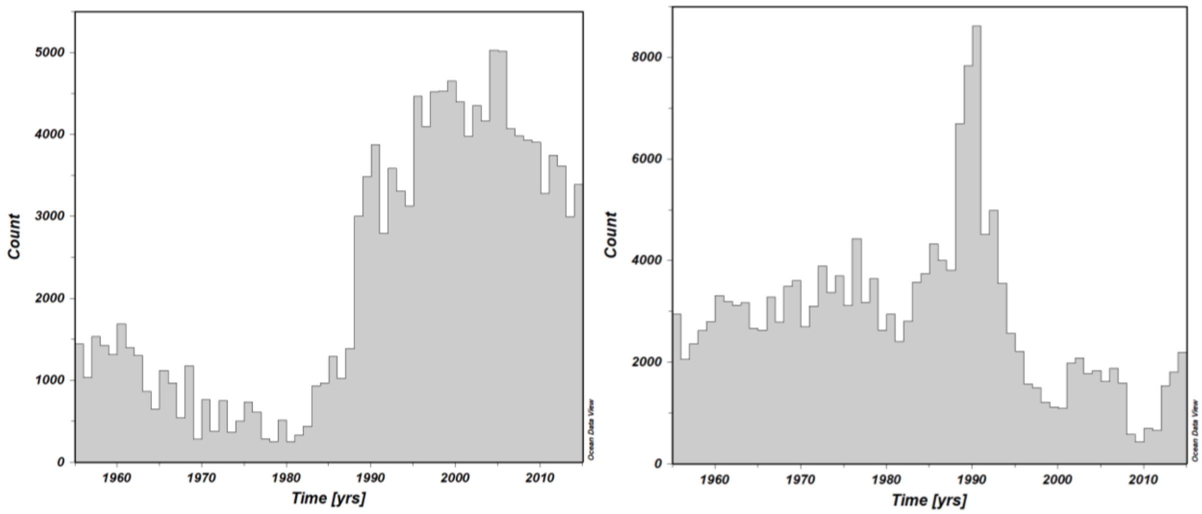


Figure 1-5 Time distribution of the number of measurement over 1955-2014 for the SeaDataCloud discrete dataset (left) and for the WOD18 observations (right). NB: vertical scales differ.

1.2. Integrated dataset

1.2.1. Handling of internal duplicate stations:

Datasets have been checked with the algorithm provided by ODV and its standard parameters (< 0.001° in latitude and longitude, < 1h between the recorded times of measurement).

- 104 true duplicate stations are still present in the SDC dataset (0.06%), *i.e.* same station, same time and same measured parameter. However, the duplicate is most of the time a smaller subset (1 value) of the full profile.
- 196 potential duplicates were found in the WOD18 (0.11%) with a check on position, time, and Cruise, Station, and Type (no direct means to check on measured parameter)

1.2.2. Characteristics of the merged collection (1955-2014)

Table 1.3 Data Statistics: total numbers.

	Stations	Values
All samples	301 238	
Temperature	291 795	8 303 954
Salinity	287 064	8 169 762

Spatial and temporal distributions of the considered data are presented at Figure **1**-**6** and Figure 1-7. As expected the density of available data is higher on the Eastern coast of the North Sea and the merged data set has a more uniform coverage of the overall time period.

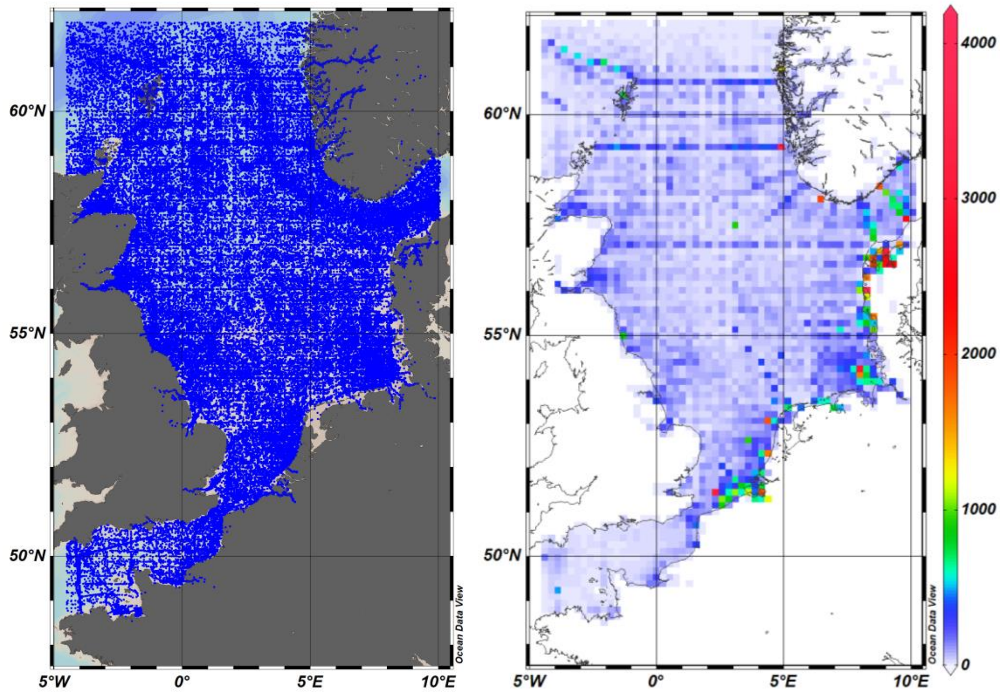


Figure 1-6 **Spatial distribution of the stations (left) and density (right) of the merged data set** (SDC_Discrete_V1 and WOD18 observations), for the period 1955-2014.

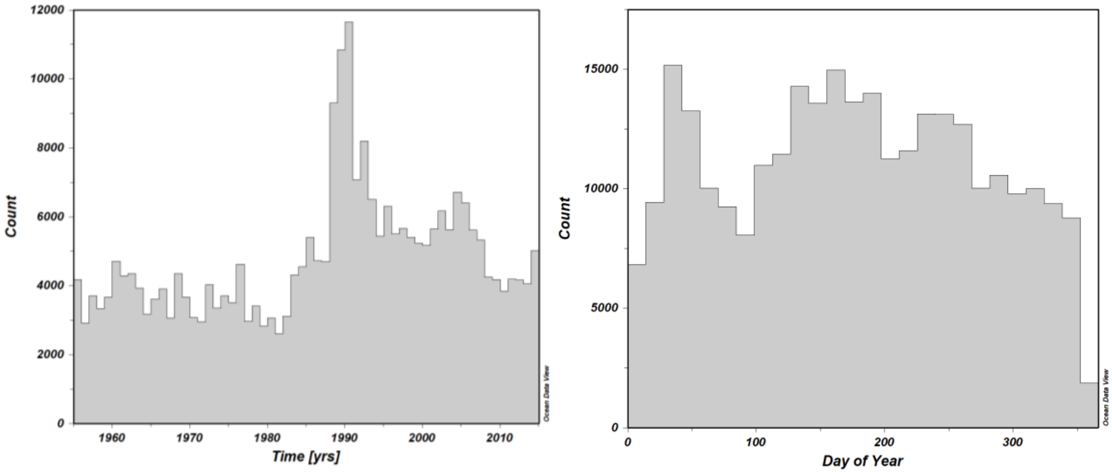


Figure 1-7 Time distribution (left) and seasonal distribution (right) of the merged data set (SDC_Discrete_V1 and WOD18 observations), for the period 1955-2014.

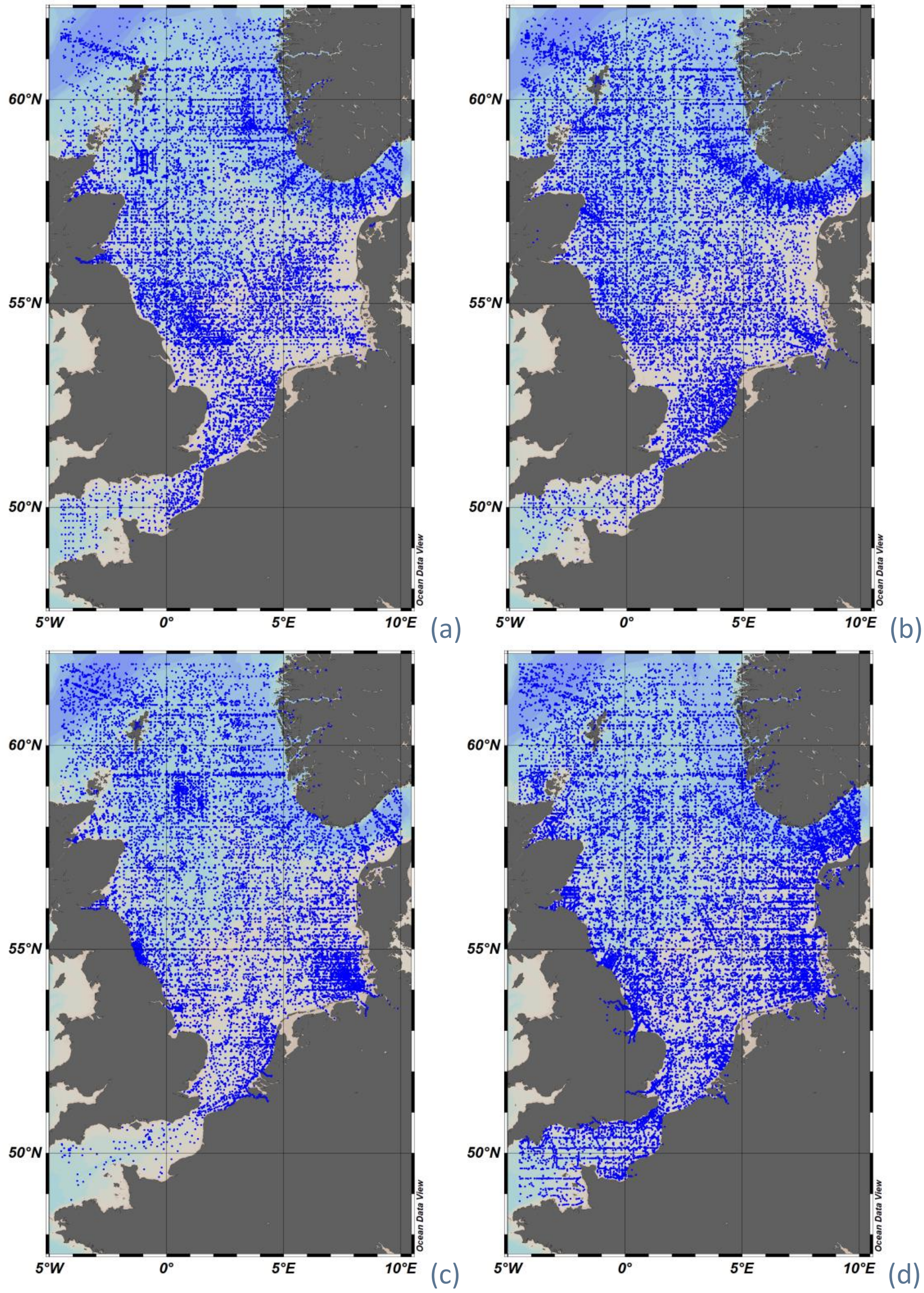
As a first estimate, using the algorithm provided by ODV and its standard parameters (< 0.001° in latitude and longitude, < 1h between the recorded times of measurement), 8046 potential duplicate stations were found (2.6%). Less strict criteria have been applied for running DIVAnd (see Section 3.1).

