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THE BUNKER CLIMATE ATLAS OF THE NORTH ATLANTIC OCEAN

- technical description of the data tapes -

by

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INTRODUCTION

This is a short guide to a climatological surface data set of the North Atlantic Ocean. A large part of this data set has been published in two volumes of "The BUNKER Climate Atlas of the North Atlantic Ocean" (ISEMER & HASSE, 1985, 1987). The purpose of this report is to describe the access to different magnetic tapes containing the climatological data set, and the retrieval of certain data. Copies of the tapes can be requested for scientific research from the Institut für Meereskunde in Kiel.

The basic version of the North Atlantic Ocean data set was evaluated by the late Andrew F. BUNKER of Woods Hole Oceanographic Institution, who left his results on computer outprints. BUNKER analysed observations from the ships of the Voluntary Observing Fleet to calculate the various components of the heat budget at the air-sea interface. The original BUNKER data set is defined on irregularly shaped areas, called "Gerrymanders". The data coverage includes the North Atlantic Ocean south of 80°N except the Baltic and Mediterranean Seas. For information about details see BUNKER (1975, 1976) and GOLDSMITH & BUNKER (1979).

Within the research project "Warmwassersphäre des Atlantiks" ("Sonderforschungsbereich 133") at the Institut für Meereskunde, Kiel, (IFMK), the climatological data were brought back on magnetic tape and were interpolated onto a regularly shaped 1° grid. Interpolation onto the 1° grid was limited to regions south of 65°N. The 1° grid data form the base for the above-mentioned climate atlas of the North Atlantic Ocean. Volume 1 of this atlas contains monthly fields of observed meteorological quantities. Monthly fields of derived parameters such as air-sea heat fluxes and wind stress are mapped in the second volume. In addition to BUNKER's methods recent observational and experimental evidence from the open ocean has been used to recalculate a revised version of air-sea heat fluxes and wind stress (ISEMER, 1987, ISEMER & HASSE, 1987). The main part of the second volume of the climate atlas presents maps of the revised fluxes. Also, a collection of charts showing BUNKER's results is given for comparison. Note, that in the appendant data tables the revised fluxes are labeled "revised" while BUNKER's results are labeled "BUNKER".

The data are now available on tape both in the original and in the interpolated and revised versions. Hence, the climatological data set is available in different forms on the VAX computers of the IFMK and on the PDP-10 computer of Kiel University computer centre.

Two different tapes were prepared at the IFMK:

1. a PDP-11 "Files 11" tape, created on a VAX-750 computer. The archive number of this tape at IFMK computer centre is MTH430, its description can be found in section 1.1 of this report. Users working at the VAX computers of the IFMK should use this tape. A copy of this tape is offered as exchange tape to users working especially on a VAX or PDP-11 computer at other institutes. The ANSI tape label of this tape copy will be "NAODAT".

2. a tape coded in EBCDIC on a VAX-750 computer. A copy of this tape is offered as exchange tape to users working on others than VAX or PDP-11 computers. The contents and structure of the data on this tape are identical to those on the PDP "Files 11" tape. The archive number of this tape at the IFMK computer centre is MTH431. Technical specifications of this tape are given in section 1.2 of this report.

The access to the tapes at Kiel University computer centre is described in chapter 2. These tapes have exclusively been prepared for PDP-10 users of this computer centre.

1 THE CLIMATE DATA SET AT THE INSTITUT FÜR MEERESKUNDE KIEL

1.1 DESCRIPTION OF TAPE MTH430

1.1.1 TECHNICAL DETAILS

PDP "Files 11" tape
1600 bpi
9 tracks
ANSI-ASCII
ANSI tape label : MTH430

First part: 50 files (filenumber 1 to 50), each file consists of 23 blocks,
each file contains 6048 integer numbers (format I7).

Second part: one file with 19 blocks (filenumber 51), containing 8388 integer numbers (format I4).

55 files (filenumber 52 to 106), each file consists of 210 blocks,
each file contains 50352 integer numbers (format I8).

The data are organized in logical records (lines) separated by a "Carriage Return-Line Feed" (CRLF). The files on the tape are named ISEMER.001, ISEMER.002, ... up to ISEMER.106. The ANSI tape label of the copy of this tape sent to other institutes upon request will be "NAODAT".

1.1.2 ORIGINAL VERSION OF THE BUNKER DATA

The first part of this tape contains the original BUNKER data - long-term monthly averages of both observed and derived parameters - defined on 502 sometimes irregularly shaped Gerrymanders over the North Atlantic Ocean from the equator to 80°N. The data have been copied from outprints which are available at Woods Hole Oceanographic Institution (WHOI). On the tape they are organized in a different way than on the original computer outprints. The organisation hierarchy on the tape is as follows:

1: parameter,
2: calender month,
3: Marsden Square,
4: Gerrymander.

Each file contains all monthly values of one single parameter for all Gerrymanders. Within each file the data are grouped according to calendar month. Every group of data consists of (1) the number of the month (January = 1, February = 2, etc), (2) the parameter identification number according to BUNKER (see table 1 in appendix 1) and (3) 502 parameter values. Thus each file consists of 6048 numbers. They are written in integer format I7. Physical units are given in table 1. "- 9999" is inserted, if no data are available. Within each monthly group the data are arranged due to the Marsden Square (10°-Square) division from south to north and from east to west. The sequence of Gerrymanders within each Marsden Square was taken from BUNKER. This report contains an appendant map which shows the Gerrymander configuration over the North Atlantic Ocean and the corresponding sequence number of each Gerrymander in the monthly data group.

A number of CRLFs divide each file into logical records. They have been inserted (a) behind the parameter identification number, (b) behind every tenth parameter value and (c) at the end of each calendar month group. A FORTRAN READ format for a whole file could be : 12(2I7/,50(10I7/),2I7).

Note, that the sign of the air-sea heatflux and its components has been chosen positive if the ocean gains energy, and negative if it looses energy at the surface.

Appendix 2 gives an outprint of the beginning of file 1 on the tape.

1.1.3 INTERPOLATED CLIMATE DATA

The second part of the tape consists of an information file and 55 parameter files containing the interpolated climate surface data. Longterm monthly means as well as standard deviations of selected parameters are given, defined on a regular 1° grid over the North Atlantic Ocean from the equator to 65°N (see table 2 in appendix 3). Net longwave radiation, parameterised according to the ELSASSER(1942) radiation chart (see BUNKER & GOLDSMITH, 1979), was caculated by using additional information from WHOI-data files, and has been added to the data set (filenumber 81). Corrections of the air-sea heat flux components by the presence of sea ice (see BUNKER & GOLDSMITH, 1979) have been applied to the 1° grid data using ice coverage data from WHOI-data files (the original data on the first part of this tape have not been corrected !). Again, the sign of the air-sea heatflux and its components is positive (negative) if the ocean gains (looses) energy at the surface.

