National Oceanographic Data Center Internal Report 15

WORLD OCEAN ATLAS 1998
CD-ROM Documentation
Version 1.0

Ocean Climate Laboratory
National Oceanographic Data Center

Silver Spring, MD
April, 1999

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Environmental Satellite Data and Information Service

National Oceanographic Data Center

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click on: Products

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U.S. DEPARTMENT OF COMMERCE
William M. Daley, Secretary

National Oceanic and Atmospheric Administration
D. James Baker, Administrator

National Environmental Satellite Data and Information Service
Robert S. Winokur, Assistant Administrator

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World Ocean Atlas 1998 (WOA98)
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1. INTRODUCTION

The ***World Ocean Atlas 1998*** (WOA98) consists of 3 CD-ROMs containing objectively analyzed fields of temperature, salinity, dissolved oxygen, derived oxygen variables (Apparent Oxygen Utilization and oxygen saturation), nutrients (phosphate, nitrate, silicate) and chlorophyll along with fields of various statistics. This CD-ROM set is associated with the following products:

- NOAA Atlas NESDIS ***World Ocean Atlas 1998*** **series** (12 volumes): contains figures showing objectively analyzed fields of each variable for various climatological compositing periods (annual, seasonal, monthly) at selected standard depth levels and a description of the methods used to generate the objectively analyzed fields;

- ***World Ocean Atlas Figures 1998*** **(WOAF98) CD-ROM set**: contains the graphical representation of all WOA98 fields (gif images)

- ***World Ocean Database 1998*** **(WOD98) CD-ROM set**: contains observed and standard level flagged data used to generate the WOA98 fields. WOD98 consists of 5 CD-ROMs;

- ***World Ocean Database 1998*** **atlas series,** an eight volume series detailing the source of the WOD98 data and showing distribution plots for each variable as a function of year.

See section 7 for a listing of these publications.

2. CONTENTS OF WOA98

The data on each WOA98 CD-ROM consists of:

- statistics of observed (vertically interpolated) data (unanalyzed) for one-degree squares and five-degree squares at standard depth levels (see table 1). The following statistics for each grid square are included: 1) number of observations, 2) mean, 3) standard deviation, 4) standard error of the mean. See table 2 for availability of statistics by variable;

- annual, seasonal, and monthly objectively analyzed mean fields by one-degree squares at standard depth levels. See table 2 for availability of objective analyses by variable;

- "interpolation error" of the objectively analyzed fields defined as fields of observed means minus annual objectively analyzed mean by one-degree squares at standard depth levels. See table 2 for availability of these fields by variable;

- seasonal and monthly objectively analyzed fields minus annual mean objectively analyzed fields by one-degree squares at standard depth levels. See table 3 for availability of these fields by variable;

- land/ocean-bottom mask used in the analyses at standard depth levels;

- definition of basins used in the objective analyses at standard depth levels (see table 4).

The seasons are defined as Winter (January-March), Spring (April-June), Summer (July-September), Fall (October-December) (based on the Northern Hemisphere). Table 1 lists the depths and Table 2 the available files for each variable in WOA98.

3. DIRECTORY STRUCTURE

The objectively analyzed fields and associated statistics for temperature, salinity, oxygen, nutrients, and chlorophyll are in three CD-ROMs:

- WOA98-01 annual, seasonal, monthly fields for temperature and salinity,

- WOA98-02 annual, seasonal, monthly fields for oxygen and the derived variables Apparent Oxygen Utilization and % oxygen saturation

- WOA98-03 annual and seasonal fields for phosphate, nitrate, silicate, and chlorophyll

There are four types of directories within each CD-ROM: **masks, programs, utils,** and **variable** data directories (variable data directories are identified by the **variable name** *e.g.* temperature, salinity, etc.. Figure 1 shows an example of the directory structure for temperature on WOA98-01. A *readme.htm, readme.wpd* and *readme.txt* files, containing HTML, Word Perfect 8, and text files of this documentation, are also included in the CD-ROM. The following "gif" images are also contained in this directory as they are needed when viewing the HTML version of the documentation: *coordin1.gif* and *coordin5.gif.*

masks directory:

basin.msk - basin mask used in the objective analysis. There are 33 standard depth levels for which each numeric one degree value corresponds to the number given for the corresponding basin in Table 4, columns 1 and 4.

landsea.msk - bottom depth assigned to each one-degree latitude by one-degree longitude square. Numerical values correspond to the depth levels given in Table 1.