1.2.3. Decadal repartition

Table 1.4 gives the number of stations that are available by decades and Figure 1-8 shows their spatial distribution. It can be seen that despite the restricted choice of WOD data types, there are a few underway data in the data set, at least in the last decade. Globally the spatial coverage of the whole domain is good.

Table 1.4 Data Statistics: numbers of stations by decade.

Period	Stations
1955-1964	40 197
1965-1974	39 010
1975-1984	37 303
1985-1994	76 026
1995-2004	59 487
2005-2014	49 215
	301 238


60°N
55°N
50°N
5°W
0°
5°E
10°E
Ocean Data View
(a)
(b)
(c)
(d)

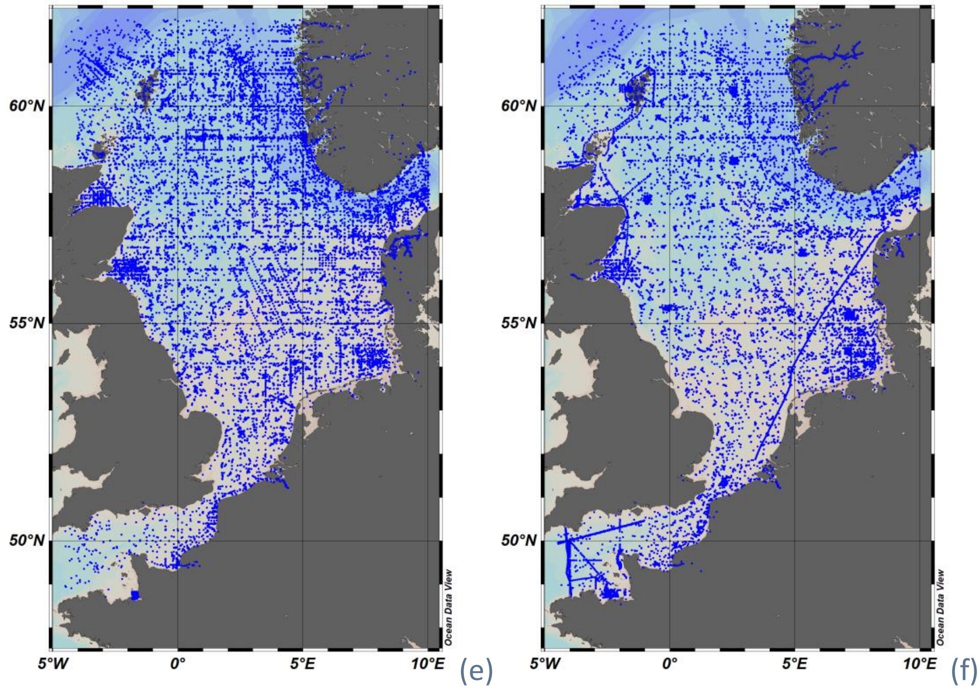


Figure 1-8 Spatial distribution of the stations of the merged data set (SDC_Discrete_V1 and WOD18 observations), by decade: (a) 1955-1964, (b) 1965-1974, (c) 1975-1984, (d) 1985-1994, (e) 1995-2004, (f) 2005-2014.

2. Methodology

2.1. DIVA implementation and settings

Computation of the North Sea Temperature and Salinity climatic fields was done with DIVAnd [7] version 5.1.7. DIVAnd has been implemented in the programming language Julia (https://github.com/gher-ulg/DIVAnd.jl) and is used in conjunction with the Jupyter notebooks (https://jupyter.org/) – the web-based interactive computational environment for creating and sharing documents that contain live code, equations, visualizations and narrative text. This is particularly convenient for climatology generation, because the input files, analysis parameters, visualisations and outputs can be defined directly in a notebook.

2.1.1. Domain definition

The North Sea is defined as the marine area between 4.5°W and 10°E in longitude and 48.5°N and 62°N in latitude. Data in the Irish Sea, the Bristol Channel and in the Great Belt have been eliminated for producing the statistics, maps and graphs above. They are however still present in the data set used when running DIVAnd, but this has no influence on the resulting climatologies for the North Sea.

The North Sea is a shallow basin (Figure 2-1) with its deepest parts in the Norwegian Channel (Skagerrak, up to -700m) and North of the Shetland Islands (up to -500m).

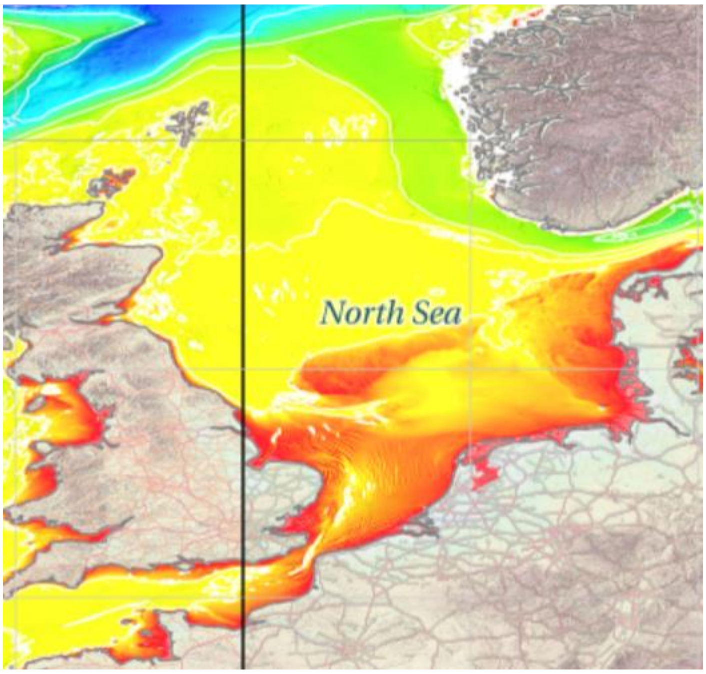


Figure 2-1: Bathymetry of the North Sea (screen copy of the EMODnet-Bathymetry viewer, http://portal.emodnet-bathymetry.eu/?menu=19, on 11/07/2019.

For the computation of the climatologies, the horizontal resolution is 1/8° and the vertical resolution corresponds to the 41 first depth levels of the WOA18: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, 125, 150, 175, 200, 225, 250, 275, 300, 325, 350, 375, 400, 425, 450, 475, 500, 550, 600, 650 and 700m.

Temporal resolution:

- Annual and monthly for the period 1955 – 2014;
- Seasonal for the periods
  1955 – 1964,
  1965 – 1974,
  1975 – 1984,
  1985 – 1994,
  1995 – 2004,
  2005 – 2014 and
  1955 – 2014.

Seasons definition: months 1, 2, 3 = winter; 4, 5, 6 = spring; 7, 8, 9 = summer; 10, 11, 12 = autumn.

No background field was used.

2.1.2. DIVAnd settings

Bathymetry: GEBCO 30 sec bathymetry [8] (original resolution decreased by a factor 16). Using a finer resolution resulted in a more complex coastline leaving disconnected fjords or lakes. Figure 2-2 below compares the 3 bathymetries, with the finest resolution on the left side. The corresponding masks (at the surface) are also displayed to highlight the presence of isolated islands or lakes.

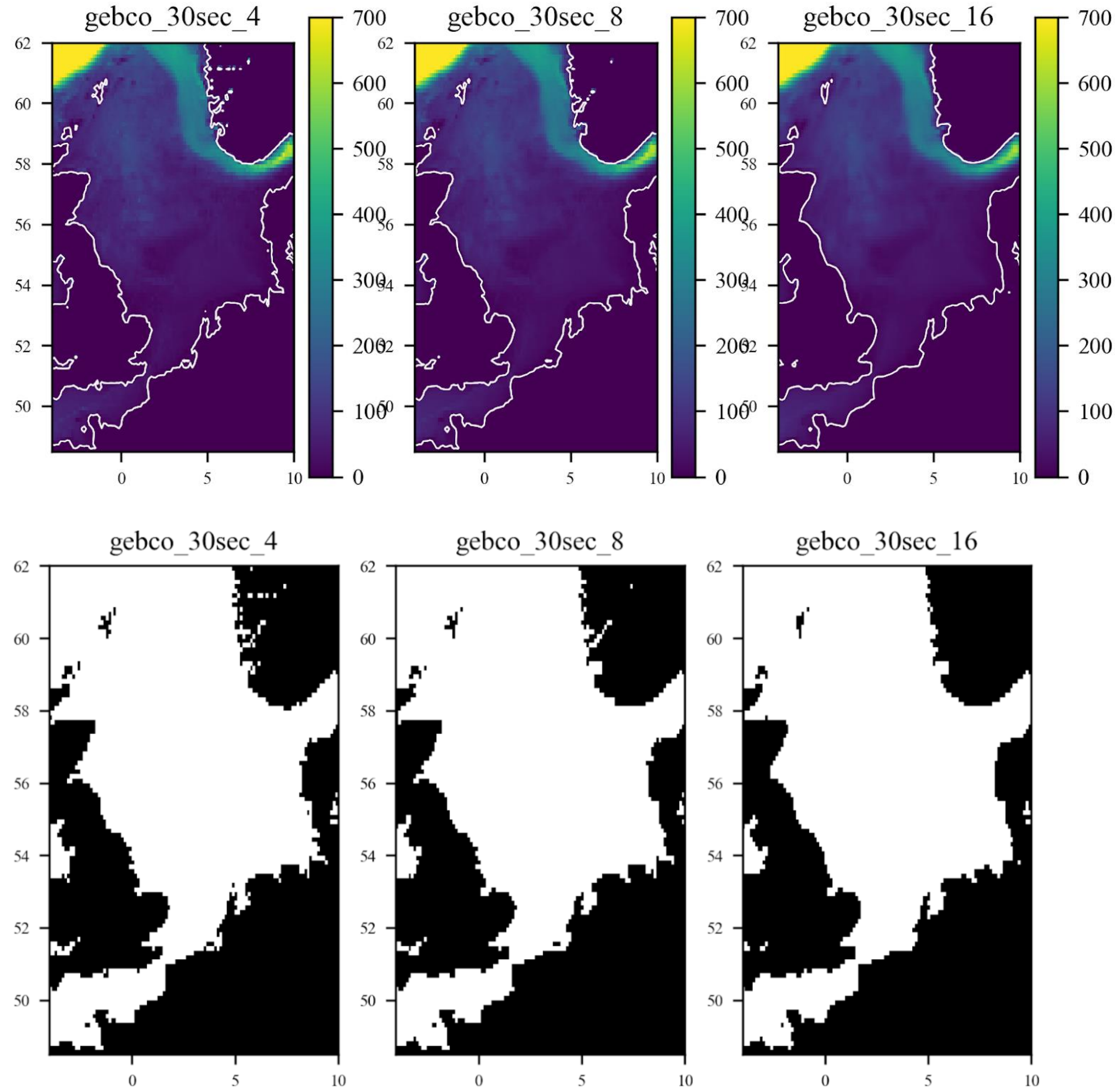


Figure 2-2: Bathymetry of the North Sea at different resolution with the resulting masks.

As said above, the external areas of the Irish Sea, the Bristol Channel and the Great Belt were not masked for the DIVAnd computations but this does not influence the results for the North Sea itself.