1.1.4 COORDINATE SYSTEM

The interpolated data are defined on the latitude (ϕ) - longitude (λ) grid. To facilitate computation, the (ϕ,λ) - system is transformed into a (ϕ,ϵ) - system with $\epsilon = 0$ at $\lambda = 100°W$. ϵ is positiv to the east, so all coordinates in the North Atlantic Ocean are positiv (for example $\epsilon = 51$ means $\lambda = 49°W$, $\epsilon = 100$ means $\lambda = 0°$.). The data are defined in the centre of each ϕ,ϵ - field, that means that the exact definition point for ϕ,ϵ is $\phi-0.5$, $\epsilon-0.5$.

The information file (filenumber 51 on both tapes MTH430 and MTH431) contains each pair of coordinates ϕ,ϵ for all 1° grid data available, in the same sequence as the data are organised in every monthly group of the parameter files. The coordinates are written in integer format I4. Ten numbers form a logical record and are separated by a CRLF. A FORTRAN READ-format for the whole information file could be : 838(10I4/),8I4.

1.1.5 ORGANISATION OF THE INTERPOLATED DATA

The organisation hierarchy on the tape is as follows:

1: parameter
2: calendar month
3: latitude, from south to north
4: longitude, from west to east

Each file contains all monthly values of one single parameter for all ϕ,ϵ coordinates over the North Atlantic Ocean. Within each file the data are grouped according to the calendar month. Every group of data consists of (1) the number of the month, (2) the parameter identification number according to table 2 (see appendix 3) and (3) 4194 parameter values. Thus each file consists of 50352 numbers. They are written in integer format I8. Parameters, filenumbers and physical units are given in table 2. A number of CRLFs divides each file into logical records. They have been inserted (a) behind the parameter identification number, (b) behind every tenth parameter value, and (c) at the end of each calendar month group. A FORTRAN READ-format for a whole file could be: 12(2I8/,419(10I8/),4I8).

Within each monthly group the data are arranged from south to north and from west to east. First, all 1° grid data for ϕ = 1°N are written from west to east for each 1° field, which is covered with water by more than 50%. Then the data for ϕ = 2°N follow, etc. As mentioned in section 1.4, the sequence of coordinates within each monthly group of all climate data files is given in the information file.

A possible access to the interpolated data within a computer program could be as follows:

1. Declare a real array DAT for one monthly North Atlantic Ocean field with dimensions at least [110,65] and set all elements equal -9999. (for land grid points or points without data).
2. Read the number of the month and the field number from the data file.
3. Read one pair of coordinates ϕ,ϵ from the information file and one data value from the data file and attach the data value to DAT[ϵ,ϕ].

Step 3 must be repeated 4194 times to read the whole January field. To get the February field, close the information file and start again with step 1. Appendix 4 gives an outprint of the beginning of file 52 on the tape.

1.1.6 FINAL REMARKS

A program TRNBNK.FOR is available on the VAX computer of the IFMK to convert the 1° grid data into the MK4 data format. This program needs files from the tape MTH430 as input data. The program was written by Johannes Diemer of the oceanographic departement of the IFMK.

Originally, the 1° grid data were created on the PDP-10 computer of Kiel University. The source tapes, containing the same data as MTH430, are archived at Kiel University computer centre under 330149 and 330010.

As mentioned above, a copy of this tape may be requested as exchange tape for scientific research. All specifications described are valid for the exchange tape, too. Note, that the ANSI tape label will be "NOADAT".

1.2 DESCRIPTION OF TAPE MTH431

1.2.1 TECHNICAL DETAILS

1600 bpi
9 tracks
Industry compatible
EBCDIC, parity: ODD
Label: none
Record length: 80 characters
Blocking factor: 50

First part:	50 files (filenumber 1 to 50), each file consists of 13 blocks, each file contains 6048 integer numbers (format I7).
Second part:	one file with 17 blocks (filenumber 51), containing 8388 integer numbers (format I4).
	55 files (filenumber 52 to 106), each file consists of 102 blocks, each file contains 50352 integer numbers (format I8).

The data are organized in logical records (lines of 80 characters each). They are not separated by a "Carriage Return-Line Feed" (CRLF). Free columns within logical records are filled with blanks to get always a record length of 80 characters. Files on the tape are separated by one EOF mark. Two subsequent EOFs define the end of tape.

1.2.2 FINAL REMARKS

The data organisation and the contents of this tape are identical to those of tape MTH430. Refer to sections 1.1.2, 1.1.3, 1.1.4 and 1.1.5 for details.

As mentioned above, a copy of this tape may be requested as exchange tape for scientific research. All specifications described are valid for the exchange tape, too.

2 THE CLIMATE DATA SET AT KIEL UNIVERSITY COMPUTER CENTRE

Again, the climate data set is available in two versions, but on different tapes:

1. the original version of the BUNKER data,

2. the interpolated 1° grid data. The results of BUNKER are contained as well as the revised air-sea heat fluxes and wind stress. The interpolation program stores all monthly and the annual fields of one parameter into one binary coded file. The structure of these files is shortly described in section 2.2. A program BINPLO.ALG is additionally offered to convert the binary coded data into PDP-10 ASCII-files. This program creates one ASCII-file for each monthly field in the socalled PLVEIS format (see HLP:PLVEIS.DOC). These files may be used as input data for plots or further numerical calculations. A detailed description of BINPLO.ALG is given in section 2.3.

2.1 ORIGINAL VERSION OF THE BUNKER DATA

The original BUNKER data set is stored in the first 50 files on tape 330147. The organisation of these data and the contents of the files on the tape are identical to those on tape MTH430 at IFMK. The user is advised to refer to section 1.1.2, table 1 and the appendant North Atlantic Ocean map for further details.

Technical details:

Tape number: 330147, with a copy on 330149
1600 bpi
9 tracks
PDP-10 ASCII
50 files, filenumber 1 to 50
Length of file: 69 blocks

2.2 INTERPOLATED CLIMATE DATA

The interpolated 1° grid data are stored in 55 files on tape 330146 (filenumber 2 to 56). The first file on this tape contains an ALGOL program and additional data files to allow an access to the climate data. The climate data are stored in binary mode. When copying the binary data file into the user's disk space in order to further process the data with BINPLO.ALG the file name and the first character of the extension may be chosen by the user. The last two characters of the extension must always be "BI" (e.g. TLUFT.2BI).