programs directory:

analysis.for - FORTRAN program to print out a latitude-longitude area from a user requested file

analysis.c - C program to print out a latitude-longitude area from a user requested file

analysis.exe - DOS executable program to print out a latitude-longitude area from a user requested file

utils directory:

gzip directory

gzip124.exe - self-extracting DOS executable

gzip-1.2.4.tar.Z - compressed and tar'd file containing source code for UNIX users

temperat directory (WOA98-01)
salinity directory (WOA98-01)
oxygen directory (WOA98-02)
o2sat directory - percent oxygen saturation data (WOA98-02)
aou directory - Apparent Oxygen Utilization data (WOA98-02)
phosph directory (WOA98-03)
nitrate directory (WOA98-03)
silicate directory (WOA98-03)
chloroph directory (WOA98-03)

Each variable data directory in WOA98-01 and WOA98-02 contains three subdirectories:

annual directory - annual objective analyses and statistics at standard depth levels
seasonal directory - seasonal objective analyses and statistics at standard depth levels
monthly directory - monthly objective analyses and statistics at standard depth levels.

Each variable data directory in WOA98-03 contains two subdirectories:

annual directory - annual objective analyses and statistics at standard depth levels
seasonal directory - seasonal objective analyses and statistics at standard depth levels.

The following file types are contained within the **annual**, **seasonal**, and **monthly** directories:

- *Analyzed mean fields (an)* -

  For temperature, salinity, and oxygen:

  > Each annual mean field is the average of the 12 analyzed monthly mean fields at and above 1500 meters. Below 1500 m the average of the four seasonal analyzed fields is used.
>
> The seasonal mean fields above 1500 m are the average of the appropriate three monthly fields. Below 1500 m the seasonal analyzed mean fields are the all-data analyses of each season.
>
> The monthly analyzed mean fields are all-data analyses.

  For phosphate, nitrate, silicate, chlorophyll:

  > Each annual mean field is the average of the four analyzed seasonal mean fields at and above 500 meters (surface for chlorophyll). Below 500 m (0 m for chlorophyll) the annual fields are all-data analyses.
>
> The seasonal mean fields are all-data analyses.

- *Seasonal or monthly fields minus annual fields (ma)* - one-degree seasonal minus annual analyzed fields.

- *Grid point fields (gp)* - the number of grid points which contain data within the radius of influence for each grid box.

- *Data distribution field (dd)* - geographic distribution of data used in analysis

- *Standard deviation field (sd)* - standard deviation from the mean by one-degree squares

- *Standard error of the mean (se)* - standard error of the mean by one-degree squares

- *Means (mn)* - unanalyzed one-degree means for all data used in analysis

- *Observed minus annual (oa)* - analyzed mean field subtracted from one degree raw (unanalyzed) means

4. DATA FORMAT

Each individual datum is stored in one of two ways:

- For *gp* (grid point) files and *dd* (data distribution) files, the value is stored as an 8 digit numeral followed by a decimal point (FORTRAN f8.0). The missing value is -100.. This is also the form for *basin.msk* and landsea.msk. For *gp, dd* and *basin.msk* files, missing value is reserved for land/ocean-bottom. Any ocean point without data values is set to zero. The *landsea.msk* file has no missing values.

- For all other files (*an, se, sd, mn, ma*), values are stored as an eight digit real with 4 places to the left of the decimal (FORTAN f8.4). The missing value is -99.9999. Missing values are used for land/ocean-bottom and for ocean points without data.

The reason for the two different formats is that *dd* and *gp* files may have values greater than 999., which can not be accommodated in the later format. For both cases, there are 10 values per line, followed by a return.

The first value in a one-degree square file corresponds to the grid square from 89.0 S to 90.0 S latitude and 0.0 E to 1.0 E longitude for one-degree data (grid square 1,1). The first 360 values are incremented eastward in longitude, constant in latitude. The 361st value in the file is for the grid square 88.0 S to 89.0 S latitude, 0.0 E to 1.0 E longitude. Figure 2 shows the one-degree coordinate system of the analyzed fields. The five-degree square files follow the same pattern, listing 72x36 values. Figure 3 shows the five-degree coordinate system.

Program *analysis.for* is a sample program which can be used as a template for reading in data in FORTRAN, *analysis.c* is a C sample program, *analysis.exe* is a DOS executable version of the above programs.