DIVAnd parameters

Parameter name	Note	Temperature climatology	Salinity climatology
Horizontal correlation length	Km	100	100
Vertical correlation length [m]	Depth dependent for the 41 levels		
epsilon2		0.1	0.1
epsilon2	With weights of the observations	Test was performed but didn't significantly influenced the results	Test was performed but didn't significantly influenced the results
niter_e			
MEMTOFIT	Controls memory allocation	100	100
Solver		Direct	Direct
fitcorrlen	If 'true' then DIVAnd calculates correlation lengths	false	false
Surfextend	If 'true' then DIVAnd will add an extra layer on top to improve the surface field	true	true
Minfield	Minimum of parameter	-1.0	0
Coeff_derivative2	Small penalty on the 2nd derivative	0	0

Note on the coefficient derivative:

When this coefficient is defined, an additional term is added to the cost function penalizing the second derivative. According to the documentation, typical values of this parameter according to x, y, z are `[0.,0.,1e-9]`. We ran the analysis with and without using this option. Results for different depths (annual fields) are shown hereinafter (Figure 2-3 and Figure 2-4) for temperature and salinity. A consequence of using a non-zero value is that DIVAnd tends to let the field converge more to the global mean. We noted, especially for the last two decades where relatively high number of low salinity data (more coastal measurements, in fjords and even in rivers) are present that this induces a significant lowering of the global salinity field for the whole area. Therefore we decided not to penalize the second derivative. This is already noticeable in the fields calculated for the whole period *e.g.* Salinity at the surface as shown on Figure 2-4.

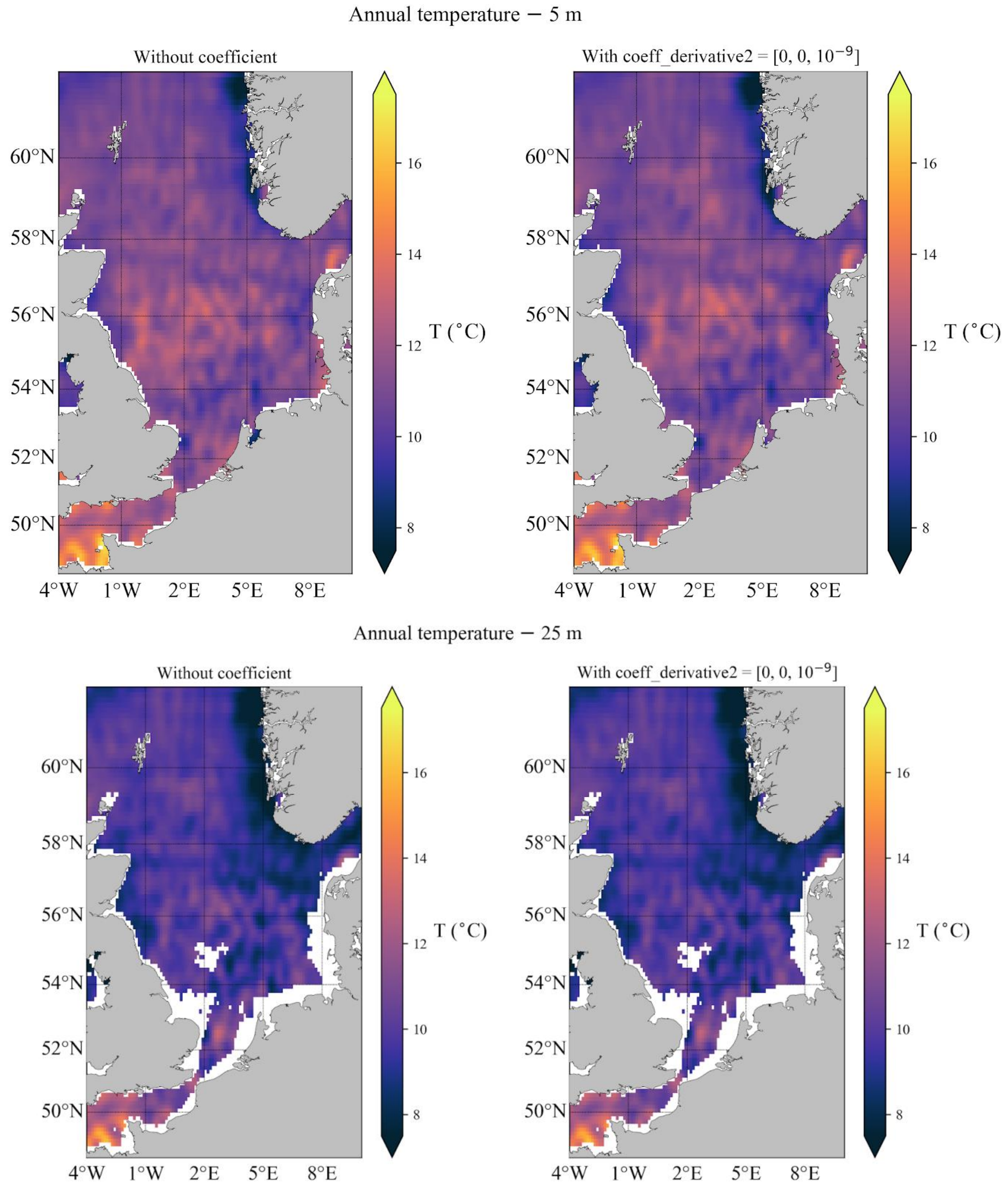


Figure 2-3: Influence of the coefficient derivative on temperature fields at 5m (top) and 25m (bottom) of depth. On the right

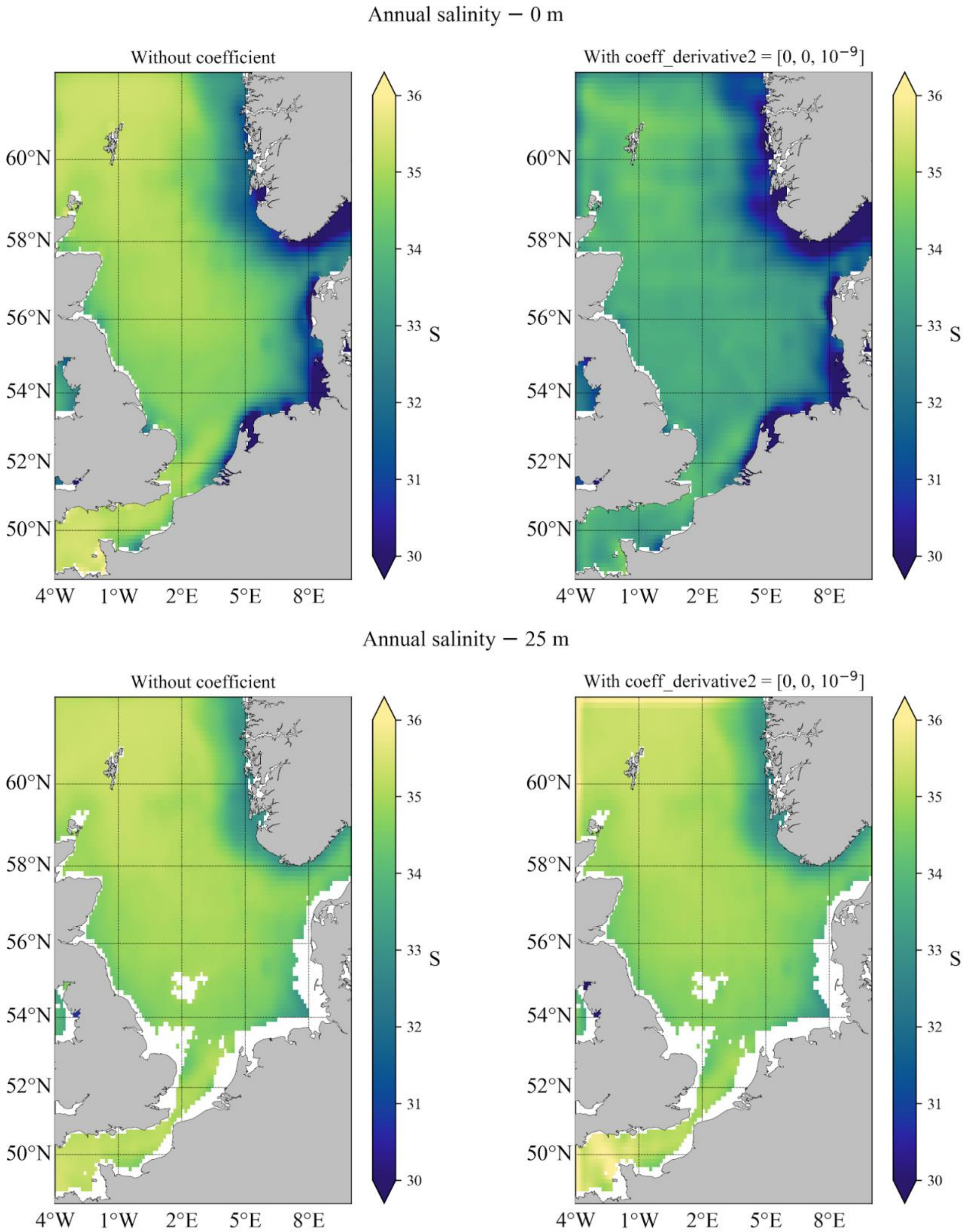


Figure 2-4: Influence of the coefficient derivative.

Note on Minfield:

This option is used to set a minimal value to the interpolated field. For salinity we use `minfield=0.0` and for temperature `minfield=-1°C`. This allows us to remove very located areas with negative salinity or very low temperature due to a few data points displaying strong gradients. We encountered this problem in the Dutch "Waddenzee", where 1169 "stations", located in fact at only 7 different locations, contain widely scattered values (all at the surface, 0 or -1 m) that generate numerical artefacts in the southern part of the area (Figure 2-5)

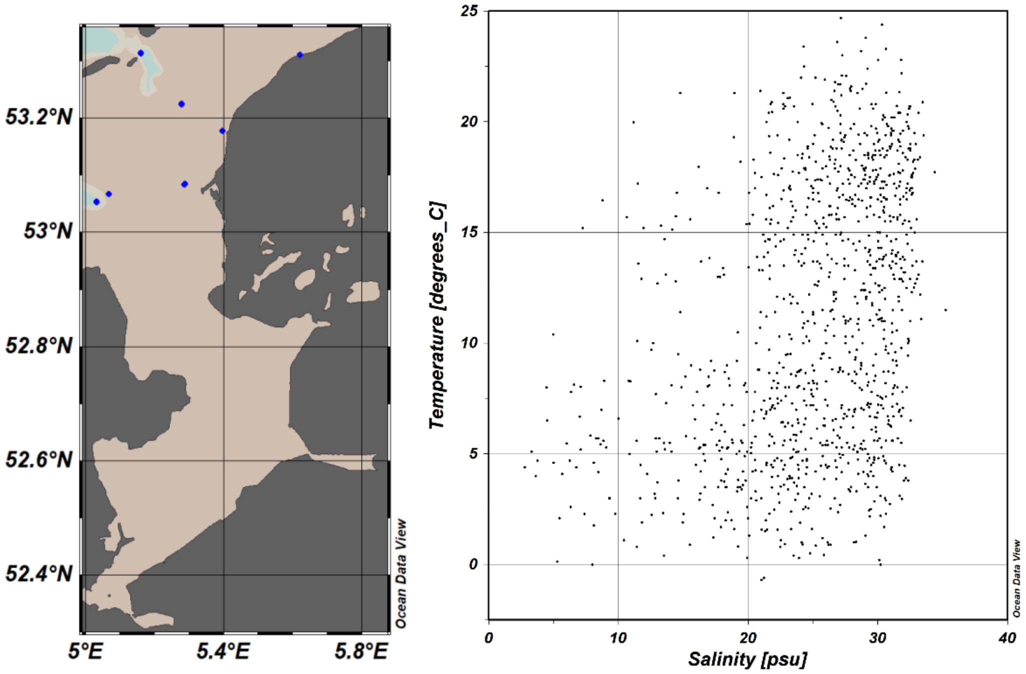


Figure 2-5: The Waddenzee area, where a limited number of measuring stations, exhibiting a widely scattered range of values, induced abnormal gradients when no lower bound was set.