Technical details:

Tape number: 330146 , with a copy on 330056
1600 bpi
9 tracks
File 1: PDP-10 ASCII,
length: 102 blocks
see section 2.3
File 2 to 56: Binary mode ,
length: 429 blocks
see section 2.4

2.3 ACCESS TO THE 1° GRID DATA

The first file on tape 330146 was created with the PDP-10 service program LIBMAN (see HLP:LIBMAN.HLP). The user should first copy this file into his disk space. By doing so the extension should be LIB (e.g. BINPLO.LIB). This file contains a subdirectory:

```
DIRECTORY OF DSKU:BINPLO.LIB:

BINPLO.ALG        11
KOORDI.NAT        56
PARAME.TER         5
BINPLO.INP         1
BINPLO.EXE        24

TOTAL OF 97 BLOCKS IN 5 FILES
```

BINPLO.EXE is the executable program to convert the binary coded climate data into PDP-10 ASCII-files. For that purpose the user has to copy all files (except the source file BINPLO.ALG) from the subdirectory into his disk space. Use one of your disks in your search list. It is important to retain the given filenames (except you like to change the source program). The files KOORDI.NAT and PARAME.TER should not be modified! On the contrary, the file BINPLO.INP is the program control file, it contains informations for the individual program run and has to be changed (or created) by the user before execution of the program. The control file must contain the following informations:

Line 1: input device (disk name, where the binary coded data file is stored)

Line 2: output device (disk name, where the ASCII files are to be created)

Line 3: m_a (first month), m_e (last month),
p (parameter identification)

Line 4: ϵ_a (first coordinate in east direction)
ϵ_e (last coordinate in east direction)
ϕ_a (first coordinate in north direction)
ϕ_e (last coordinate in north direction)

Line 5: filename and first character of the extension.

Example of file BINPLO.ALG:

```
DSKT
DSKU
1,13,4
1,110,1,70
TLUFT.2
```

Comments:

Line 3: One program run allows the conversion of all monthly fields (including the annual field) of one parameter or a sequence of months defined by m_a and m_e. The filenames and the first character of the extensions of the output files are identical to those of the input file. The last two characters of the output file extensions contain the number of the respective calendar month (January = 01, February = 02, ..., year = 13). Hence, a run of BINPLO with the example file BINPLO.INP given above creates DSKU:TLUFT.201, TLUFT.202,..., TLUFT.213. An input file DSKT:TLUFT.2BI is required containig the North Atlantic Ocean air temperature data.

The parameter identification numbers of all parameters available are listed in table 3 in appendix 5 as well as the physical units of the parameters in the ASCII outputfile. These units are identical to those in the real array DAT in the procedure REABIN (see appendix 6). The divisor in the second line of the ASCII file's header (see HLP:PLVEIS.DOC) is always set to 1. If the value of the parameter identification number in BINPLO.INP is not identical to that stored in the binary data file a message returns to the user and the program execution is stopped.

Line 4: Maximum dimensions for one North Atlantic Ocean field are

1,110,1,70.

In this case all data available are read into the ASCII file. The file length then is 169 blocks. Gridpoints without data are filled with -9999.0. The FORTRAN READ format for one ASCII line is (3I6, 10F12.3). ϕ_a and ϕ_e should always be $(n \cdot 10)+1$ and $(m \cdot 10)$, respectively, for $n=0,1,2,3,4,5,6$ and $m=1,2,3,4,5,6,7$ and $n<m$.

The source program BINPLO.ALG is given in appendix 6. The procedure REABIN may be linked to other ALGOL or SIMULA programs. Users preferring FORTRAN should use BINPLO.ALG first and read the ASCII files. Users, who insist on reading the binary data by means of a FORTRAN program must use the socalled binary "image" mode.

2.4 STRUCTURE AND PHYSICAL UNITS OF THE 1° GRID DATA

The structure and sequence of the 1° grid data in the binary files are identical to those of the 1° data ASCII files on tape MTH430. Of course, CRLFs are omitted. Refer to sections 1.1.3, 1.1.4 and 1.1.5 for details. There is one general exception: Unlike the ASCII files on tape MTH430, the binary coded files additionally contain the annual mean field, which is stored as an additional monthly group behind the December field. Filenumbers on tape 330146, the parameter names and parameter identifications are listed in table 3. Also documented are the physical units of the parameters in the ASCII files after conversion with BINPLO.ALG.

3 ACKNOWLEDGEMENTS

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Springer Verlag, Heidelberg,New York,Tokyo

APPENDIX 1

Table 1: List of parameterfiles which are given in the first part of the tapes MTH430 and MTH431. The sequence number of the respective file on the tapes and the parameter identification number according to BUNKER's outprints are listed as well as the units.
stdev = standard deviation.

File-number	Identification number	Parameter name	Unit
1	3	number of observations	
2	4	air temperature TAIR	°C · 10
3	5	stdev. of TAIR	°C · 10
4	6	minimum of TAIR	°C
5	7	maximum of TAIR	°C
6	8	dewpoint temperature TDEWP	°C · 10
7	9	stdev. of TDEWP	°C · 10
8	10	minimum of TDEWP	°C
9	11	maximum of TDEWP	°C
10	12	sea surface temperature SST	°C · 10
11	13	stdev. of SST	°C · 10
12	14	minimum of SST	°C
13	15	maximum of SST	°C
14	16	TAIR minus SST	°C · 10
15	17	stdev. of TAIR minus SST	°C · 100
16	18	minimum of TAIR - SST	°C
17	19	maximum of TAIR - SST	°C
18	20	total cloud cover	oktas · 10
19	21	low cloud cover	oktas · 10
20	22	mixing ratio	g/kg · 10
21	23	mixing ratio at SST	g/kg · 10
22	24	sea level air pressure PRESS	hPa
23	25	stdev. of PRESS	hPa · 10
24	26	minimum of PRESS	hPa
25	27	scalar wind speed W	m/s
26	28	stdev. of W	m/s
27	29	maximum of W	m/s
28	30	east-west component of wind speed U	cm/s
29	31	stdev. of U	cm/s
30	32	north-south component of wind speed V	cm/s
31	33	stdev. of V	cm/s
32	34	wind direction	degrees from north
33	35	precipitation frequency	per cent
34	36	sea ice coverage	per cent
35	37	net shortwave radiation (BUDYKO/BERLIAND)	W/m^2 · 10
36	38	net longwave radiation (BUDYKO/EFIMOVA)	W/m^2 · 10
37	39	net radiation (BUDYKO)	W/m^2 · 10
38	40	latent heatflux (BUDYKO)	W/m^2 · 10
39	41	sensible heatflux (BUDYKO)	W/m^2 · 10
40	42	net air-sea heatflux (BUDYKO)	W/m^2 · 10
41	43	latent heatflux (BUNKER)	W/m^2 · 10
42	44	sensible heatflux (BUNKER)	W/m^2 · 10
43	45	net air-sea heatflux (BUNKER)	W/m^2 · 10
44	46	east component of wind stress (BUNKER)	Pa · 100

45	47	north component of wind stress (BUNKER)	Pa $\cdot$ 100
46	48	mean Dalton number	10^5
47	49	transport ratio	10^2
48	50	air density	$kg/m^3 \cdot 10^2$
49	51	integrated net air-sea heatflux (BUDYKO)	$W \cdot 10^{-10}$
50	52	integrated net air-sea heatflux (BUNKER)	$W \cdot 10^{-10}$

APPENDIX 2

Outprint of the first monthly data group of the first file on MTH430, containing the January air temperature data for each Gerrymander. Units are °C · 10 (table 1); 276 means 27.6°C.

```
      1      4
    276    276    278    273    274    275    274    268    267    257
    267    272    272    273    275    266    273    268    251    250
    259    262    264    266    264    268    264    268    255    263
    266    266    269    265    261    265    266    270    267    271
    267    266    265    267    205    197    204    209    212    224
    211    223    239    243    225    219    215    211    231    235
    234    234    235    242    233    235    241    243    249    240
    246    251    256    249    247    253    251    257    257    261
    262    265    254    252    259    256    263    261    265    264
    260    264    256    257    263    262    266    264    266    260
    267    261    253    254    255    261    261    267    269    262
    186    182    181    189    185    190    189    183    192    186
    198    192    209    198    198    209    207    202    204    201
    211    207    219    215    226    222    231    227    207    205
    215    213    223    221    230    229    237    235    207    206
    217    216    226    225    236    233    243    241    204    204
    217    216    229    226    241    238    248    245    202    201
    202    221    223    216    229    239    247    250    157    201
    196    184    215    217    234    234    219    246    158    166
    195    189    194    218    229    230    136    147    148    144
    145    149    143    137    156    160    150    155    149    159
    166    166    168    173    178    175    156    154    161    164
    169    172    180    180    188    185    157    158    168    166
    176    175    185    184    194    192    146    153    167    166
    176    175    187    186    196    195    135    140    156    163
    170    174    183    185    193    196     95    119    141    150
    158    165    176    181    188    191     67     76    107    123
    146    151    172    163    181    181    144    141    156    102
     96     83    109    100    119    115     92    124    130    108
    110    119    116    126    122    134    129    142    136    106
    109    116    120    129    128    138    136    146    146     86
     98    103    109    113    124    133    136    146    151      9
     26     42     64     85     67    105     87    128    134    -45
    -23    -13     -5     10     20     33     63     93    117    -80
    -38      1     -2     24     32     38     64     52     89    -19
     -6     21     28     14     14     17     39     40     39     58
     41     59     45     29     49     22     56     30     67     71
     69     58     53     62     77     68     93     85     79     65
     70     75     75     88     85     85     95    101    101     58
     66     75     71     84     85     94     97    102     31     46
     49     60     57     66     70     84      0     17     19     -8
     30     -1     49     59    -47     -9    -21    -64    -34    -49
    -50    -17     15     11     22     20    -14     49     47     37
     54     44     33     43     59     45     59     45     36     37
     55     45     58     63     62     21    -14      8     40     24
     56     63    -16    -11      1     22    -11     42     31     39
     51     64     16     25     29    -19    -17     -1     -6    -57
    -12    -53    -58    -32  -9999    -22  -9999    -45    -45    -44
  -9999    -29    -42    -24    -35    -21  -9999     31     15   -107
    -58     -2      1  -9999     -2  -9999  -9999  -9999  -9999  -9999
     42  -9999
```

APPENDIX 3

Table 2: List of parameterfiles which are given in the second part of the tapes MTH430 and MTH431. The sequence number of the respective file on the tape and the parameter identification number, which refers to BUNKER's outprints (exceptions are in brackets) are listed as well as the units. "Charts" indicates volume number and chart number of the climate atlas (ISEMER & HASSE, 1985,1987).
stdev = standard deviation.

File-number	Identification number	Parameter name	Charts	Unit
51	/	information about coordinates		/
52	4	air temperature TAIR	I/25-30	°C · 100
53	5	stdev. of TAIR		°C · 100
54	8	dewpoint temperature TDEWP		°C · 100
55	9	stdev. of TDEWP		°C · 100
56	12	sea surface temperature SST	I/6-19	°C · 100
57	13	stdev. of SST	I/20-24	°C · 100
58	16	TAIR minus SST	I/31-44	°C · 100
59	17	stdev. of TAIR minus SST	I/45-49	°C · 10^3
60	20	total cloud cover	I/81-94	oktas · 100
61	21	low cloud cover	I/95-100	oktas · 100
62	22	mixing ratio	I/50-63	g/kg · 100
63	(53)	stdev. of mixing ratio	I/64-68	g/kg · 100
64	23	mixing ratio at SST		g/kg · 100
65	(54)	mixing ratio minus mixing ratio at SST	I/75-80	g/kg · 100
66	(55)	relative humidity	I/69-74	per cent · 100
67	24	sea level air pressure PRESS	I/115-128	hPa · 10
68	25	stdev. of PRESS	I/129-133	hPa · 100
69	27	scalar wind speed W	I/134-147	m/s · 10
70	28	stdev. of W		m/s · 10
71	30	east component of wind speed U		cm/s · 10
72	31	stdev. of U	I/167-171	cm/s · 10
73	32	north component of wind speed V		cm/s · 10
74	33	stdev. of V	I/172-176	cm/s · 10
75	(57)	directional steadiness of the wind	I/162-166	per cent · 10
76	(58)	divergence of the wind	I/177-181	$s^{-1} \cdot 10^8$
77	35	precipitation frequency	I/101-114	per cent · 10
78	50	air density		$kg/m^3 \cdot 10^3$
79	37	net shortwave radiation (BUDYKO/BERLIAND)	II/1-6	W/m^2 · 100
80	38	net longwave radiation (BUDYKO/EFIMOVA)	II/7-12	W/m^2 · 100
81	(1)	net longwave radiation (ELSASSER)		W/m^2 · 100
82	39	net radiation (BUDYKO)		W/m^2 · 100
83	40	latent heatflux (BUDYKO)		W/m^2 · 100
84	41	sensible heatflux (BUDYKO)		W/m^2 · 100
85	42	net air-sea heatflux (BUDYKO)		W/m^2 · 100