3. Climatology

3.1. Pre-processing

For the WOD data, only the observations with a quality flag (QF) equal to 0 (good data) are conserved. For the SDC data, only the observations with a QF equal to 1 (good) or 2 (probably good) are conserved.

A few remaining data points with a missing value (-999.99, *etc.*) also had to be removed. In addition, a few stations with a suspicious date (negative year) due to incomplete metadata, have been removed.

The duplicate detection and removal was performed using the tool DIVAnd.Quadtrees.checkduplicates [9], with the following values for the parameters:

Delta lon	0.01°
Delta lon	0.01°
Delta depth	1 m

Delta time	2 hours (to take into account possible inconsistencies UTC vs. local (summer) time)
Delta T **Delta S**	0.1°C 0.1 PSU

The check for duplicates is thus done at the data level, not at the station level as done with ODV in the inspection of the data sources described above. The criteria on location and time difference are also wider than the standard values used by ODV.

Both for temperature and salinity, this resulted in the identification of 2.4% of the data (compared to the 2.6% estimated in first instance using ODV). These have been eliminated before proceeding.

3.2. Temperature

3.2.1. Whole period: 1955-2014

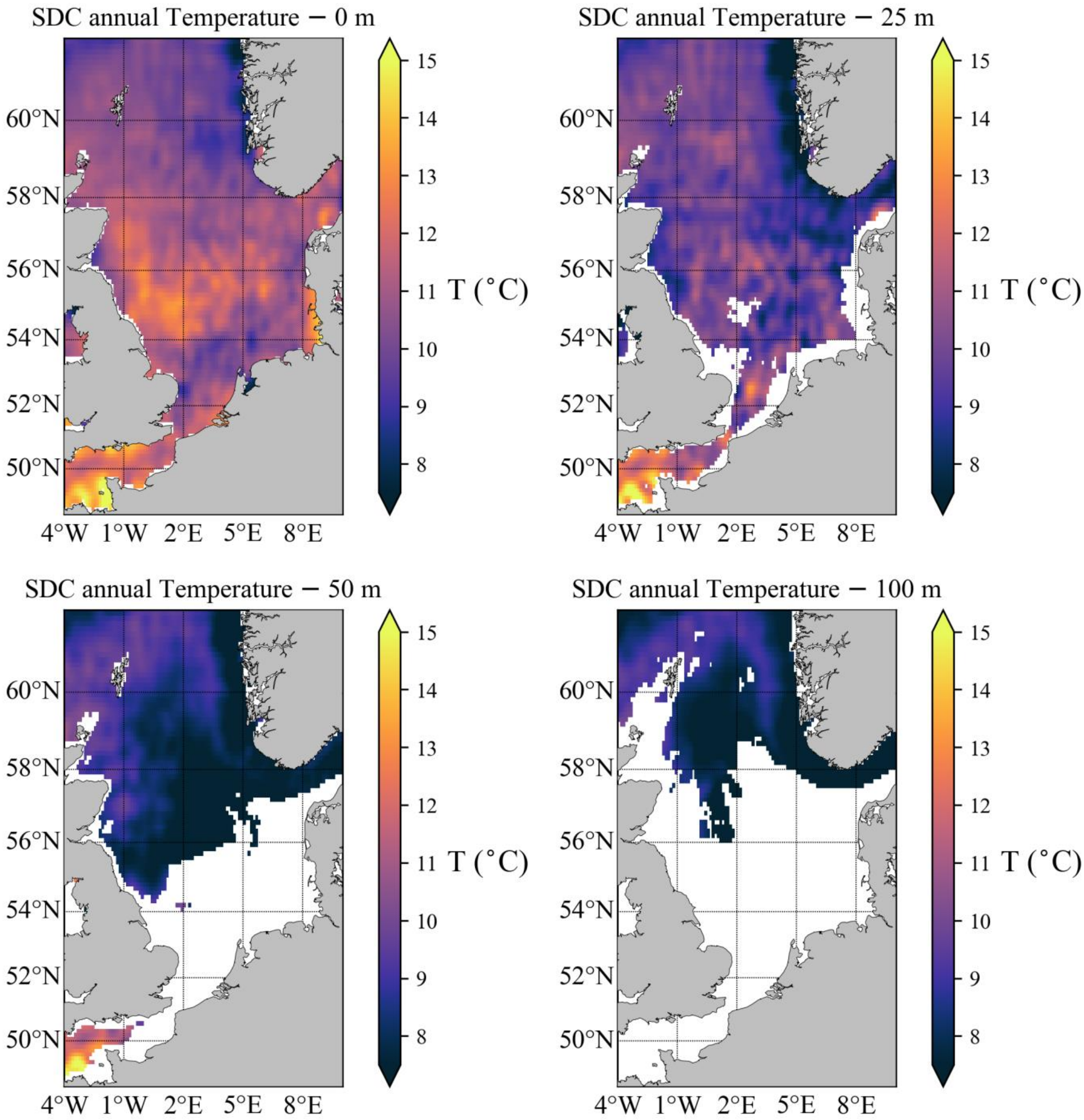


Figure 3-1 Temperature fields at depths = 0, 25, 50 and 100m as computed with the whole data set (1955-2014).

3.2.2. Monthly fields over the whole period

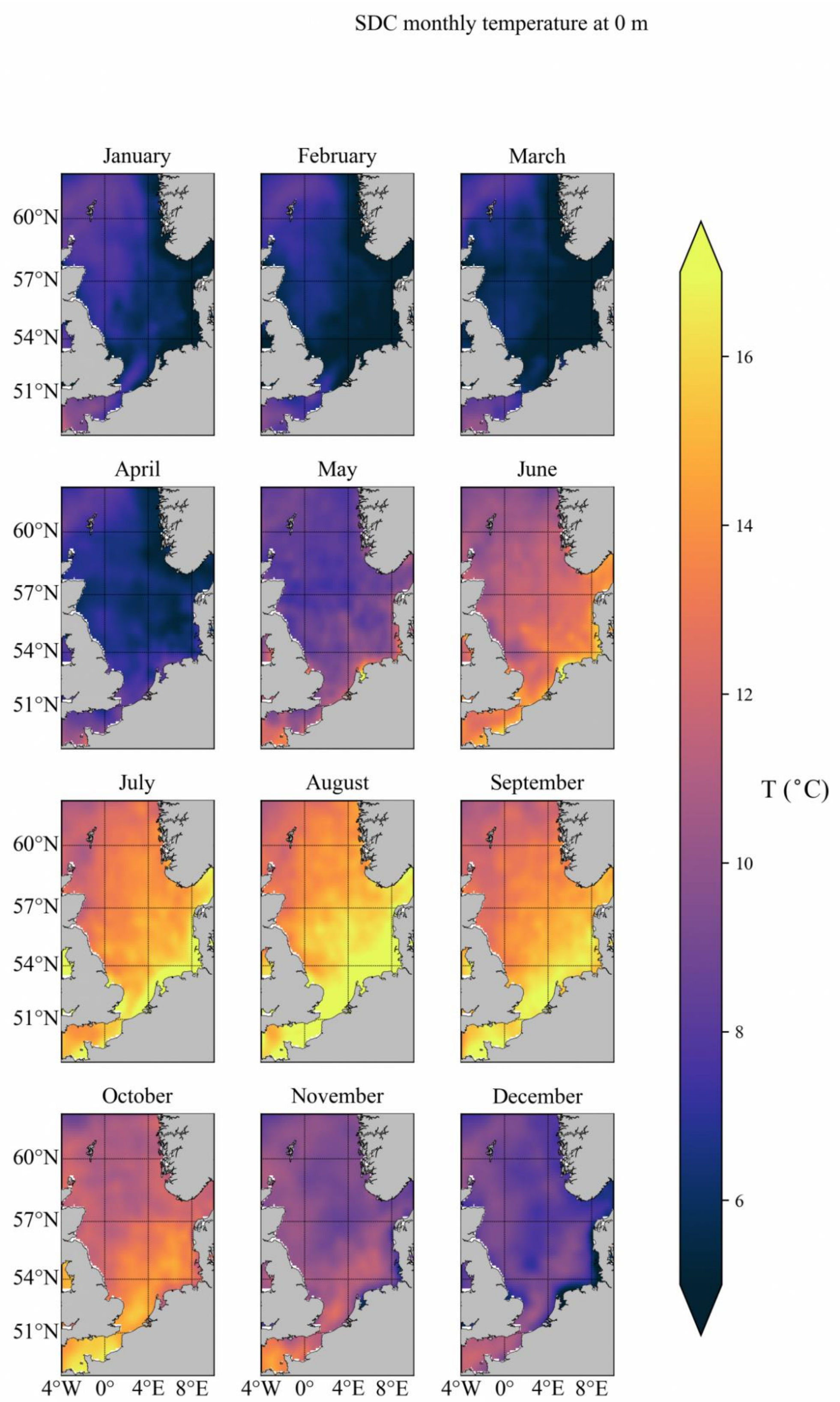
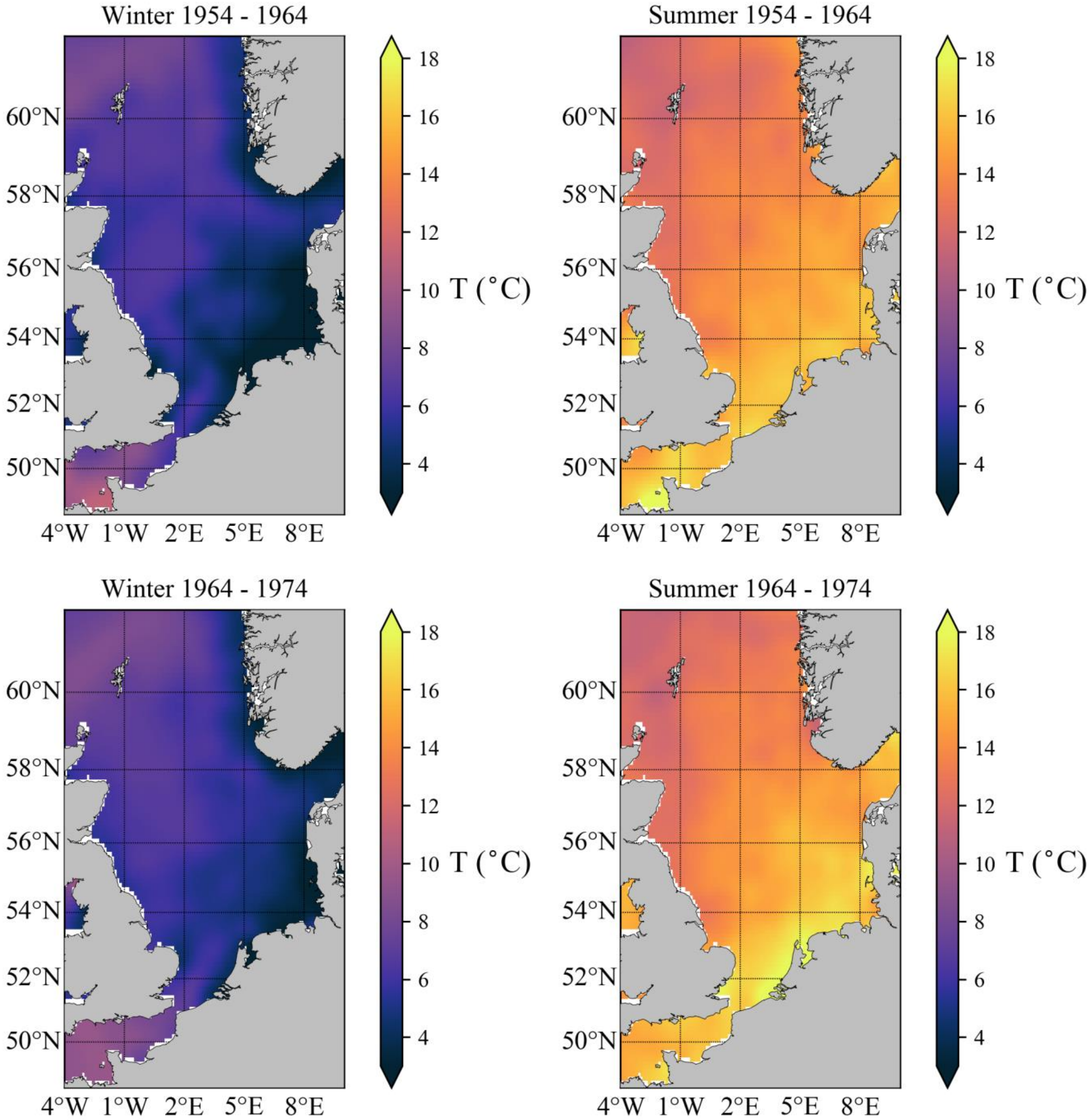
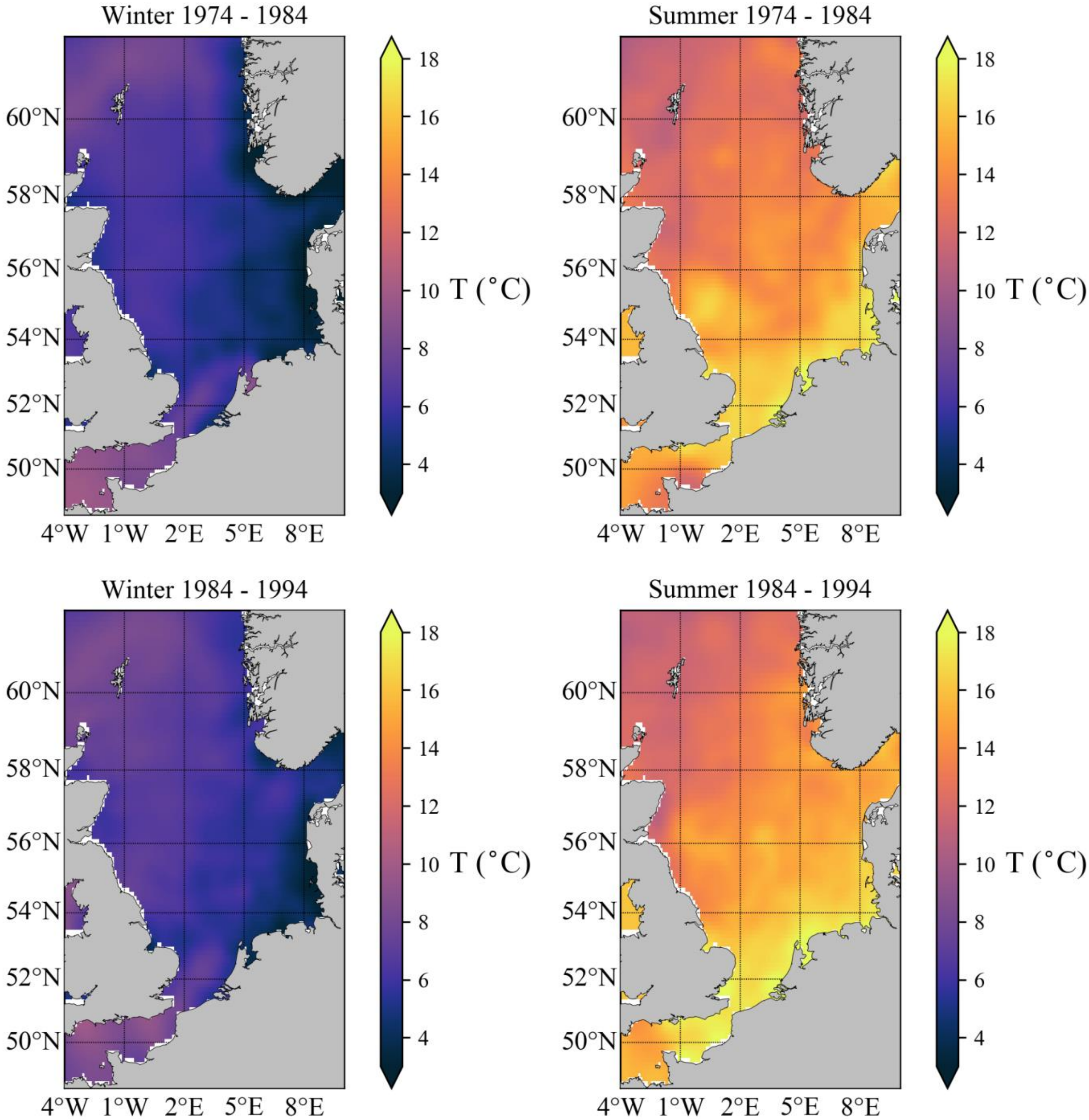