86	43	latent heatflux (BUNKER)	II/13-18	$W/m^2 \cdot 100$
87	44	sensible heatflux (BUNKER)	II/19-24	$W/m^2 \cdot 100$
88	45	net air-sea heatflux (BUNKER)	II/25-30	$W/m^2 \cdot 100$
89	46	east component of wind stress (BUNKER)	II/31-36	$Pa \cdot 10^3$
90	47	north component of wind stress (BUNKER)	II/31-36	$Pa \cdot 10^3$
91	(59)	scalar wind speed (revised)	II/37-42	$m/s \cdot 10$
92	(60)	net shortwave radiation (REED)		$W/m^2 \cdot 100$
93	(61)	net shortwave radiation (revised)	II/43-56	$W/m^2 \cdot 100$
94	(62)	net longwave radiation (revised)	II/57-70	$W/m^2 \cdot 100$
95	(63)	net radiation (revised)	II/71-76	$W/m^2 \cdot 100$
96	(64)	latent heat flux (revised)	II/77-90	$W/m^2 \cdot 100$
97	(65)	evaporation (revised)	II/91-96	mm/month
98	(66)	sensible heat flux (revised)	II/97-110	$W/m^2 \cdot 100$
99	(67)	net air-sea heat flux (revised)	II/117-130	$W/m^2 \cdot 100$
100	(68)	oceanic heat loss by net longwave radiation, latent and sensible heat fluxes (revised)	II/111-116	$W/m^2 \cdot 100$
101	(69)	east component of wind stress (revised)	II/159-186	$Pa \cdot 10^3$
102	(70)	north component of wind stress (revised)	II/159-186	$Pa \cdot 10^3$
103	(71)	curl of wind stress (revised)	II/132-158	$N/m^3 \cdot 10^9$
104	(72)	east component of Ekman volume transport (revised)	II/187-200	$m^3/s \cdot 10^{-3}$
105	(73)	north component of Ekman volume transport (revised)	II/187-200	$m^3/s \cdot 10^{-3}$
106	(74)	vertical Ekman velocity (revised)	II/201-206	$m/s \cdot 10^8$

APPENDIX 4

Outprint of the beginning of file 52 on MTH430.

```
   1       4
2740    2734    2729    2724    2721    2720    2719    2718    2717    2716
2714    2711    2707    2703    2699    2695    2688    2677    2663    2649
2639    2636    2638    2645    2655    2667    2676    2681    2679    2667
2650    2636    2629    2628    2632    2641    2653    2661    2663    2662
2661    2663    2670    2677    2681    2684    2690    2699    2711    2725
2739    2749    2755    2759    2762    2765    2769    2774    2780    2717
2713    2709    2706    2704    2702    2701    2700    2699    2697    2696
2694    2691    2688    2684    2680    2675    2668    2658    2649    2641
2638    2640    2645    2655    2665    2674    2679    2679    2671    2660
2651    2648    2650    2656    2667    2678    2688    2692    2692    2691
2693    2698    2703    2708    2713    2720    2727    2735    2742    2748
2752    2756    2759    2763    2766    2770    2775    2780    2688    2694
2694    2692    2689    2687    2686    2685    2684    2682    2682    2681
2680    2677    2674    2671    2668    2664    2660    2655    2649    2643
2640    2641    2646    2654    2663    2672    2677    2679    2676    2671
2667    2669    2674    2682    2692    2703    2711    2716    2718    2720
2722    2725    2727    2730    2735    2741    2746    2750    2752    2753
2754    2757    2760    2764    2768    2772    2776    2780    2681    2681
2679    2677    2675    2674    2674    2673    2672    2671    2671    2670
2669    2667    2665    2662    2659    2656    2653    2651    2647    2643
2640    2641    2644    2651    2659    2667    2673    2678    2680    2682
2685    2691    2699    2707    2716    2724    2730    2734    2735    2739
2747    2748    2741    2738    2741    2745    2749    2752    2753    2753
2755    2757    2761    2766    2771    2775    2779    2780    2675    2673
2671    2668    2665    2664    2664    2665    2665    2665    2664    2663
2662    2661    2660    2657    2655    2652    2649    2646    2644    2641
2638    2636    2636    2639    2644    2650    2657    2665    2673    2681
2689    2699    2709    2720    2729    2736    2739    2742    2744    2742
2734    2729    2731    2734    2737    2740    2743    2746    2750    2754
2758    2762    2767    2668    2669    2668    2666    2663    2659    2656
2654    2654    2656    2657    2656    2655    2655    2654    2653    2651
2649    2646    2642    2639    2635    2632    2628    2626    2624    2624
2626    2629    2634    2641    2650    2660    2673    2687    2702    2716
2729    2740    2746    2746    2744    2743    2748    2753    2759    2764
2769    2662    2664    2664    2665    2664    2663    2662    2658    2654
2649    2646    2644    2643    2643    2643    2642    2641    2640    2640
2639    2636    2633    2629    2625    2620    2614    2610    2606    2603
2602    2601    2602    2603    2608    2615    2625    2636    2650    2667
2684    2702    2718    2731    2739    2741    2737    2732    2658    2663
2664    2664    2662    2660    2657    2654    2649    2644    2639    2635
2632    2630    2628    2626    2623    2620    2619    2618    2617    2613
2609    2604    2598    2591    2585    2578    2574    2572    2571    2569
2567    2567    2570    2576    2585    2596    2610    2625    2643    2662
2681    2699    2715    2726    2654    2660    2663    2664    2662    2658
2654    2650    2645    2639    2634    2629    2624    2620    2616    2612
2608    2603    2599    2595    2593    2590    2585    2580    2573    2566
2558    2550    2543    2538    2536    2533    2529    2526    2523    2524
2528    2535    2545    2555    2566    2580    2598    2620    2647    2676
2708    2654    2659    2661    2660    2656    2652    2646    2641    2635
2630    2625    2620    2614    2609    2603    2597    2591    2585    2578
2573    2568    2563    2557    2550    2542    2533    2524    2515    2506
```

APPENDIX 5

Table 3: List of parameterfiles which are given on tape 330146. The sequence number of the respective file on the tape and the parameter identification number, which refers to BUNKER's outprints (exceptions are in brackets) are listed as well as the physical units in the ASCII files after conversion with BINPLO.ALG. "Charts" indicates volume number and chart number of the climate atlas.
stdev = standard deviation.

File-number	Identification number	Parameter name	Charts	Unit
1	/	subdirectory file		/
2	4	air temperature TAIR	I/25-30	°C
3	5	stdev. of TAIR		°C
4	8	dewpoint temperature TDEWP		°C
5	9	stdev. of TDEWP		°C
6	12	sea surface temperature SST	I/6-19	°C
7	13	stdev. of SST	I/20-24	°C
8	16	TAIR minus SST	I/31-44	°C
9	17	stdev. of TAIR minus SST	I/45-49	°C
10	20	total cloud cover	I/81-94	oktas
11	21	low cloud cover	I/95-100	oktas
12	22	mixing ratio	I/50-63	g/kg
13	(53)	stdev. of mixing ratio	I/64-68	g/kg
14	23	mixing ratio at SST		g/kg
15	(54)	mixing ratio minus mixing ratio at SST	I/75-80	g/kg
16	(55)	relative humidity	I/69-74	per cent
17	24	sea level air pressure PRESS	I/115-128	hPa
18	25	stdev. of PRESS	I/129-133	hPa
19	27	scalar wind speed W	I/134-147	m/s
20	28	stdev. of W		m/s
21	30	east component of wind speed U		cm/s
22	31	stdev. of U	I/167-171	cm/s
23	32	north component of wind speed V		cm/s
24	33	stdev. of V	I/172-176	cm/s
25	(57)	directional steadiness of the wind	I/162-166	per cent
26	(58)	divergence of the wind	I/177-181	$s^{-1} \cdot 10^{6}$
27	35	precipitation frequency	I/101-114	per cent
28	50	air density		kg/m^3
29	37	net shortwave radiation (BUDYKO/BERLIAND)	II/1-6	W/m^2
30	38	net longwave radiation (BUDYKO/EFIMOVA)	II/7-12	W/m^2
31	(1)	net longwave radiation (ELSASSER)		W/m^2
32	39	net radiation (BUDYKO)		W/m^2
33	40	latent heatflux (BUDYKO)		W/m^2
34	41	sensible heatflux (BUDYKO)		W/m^2
35	42	net air-sea heatflux (BUDYKO)		W/m^2

36	43	latent heatflux (BUNKER)	II/13-18	W/m^2
37	44	sensible heatflux (BUNKER)	II/19-24	W/m^2
38	45	net air-sea heatflux (BUNKER)	II/25-30	W/m^2
39	46	east component of wind stress (BUNKER)	II/31-36	$Pa \cdot 10^2$
40	47	north component of wind stress (BUNKER)	II/31-36	$Pa \cdot 10^2$
41	(59)	scalar wind speed (revised)	II/37-42	m/s
42	(60)	net shortwave radiation (REED)		W/m^2
43	(61)	net shortwave radiation (revised)	II/43-56	W/m^2
44	(62)	net longwave radiation (revised)	II/57-70	W/m^2
45	(63)	net radiation (revised)	II/71-76	W/m^2
46	(64)	latent heat flux (revised)	II/77-90	W/m^2
47	(65)	evaporation (revised)	II/91-94,96 II/95	cm/month dm/year
48	(66)	sensible heat flux (revised)	II/97-110	W/m^2
49	(67)	net air-sea heat flux (revised)	II/117-130	W/m^2
50	(68)	oceanic heat loss by net longwave radiation, latent and sensible heat fluxes (revised)	II/111-116	W/m^2
51	(69)	east component of wind stress (revised)	II/159-186	$Pa \cdot 10^2$
52	(70)	north component of wind stress (revised)	II/159-186	$Pa \cdot 10^2$
53	(71)	curl of wind stress (revised)	II/132-158	$N/m^3 \cdot 10^7$
54	(72)	east component of Ekman volume transport (revised)	II/187-200	$m^3/s \cdot 10^5$
55	(73)	north component of Ekman volume transport (revised)	II/187-200	$m^3/s \cdot 10^5$
56	(74)	vertical Ekman velocity (revised)	II/201-206	$m/s \cdot 10^6$