Figure 3-2 A comparison of the monthly Temperature fields at the surface as computed with the whole data set (1955-2014).

3.2.3. Seasonal fields over the six decades




Winter 1974 - 1984
Summer 1974 - 1984
Winter 1984 - 1994
Summer 1984 - 1994
60°N
58°N
56°N
54°N
52°N
50°N
4°W 1°W 2°E 5°E 8°E
18
16
14
12
10 T (°C)
8
6
4

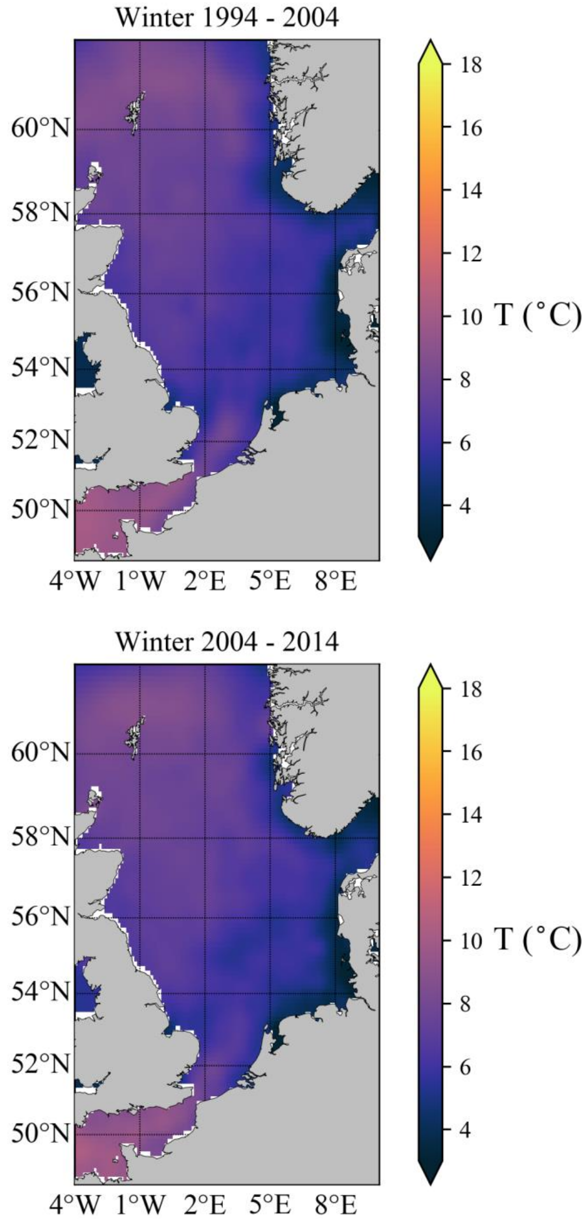


Figure 3-3 Variation of winter Temperature (Jan, Feb, Mar) and summer Temperature (Jul, Aug, Sep) at the surface in 6 decades in period 1955-2014.

3.3. Salinity

3.3.1. Whole period: 1955-2014

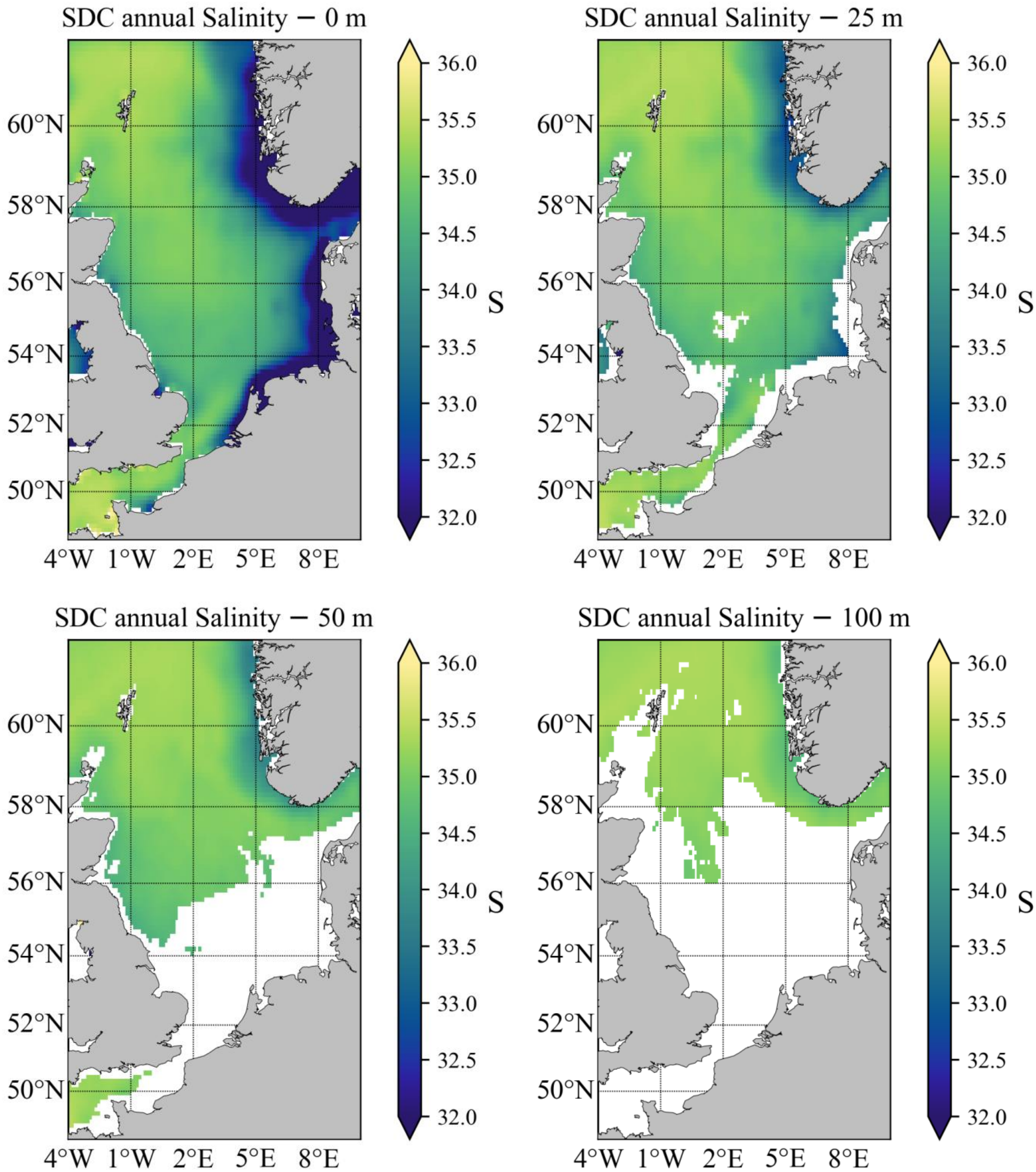


Figure 3-4 Salinity fields at depths = 0, 25, 50 and 100m as computed with the whole data set (1955-2014).

3.3.2. Monthly fields over the whole period

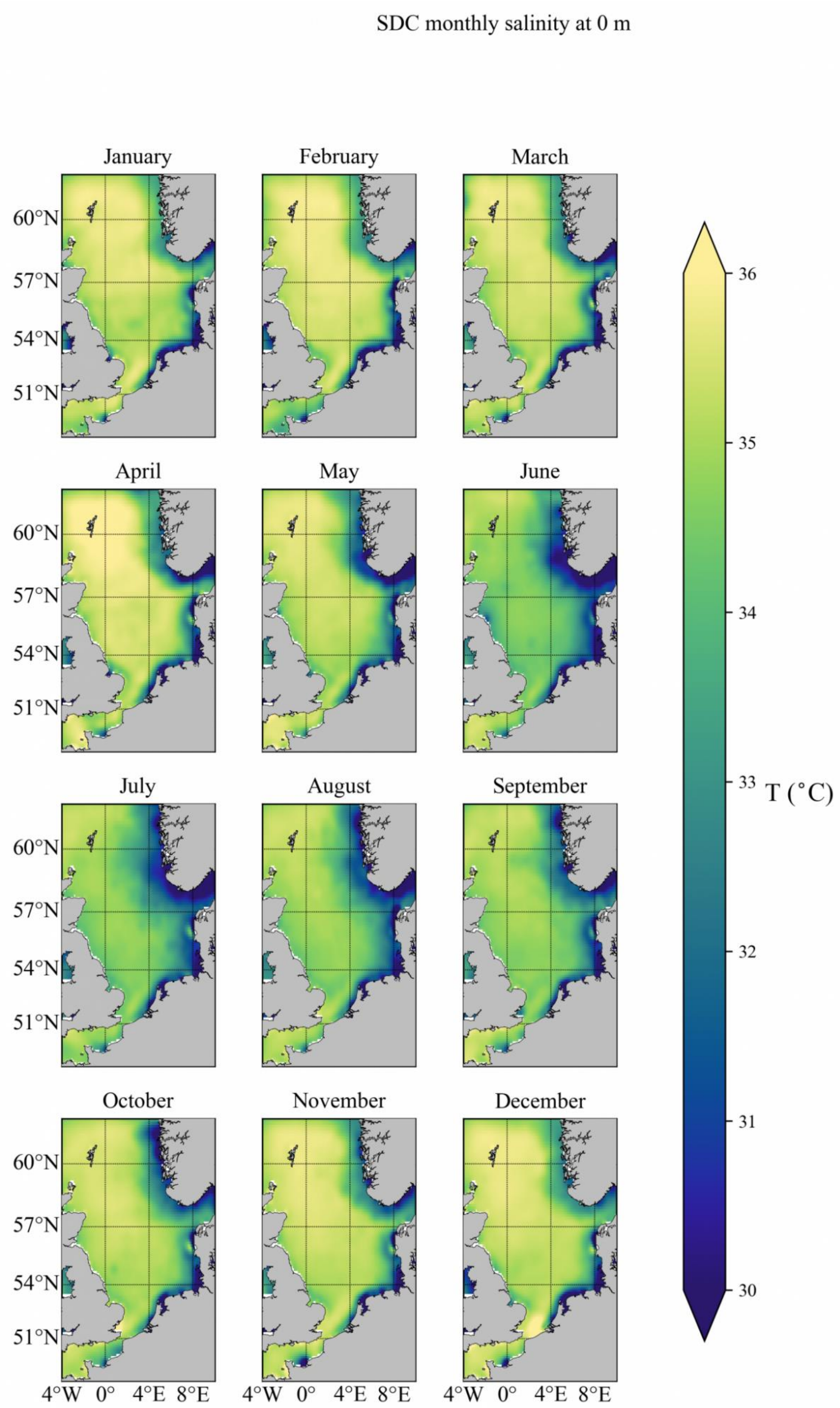
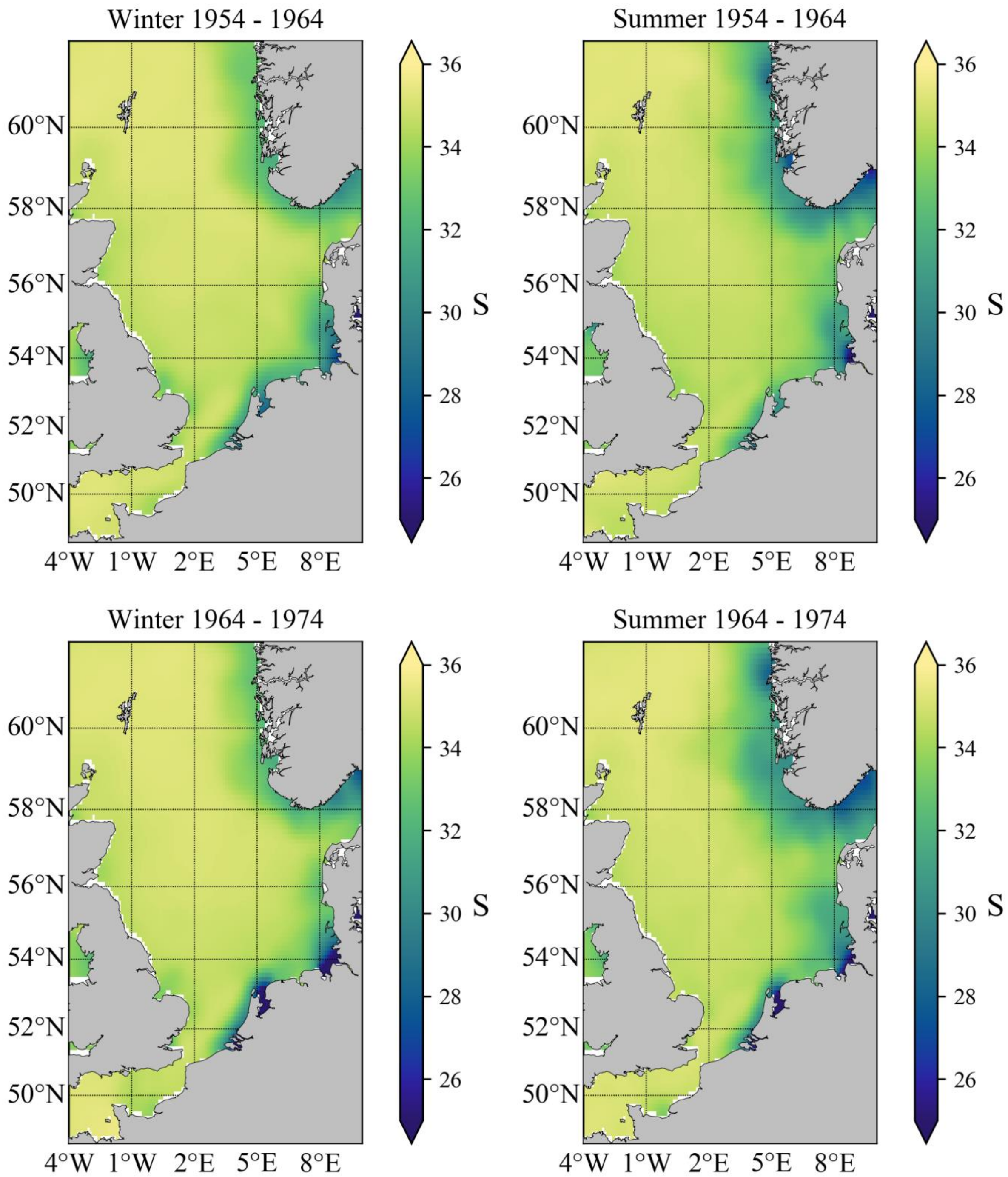
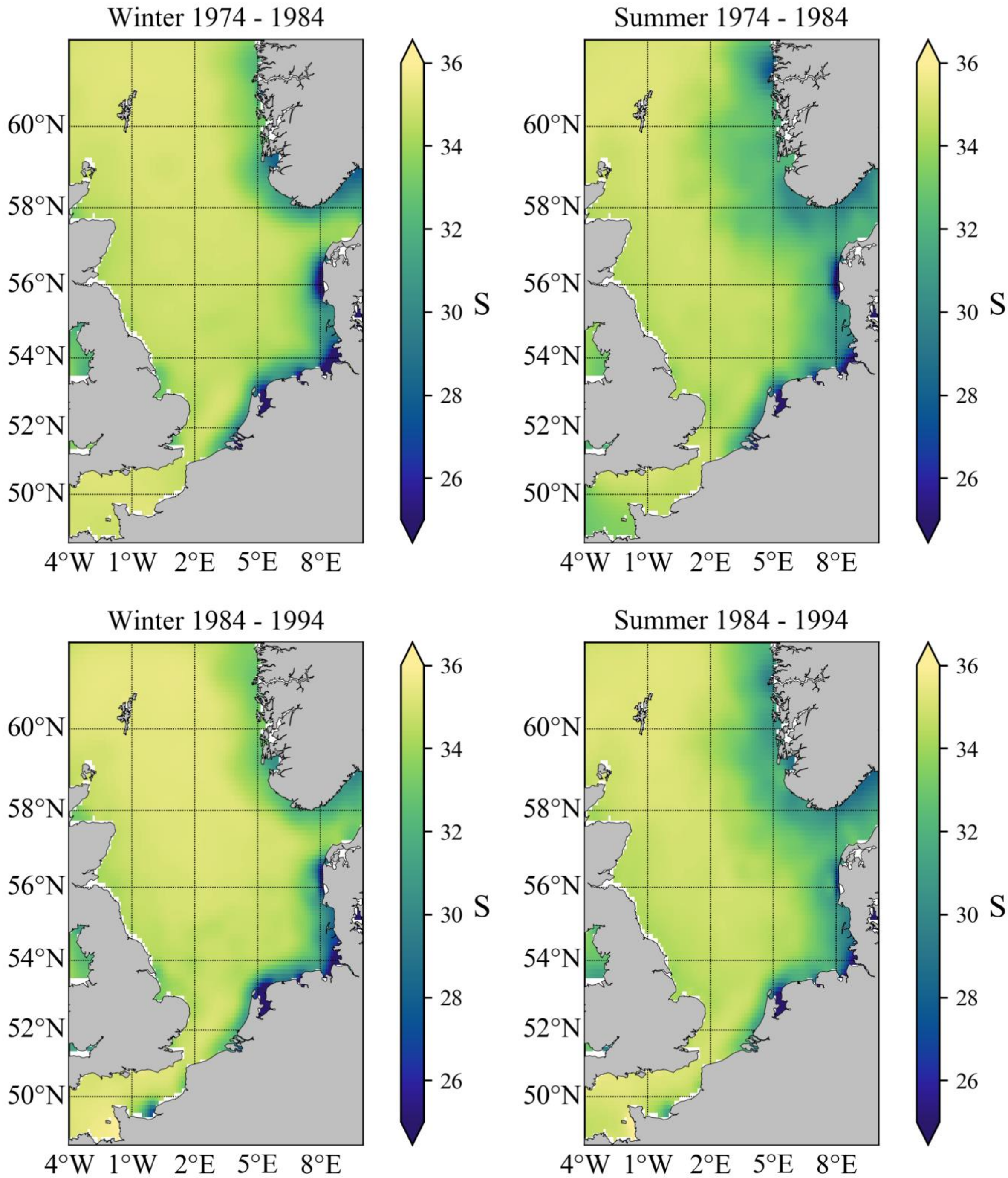


Figure 3-5 A comparison of the monthly Salinity fields at the surface as computed with the whole data set (1955-2014).