APPENDIX 6

Source code of BINPLO.ALG written in ALGOL-60.

```
 COMMENT

 PROGRAMM  B I N P L O . A L G

 VERSION MAERZ 1987
 HANS-JOERG ISEMER

 NORD-ATLANTIK-KLIMADATEN WERDEN AUS EINEM BINAERFILE
 IN DAS ARRAY "FELD" GELESEN.
 DAS ARRAY "FELD" ENTHAELT JEWEILS EIN MONATSFELD.
 DIESES MONATSFELD WIRD IN EIN ASCII FILE
 GESCHRIEBEN, DER ENTSPRECHEND DEN FORMATANFORDERUNGEN
 FUER ZEICHENPROGRAMME AUFGEBAUT IST (Z.B. PLVEIS ETC).
 INFORMATIONEN ZUM PROGRAMMABLAUF WERDEN DEM FILE BINPLO.INP
 ENTNOMMEN.
 DAS PROGRAMM BENOETIGT
 1. EINEN INFORMATIONSFILE "DSK:BINPLO.INP",
 2. EINEN KOORDINATENFILE "DSK:KOORDI.NAT",
 3. EINEN PARAMETERFILE "DSK:PARAME.TER",
 4. EINEN BINAEREN DATENFILE, DER AUF DER IM
    INFORMATIONSFILE ANGEGEBENEN PLATTE STEHT.

                ;
BEGIN

BOOLEAN PMRF;
REAL ARRAY FELD[1:120,1:70];
INTEGER M,MA,ME,P,P1,I,J,UEBNUM,PFILE,XA,XE,YA,YE;
REAL DIVIS;
STRING NAME,MIT,DATDSK,BINDSK,NAM,UEB,UEBS;
STRING ARRAY ENDUNG[1:74],MONAT[1:13],UEBER[1:74];

PROCEDURE SET2(XARR,A1,B1,A2,B2,WERT);
COMMENT=====================================================
DIE PROZEDUR "SET2" ORDNET JEDEM ELEMENT DES
ZWEIDIMENSIONALEN ARRAYS "FELD[A1:B1,A2:B2]"
DEN DURCH DIE VARIABLE "WERT" DEFNIERTEN WERT ZU
;
REAL ARRAY XARR;INTEGER B1,B2,A1,A2;REAL WERT;
BEGIN
INTEGER I,J;
FOR I:= A1 UNTIL B1 DO
BEGIN
FOR J:= A2 UNTIL B2 DO
XARR[I,J]:=WERT;
END--I--;
END--"WERT"-SETZEN EINES ZWEIDIMENSIOALEN REAL ARRAYS--;
```

```
PROCEDURE PLOFI(XA,XE,YA,YE,P,M,UEBERSCHRIFT,FELD);
COMMENT======================================================
DIE PROZEDUR "PLOFI" ERZEUGT EINEN ASCII-FILE, DER EIN
MONATSFELD EINES PARAMETERS, DAS IM ARRAY "FELD" UEBERGEBEN
WIRD, IM PLVEIS-FORMAT ENTHAELT.
XA,XE,YA,YE SIND DIE ANFANGS- UND ENDKOORDINATEN DES GE-
WUENSCHTEN FELDAUSSCHNITTS. XA, YA SOLLTEN JEWEILS (N*10.)+1 SEIN.
XE,YE MUESSEN (N*10.) SEIN.
P UND M SIND DIE PARAMETER- BZW MONATSKENNUNG.
"UEBERSCHRIFT" ENTHAELT EINEN STRING, DER IN DEN HEADER DES
ASCII-FILES GESCHRIEBEN WIRD (SIEHE PLVEIS.DOC).
;
REAL ARRAY FELD;
INTEGER XA,XE,YA,YE,P,M;
STRING UEBERSCHRIFT;
BEGIN
INTEGER I;
REAL ARRAY PARAM[YA:YE];
INTEGER Q1,Q2,TYP,ZMAX,MA,ME,NA,NE,X,Y,ZZ;
REAL Q3,ZEIT,DIVISOR,POSWERT,NN;

MA:=1;
ME:=XE-XA+1;
NA:=1;
NE:=YE-YA+1;
Q1:=1;
Q2:=999;
Q3:=-7777.0;
TYP:=100+M;
ZEIT:=0.;

DIVISOR:=1.;
PF1:
WRITE(UEBERSCHRIFT);
NEWLINE;
PRINT(TYP,4,0);
PRINT(ZEIT,4,2);
PRINT(DIVISOR,4,2);PRINT(DIVISOR,4,2);NEWLINE;

NN:=NE;
ZMAX:=(NN/10.);

FOR X:= XA STEP 1 UNTIL XE DO
BEGIN
FOR Y:= YA STEP 1 UNTIL YE DO
BEGIN
PARAM[Y]:=FELD[X,Y];
END---Y---;
```

```
FOR ZZ:= 1 STEP 1 UNTIL ZMAX DO
BEGIN
PRINT(X-XA+1,5,0);PRINT(((ZZ-1)*10)+1,5,0);PRINT(ZZ*10,5,0);
FOR Y:= ((ZZ-1)*10)+YA STEP 1 UNTIL ((ZZ*10)+YA-1) DO
PRINT(PARAM[Y],7,3);
NEWLINE;
END---ZZ---;
END---X----;
COMMENT
DAS BILD LIEGT NUN MIT WEST-OST ACHSE
IN PLOTPAPIERRICHTUNG. X UND Y ENTSPRECHEN DEN KOORDINATEN
IN ZEICHENPROGRAMMEN WIE Z.B. PLVEIS.
;
PRINT(X,5,0);PRINT(Q1,5,0);PRINT(Q1,5,0);
PRINT(Q3,7,3);
NEWLINE;
PRINT(Q2,5,0);
FOR I:= 1,2 DO PRINT(ZEIT,5,2);NEWLINE;
END---PROZEDUR PLOFI---;

PROCEDURE REABIN(NAME,M,P,PFILE,FELD,BINDSK,DIVIS,PR);
!=========================================================;
BOOLEAN PR;
STRING NAME,BINDSK;
INTEGER M,PFILE,P;
REAL DIVIS;
REAL ARRAY FELD;
COMMENT
DIE PROZEDUR "REABIN" LIEST JEWEILS EIN MONATSFELD FUER DEN
NORDATLANTIK AUS BINAEREN DATENFILES
IN DAS ARRAY FELD;

BEGIN
INTEGER ANZDAT,I,MI,PI,DI,PHI,LAM,WERT;
INPUT(1,BINDSK,11);
INPUT(2,"DSK");
OPENFILE(2,"KOORDI.NAT");
COMMENT DER FILE KOORDI.NAT ENTHAELT DIE
KOORDINATEN SAEMTLICHER 1 GRAD GITTERPUNKTE
IM NORDATLANTIK;

OPENFILE(1,NAME);
ANZDAT:=4194;
COMMENT ANZAHL SAEMTLICHER 1 GRAD GITTERPUNKTE
IM NORDATLANTIK;
```

```
SET2(FELD,1,110,1,70,-9999.);
SELECTINPUT(1);
IF M=1 THEN GO TO LB1;
FOR I:=1 UNTIL ((M-1)*(ANZDAT+3)) DO
BEGIN
SKIPSYMBOL;
END;
LB1:
INSYMBOL(MI);
INSYMBOL(PI);
INSYMBOL(DI);
COMMENT EINLESEN DER MONATS-, PARAMETERKENNUNG UND
DES DIVISIONSFAKTORS (IST IMMER = 100.)
;
PFILE:=PI;
IF MI#M OR PI#P THEN PR:=TRUE;
IF PR THEN GOTO MUNGLEICH;

FOR I:= 1 UNTIL ANZDAT DO
BEGIN
SELECTINPUT(2);
READ(PHI);
READ(LAM);
SELECTINPUT(1);
INSYMBOL(WERT);
FELD[LAM,PHI]:=WERT;
FELD[LAM,PHI]:=FELD[LAM,PHI]/(DI*DIVIS);
COMMENT EINLESEN EINES KOORDINATENPAARES UND DES ZU-
GEHOERIGEN DATENWERTES UND ZUORDNUNG IN DAS ARRAY
"FELD". "DIVIS" IST EIN PARAMETERABHAENGIGER DIVISOR,
DER DIE PARAMETEREINHEIT ERZEUGT (SIEHE IFM BERICHT 160A)
;

END---I---;

MUNGLEICH:
FOR I:= 1,2 DO RELEASE(I);
IF PR THEN
BEGIN
SELECTOUTPUT(0);
WRITE("ACHTUNG ! PARAMETER UNGLEICH: ");
NEWLINE;
WRITE("MONATSWERT IN BINPLO.INP: ");
PRINT(M,5,0);NEWLINE;
WRITE("MONATSWERT IM DATENFILE:  ");
PRINT(MI,5,0);NEWLINE;
WRITE("PARAMETERWERT IN BINPLO.INP: ");
PRINT(P,5,0);NEWLINE;
WRITE("PARAMETERWERT IM DATENFILE:  ");
PRINT(PI,5,0);
NEWLINE;
END;

END---REABIN-----------------------------------------------;

PROCEDURE FB(PWERT,DWERT,P,DIVIS);
!==========================================================;
INTEGER PWERT,P;
REAL DWERT,DIVIS;
BEGIN
IF P=PWERT THEN DIVIS:=DWERT;
END;
```

```
COMMENT  BEGINN DES HAUPTPROGRAMMS
==============================================================;


PMRF:=FALSE;
COMMENT
DIE BOOLSCHE VARIABLE PMRF IST NUR "TRUE", WENN PARAMETER-
ODER MONATSKENNUNG IM DATENFILE NICHT MIT DEN GEWUENSCHTEN
ANGABEN IM FILE "BINPLO.INP" UEBEREINSTIMMEN. DANN ERFOLGT
PROGRAMMABBRUCH.
;

OUTPUT(0, "TTY");
INPUT(3,"DSK");
OPENFILE(3, "PARAME.TER");
SELECTINPUT(3);
FOR I:= 1 UNTIL 13 DO
READ(MONAT[I]);
FOR I:= 1 UNTIL 74 DO
READ(ENDUNG[I]);
FOR I:= 1 UNTIL 74 DO
READ(UEBER[I]);
CLOSEFILE(3);
COMMENT
MONATSNAMEN UND PARAMETERNAMEN WERDEN EINGELESEN;

OPENFILE(3, "BINPLO.INP");
SELECTINPUT(3);
INLINE(BINDSK);
INLINE(DATDSK);
READ(MA);
READ(ME);
READ(P);
READ(XA);READ(XE);READ(YA);READ(YE);
INLINE(NAM);
CLOSEFILE(3);
COMMENT
INFIRMATIONEN ZUM PROGRAMMABLAUF WERDEN
EINGELESEN;
```