3.3.3. Seasonal fields over the six decades




Winter 1974 - 1984
Summer 1974 - 1984
Winter 1984 - 1994
Summer 1984 - 1994
60°N
58°N
56°N
54°N
52°N
50°N
4°W 1°W 2°E 5°E 8°E
36
34
32
30
28
26
S

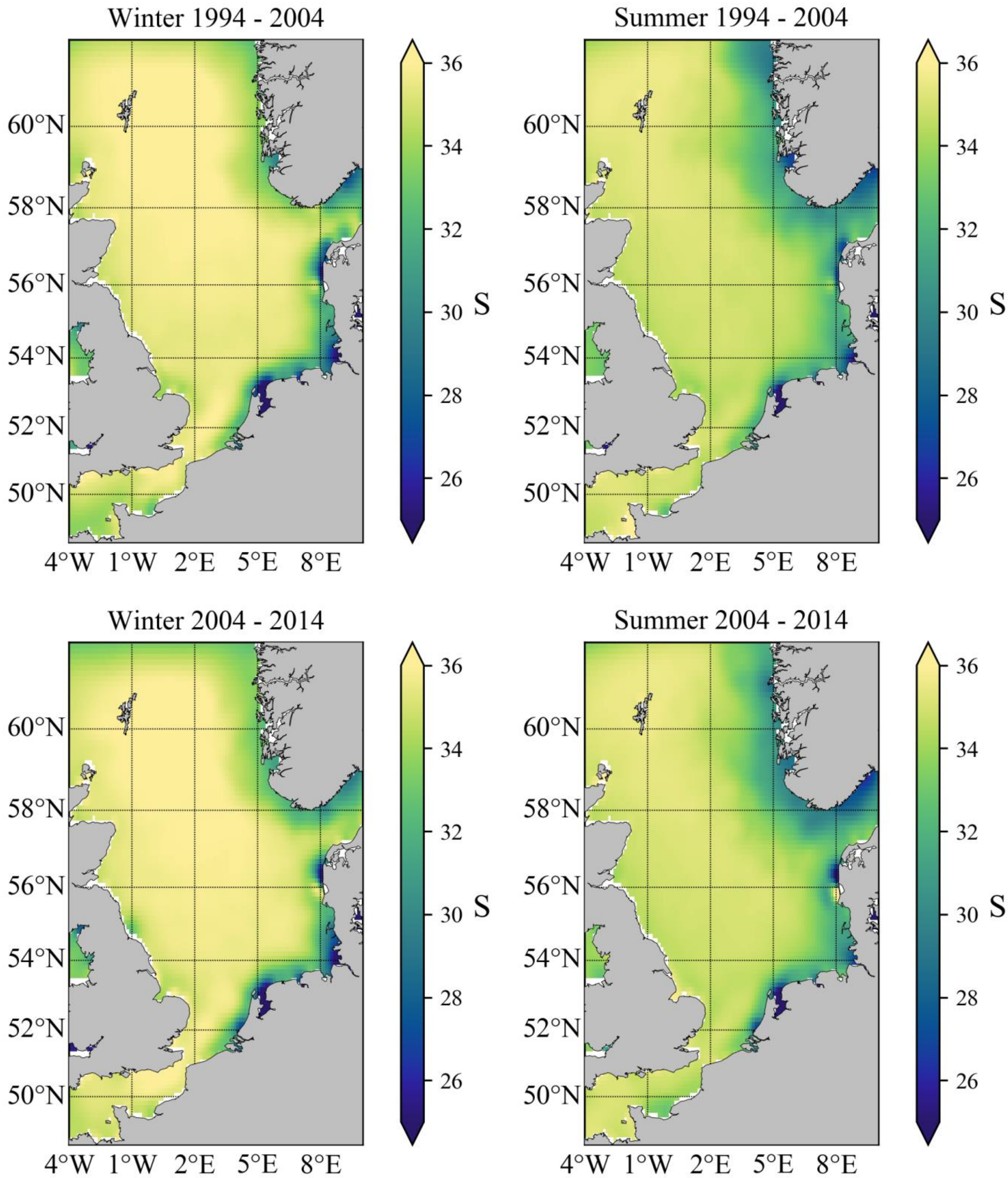


Figure 3-6 Variation of winter Salinity (Jan, Feb, Mar) and summer Salinity (Jul, Aug, Sep) at the surface in 6 decades for the period 1955-2014

4. Product validation

A visual consistency analysis was performed against the well-known and widely used product of the NOAA NODC Ocean Climate Laboratory – the World Ocean Atlas (6). The latest version of the World Ocean Atlas was released in September 2018 (WOA18). Seasonal climatological fields of Temperature and Salinity (objectively analysed mean) are available at resolution1/4° for 6 decades: 1955-1964, 1965-1974, 1975-1984, 1985-1994, 1995-2004, and 2005-2017. The monthly fields at resolution 1/4° are available for time spans 1981-2010, 2005-2017, and 1955-2017.

Comparison of selected Temperature and Salinity fields is presented in Figure 4-1 and Figure 4-2. The maps have similarities and differences. The WOA18 maps are smoother and have fewer details, while SDC maps look noisier but seem to be more realistic.

4.1. Annual fields

For the salinity both fields display the same features: the lower values present near the surface along the coast in the eastern part of the domain. In the SDC product (right side) the influence of freshwater input through river runoff is clearly visible, for instance for the Seine (43.45°N, 0°E) or along the English coast at 53°N (Thames).

It is also worth mentioning the strong, artificial gradients appearing in the WOA product along 61°N, especially visible in the temperature field. This might be due to a merging of different sub-regions where the interpolation was performed separately.

SDC temperature appears much noisier than the WOA, this is a consequence of the shorter correlation length employed for the computations.

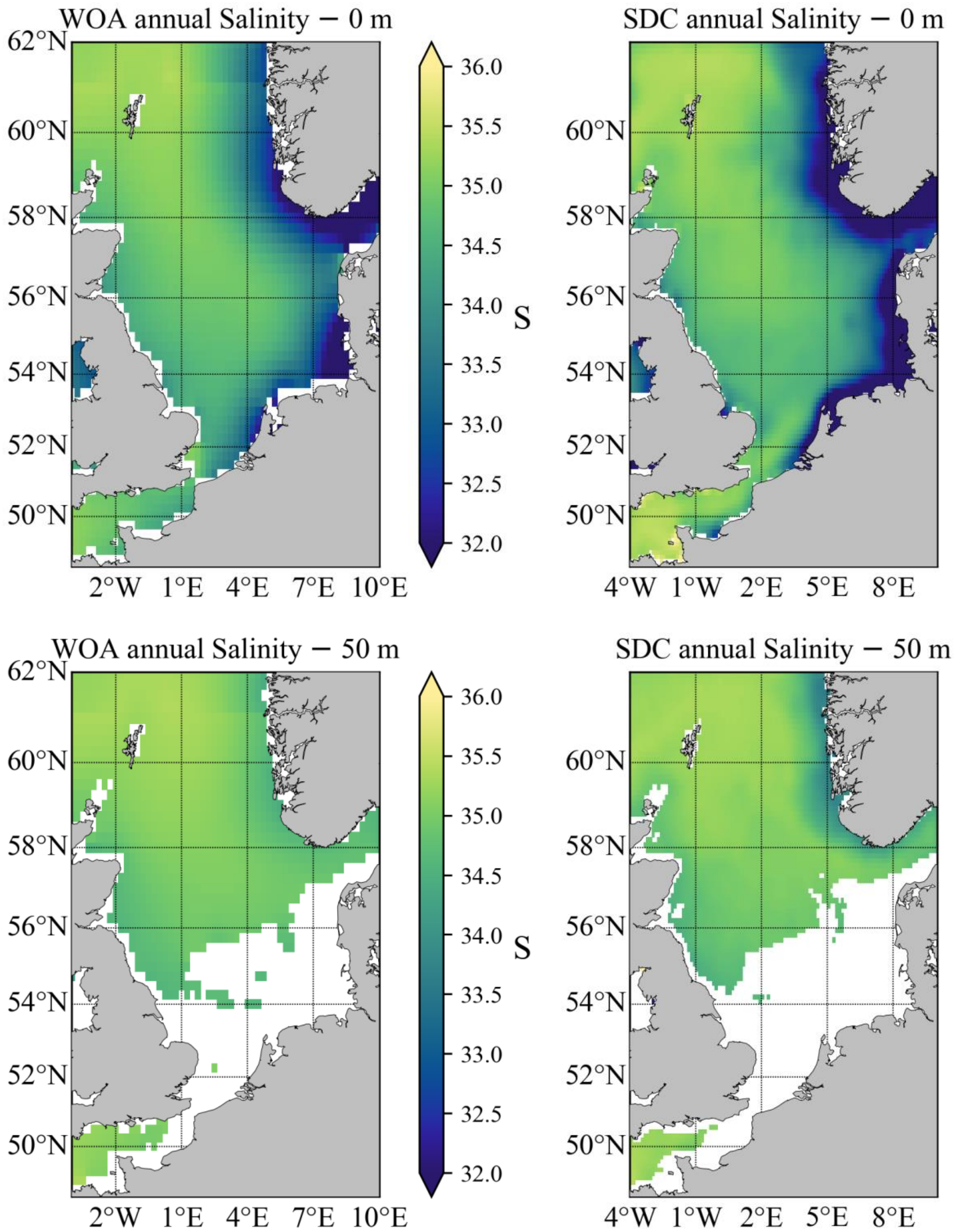


Figure 4-1 Comparison of the WOA (left) and SDC (right) annual salinity fields at depth = 0 (top) and 50 m (bottom).