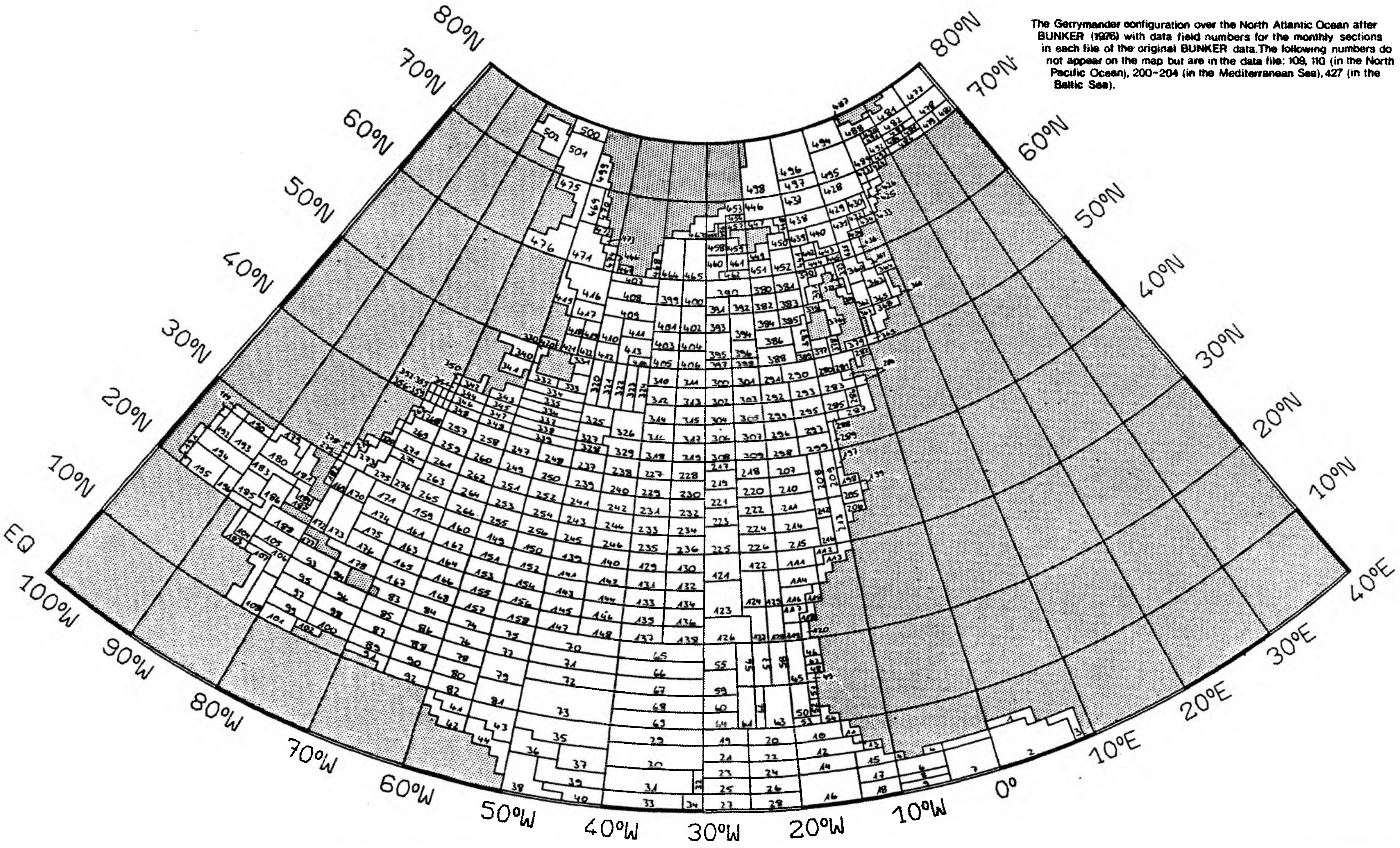
```
DIVIS:=10.;
FOR P1:= 24,25,27,28,30,32,35,46,47,53,55,57,58,74 DO
FB(P1,1.,P,DIVIS);
FOR P1:= 59,69,70 DO
FB(P1,100.,P,DIVIS);
FB(71,1000.,P,DIVIS);
COMMENT
FESTLEGUNG EINES PARAMETERABHAENGIGEN
DIVISORS;

FOR M:=MA UNTIL ME DO
BEGIN
NAME:=CONCAT(NAM,"BI");
REABIN(NAME,M,P,PFILE,FELD,BINDSK,DIVIS,PMRF);

IF PMRF THEN
BEGIN
SELECTOUTPUT(0);
NEWLINE;
WRITE("PROGRAMMABBRUCH");NEWLINE;
GOTO SCHLUSS;
END;

OUTPUT(9,DATDSK);
NAME:=CONCAT(NAM,ENDUNG[M]);
OPENFILE(9,NAME);
SELECTOUTPUT(9);
UEBS:=CONCAT(UEBER[P],"  ",MONAT[M]);
PLOFI(XA,XE,YA,YE,P,M,UEBS,FELD);
RELEASE(9);
SELECTOUTPUT(0);
WRITE("FERTIG:  ");
WRITE(MONAT[M]);
NEWLINE;
END---M---;

SCHLUSS:
END;
```



The Gerrymander configuration over the North Atlantic Ocean after BUNKER (1976) with data field numbers for the monthly sections in each file of the original BUNKER data. The following numbers do not appear on the map but are in the data file: 109, 110 (in the North Pacific Ocean), 200-204 (in the Mediterranean Sea), 427 (in the Baltic Sea).