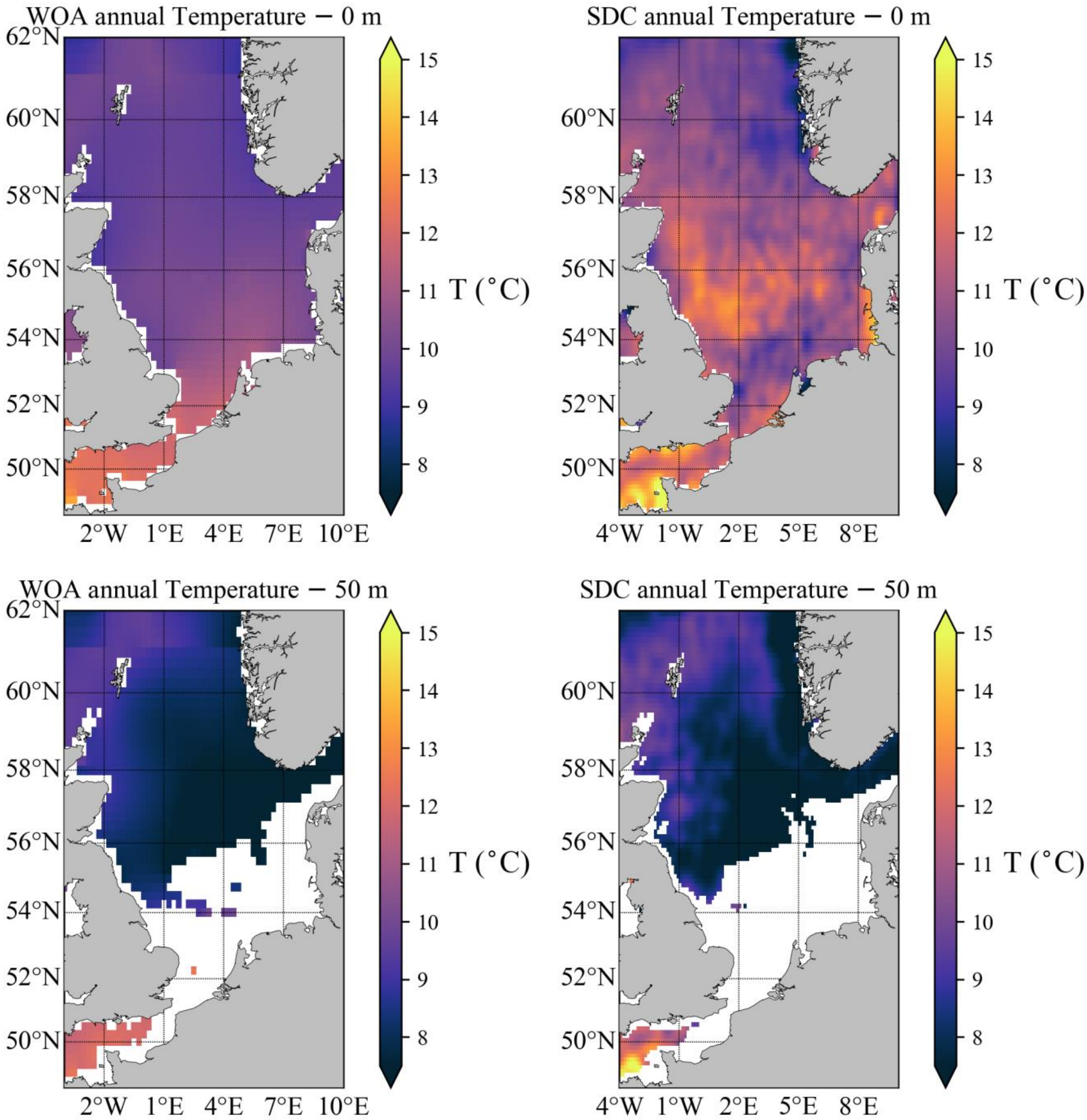


Figure 4-2 Comparison of the WOA (left) and SDC (right) annual temperature fields at depth = 0 and 50 m.

5. Technical Specifications

5.1. Product Format

The product is delivered in 6 files in NetCDF format. Each file contains four 4d arrays (3 space dimensions + 1 time dimension) named according to the following rule:

- *Parameter_Name* – 4d array for a parameter,
- *Parameter_Name_L1* – … parameter masked using relative error threshold 0.3,
- *Parameter_Name_L2* – … parameter masked using relative error threshold 0.5,
- *Parameter_Name_relerr* – relative error of parameter.

Content of NetCDF files:

1. **SDC_NS_CLIM_T_1955_2014_0125_m.4Danl.nc** Temperature monthly climatological fields covering the time period 1955-2014 at 0.125 degrees of resolution
2. **SDC_NS_CLIM_S_1955_2014_0125_m.4Danl.nc** Salinity monthly climatological fields covering the time period 1955-2014 at 0.125 degrees of resolution
3. **SDC_NS_CLIM_T_1955_2014_0125_a.4Danl.nc** Temperature annual climatological fields covering the time period 1955-2014 at 0.125 degrees of resolution
4. **SDC_NS_CLIM_S_1955_2014_0125_a.4Danl.nc** Salinity annual climatological fields covering the time period 1955-2014 at 0.125 degrees of resolution
5. **SDC_NS_CLIM_T_1955_2014_0125_s.4Danl.nc** Temperature seasonal climatological fields for time periods: 1955-1964, 1965-1974, 1975-1984, 1985-1994, 1995-2004, 2005-2017.
6. **SDC_NS_CLIM_S_1955_2014_0125_s.4Danl.nc** Salinity seasonal climatological fields for time periods: 1955-1964, 1965-1974, 1975-1984, 1985-1994, 1995-2004, 2005-2014.

Every NetCDF file, along with the field attributes, contains a set of attributes describing the product:

- Name of the project,
- EDMO code of the product developer,
- Name of activity,
- Contact e-mail of developer,
- Source of observations,
- Keywords for the parameter and the area and their codes in SeaDataNet Vocabularies P35, P01, and C19,
- Product code and version and abstract,
- Bathymetry source,
- Acknowledgement,
- Links to documentation, data and visualization tools.

5.2. Product Usability

The climatic fields can be used as to support the general oceanographic studies, ocean modelling and forecast, processes studies, climate change studies etc. They can be used, for example, for initialization and verification of different ocean models, for investigation of climatic trends.

The SDC climatology well reproduces well the main features of the North Sea basin, especially, the lower salinity flow along its Eastern boundary and the variation of both T and S over the year in the whole basin.

5.3. Changes since previous version

The previous version of the product was released in framework of the SeaDataNet2 project and available at SEXTANT Catalogue (http://sextant.ifremer.fr/en/web/seadatanet) under the name “North Sea Temperature and Salinity Climatology V1.1”.

Compared to the previous version there are significant changes: the SDN product contained monthly climatological fields calculated only for single interval 1900 – 2013, i.e. it did not contain fields for sub-periods and decades, which are present in the current product. The horizontal resolution was higher (0.1° in SDN product vs 0.125° in SDC product), while the vertical resolution was much coarser – 14 levels vs 41.

For the SDN products, the dataset used for the computations was also completely different: only the data extracted from the SeaDataNet infrastructure but including the underway data.

Annex 1 - Naming convention for SeaDataCloud climatologies

File naming conventions: [PRO]_[REG]_[PROD]_[V]_[YYYY1]_[YYYY2]_[T], where:

1. [PRO] - project
2. [REG] - region
3. [PROD] - product
4. [V] - variable
5. [YYYY1]_[YYYY2] - time coverage
6. [S] – spatial resolution
7. [T] - temporal resolution (m=monthly, s=seasonal, a=annual)

Project	Region	Product	Var	Time Coverage	Time Res	Full Name
SDC	NS	CLIM	T	1955-2014	Annual	SDC_NS_CLIM_T_1955-2014_0125_a
SDC	NS	CLIM	S	1955-2014	Annual	SDC_NS_CLIM_S_1955-2014_0125_a
SDC	NS	CLIM	T	1955-2014	monthly	SDC_NS_CLIM_T_1955-2017_0125_m
SDC	NS	CLIM	S	1955-2014	monthly	SDC_NS_CLIM_S_1955-2017_0125_m
SDC	NS	CLIM	T	1955-1964 1965-1974 1975-1984 1985-1994 1995-2004 2005-2014	seasonal	SDC_NS_CLIM_T_1955-1964_0125_s SDC_NS_CLIM_T_1965-1974_0125_s SDC_NS_CLIM_T_1975-1984_0125_s SDC_NS_CLIM_T_1985-1994_0125_s SDC_NS_CLIM_T_1995-2004_0125_s SDC_NS_CLIM_T_2005-2014_0125_s
SDC	NS	CLIM	S	1955-1964 1965-1974 1975-1984 1985-1994 1995-2004 2005-2014	seasonal	SDC_NS_CLIM_S_1955-1964_0125_s SDC_NS_CLIM_S_1965-1974_0125_s SDC_NS_CLIM_S_1975-1984_0125_s SDC_NS_CLIM_S_1985-1994_0125_s SDC_NS_CLIM_S_1995-2004_0125_s SDC_NS_CLIM_S_2005-2014_0125_s

6. References

1. SeaDataCloud - Further developing the pan-European infrastructure for marine and ocean data management. Grant Agreement Number: 730960 - HBM4EU - H2020-SC1-2016-2017/ H2020-SC1-2016-RTD. *https://www.hbm4eu.eu/wp-content/uploads/2017/03/HBM4EU-Grant-Agreement.pdf*
2. Serge Scory, Dick Schaap, Reiner Schlitzer (2018). North Sea - Temperature and salinity Historical Data Collection SeaDataCloud V1. *http://doi.org/10.12770/d9310aa6-c6b3-4657-a3c9-b0a4dd0f016c*
3. Boyer, T.P., O. K. Baranova, C. Coleman, H. E. Garcia, A. Grodsky, R. A. Locarnini, A. V. Mishonov, T.D. O'Brien, C.R. Paver, J.R. Reagan, D. Seidov, I. V. Smolyar, K. Weathers, and M. M. Zweng, 2018: World Ocean Database 2018 (in preparation). Resource web address: *https://www.nodc.noaa.gov/OC5/WOD/pr_wod.html*.
4. Scory Serge, Simoncelli Simona (2018). SeaDataCloud Temperature and Salinity Historical Data Collections for the North Sea (Version 1). Product Information Document (PIDoc). https://doi.org/10.13155/57330
5. Schlitzer, R., Ocean Data View, odv.awi.de, 2017
6. WORLD OCEAN ATLAS 2018 (WOA18) – prerelease *https://www.nodc.noaa.gov/OC5/woa18/*
7. Barth, A., Beckers, J.-M., Troupin, C., Alvera-Azcárate, A., and Vandenbulcke, L.: DIVAnd-1.0: n-dimensional variational data analysis for ocean observations, Geosci. Model Dev., 7, 225-241, doi:10.5194/gmd-7-225-2014, 2014.
8. The GEBCO Digital Atlas published by the British Oceanographic Data Centre on behalf of IOC and IHO, 2003
9. https://github.com/gher-ulg/SeaDataCloud/blob/master/Julia/Climatologies/duplicate_detection.jl

7. List of acronyms

Acronym	Definition
ARC	Arctic ocean
BAL	Baltic Sea
BLS	Black Sea
CDI	Common Data Index
CLIM	Climatology
CMEMS	Copernicus Marine Environment Monitoring Service
DATA	Aggregated Dataset
DIVA	Data-Interpolating Variational Analysis (software)
DOI	Digital Object Identifier
EC	European Commission
EDMO	European Directory of Marine Organisations (SeaDataNet catalogue)
GLO	Global Ocean
IOC	Intergovernmental Oceanographic Commission
IODE	International Oceanographic Data and Information Exchange (IOC)
MED	Mediterranean Sea
NAT	North Atlantic Ocean
NS	North Sea
NWS	North West Shelf
ODV	Ocean Data View Software
QC	Quality Checks
QF	Quality Flags
RMSE	Root mean squared error
SDC	SeaDataCloud
SDN	SeaDataNet
TS	Temperature and Salinity
WOA	World Ocean Atlas
WP	Work Package