5. FILE NAMING CONVENTION FOR ANALYZED DATA AND STATISTICS

All the files in the directories containing the data follow the same naming convention:

[p][tp][ft][g].gz

where:

[p] = parameter:
- t = temperature
- s = salinity
- o = dissolved oxygen
- x = percent oxygen saturation
- a = Apparent Oxygen Utilization

p = phosphate
n = nitrate
i = silicate
c = chlorophyll

[tp] = time period:
00 = all data annual
13 - 16 = seasons (starting with Winter (Jan-Mar))
01 - 12 = months (starting with January)

[ft] = file type:
an = analyzed mean field
dd = distribution of data
sd = standard deviation of data
se = standard error of the mean of data
mn = raw (unanalyzed) mean of data
oa = observed (raw) mean minus analyzed field
gp = number of grid points containing data
within the radius of influence around present grid point

[g] = one-degree (1) or 5-degree (5) square file

Example: t14se1.gz = compressed file for one-degree square standard error of the mean for spring temperature

6. util DIRECTORY

Within the **util** directory of each CD-ROM there is a GZIP directory which contains two files used for decompressing the data on the WOA98. The first (GZIP124.EXE) is a self-extracting DOS executable and the second (gzip-1.2.4.tar.Z) is a compressed and tar'd file containing source code for UNIX users. This file may appear as gzip-1~1.Z.

a. Installing gzip For the First Time

DOS Users:

The file *gzip124.exe* is a self-extracting DOS executable. Copy *gzip124.exe* to your hard drive. Run *gzip124.exe* and use the file *gzip.exe* to decompress data as described below.

UNIX Users:

Copy gzip-1.2.4.tar.Z to your UNIX system. **If the file name is gzip-1~1.Z, rename it to gzip-1.2.4.tar.Z.**

Run the following commands:

```
decompress gzip-1.2.4.tar.Z
tar xvf gzip-1.2.4.tar
```

These commands will create a directory named gzip-1.2.4 which include the gzip source code and documentation on copyrights, compression methods and how to compile and install the gzip code.

Read through the README file and when ready to build the gzip executable, follow the instructions in the INSTALL file.

b. Decompressing Data From WOD98

To decompress the contents of a directory and all of it's subdirectories:

gzip -ndr <directoryname>

If an older version of gzip is used, the -n option is required in order to preserve the correct file names.

Special Note for UNIX Users

The DOS CR-LF (Carriage Return-Line Feed (^M)) indicates the end of a record and may cause problems when working in a UNIX environment. Many systems have a "dos2unix" program which removes these characters from an ASCII file. Files can also be converted by transferring from DOS/WINDOWS using FTP (File Transfer Protocol). The UNIX "tr" or "perl" utilities will also remove the CR-LF.

a. *To use the UNIX translate utility, "tr":*

```
tr -d '\r' < original_filename > new_filename
```

(Note that the "<" and ">" must be typed for this command to work).

b. *To use the UNIX perl utility*:

```
perl -pi -e 's/\r\n/\n/g' filename
```

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Table 1. Standard levels and depths (meters)

Depth	**Level**	**Depth**	**Level**	**Depth**	**Level**
0	1	300	12	1400	23
10	2	400	13	1500	24
20	3	500	14	1750	25
30	4	600	15	2000	26
50	5	700	16	2500	27
75	6	800	17	3000	28
100	7	900	18	3500	29
125	8	1000	19	4000	30
150	9	1100	20	4500	31
200	10	1200	21	5000	32
250	11	1300	22	5500	33

Table 2. Availability of fields for each variable and the ***maximum*** depth for each data type. An X indicates that these files are not available for the specified variable.

Variable	Annual	Seasonal	Monthly
Temperature	5500	5500	1500
Salinity	5500	5500	1500
Dissolved Oxygen	5500	5500	1500
Apparent Oxygen Utilization	5500	5500	1500
Oxygen Saturation	5500	5500	1500
Phosphate	5500	500	X
Nitrate	5500	500	X
Silicate	5500	500	X
Chlorophyll	100	surface	X

Table 3. Availability of difference fields for each variable and the ***maximum*** depth available for each variable. An X indicates that these files are not available for the specified variable.

Variable	Seasonal	Monthly
Temperature	1500	1500
Salinity	1500	1500
Dissolved Oxygen	1500	1500
Apparent Oxygen Utilization	1500	1500
Oxygen Saturation	1500	1500
Phosphate	500	X
Nitrate	500	X
Silicate	500	X
Chlorophyll	surface	X

Table 4. Basins defined for objective analysis and the shallowest standard depth level for which each basin is defined.

#	BASIN	STANDARD DEPTH LEVEL	#	BASIN	STANDARD DEPTH LEVEL
1	Atlantic Ocean	1	29	Fiji Basin	29
2	Pacific Ocean	1	30	North American Basin	29
3	Indian Ocean	1	31	West European Basin	29
4	Mediterranean Sea	1	32	Southeast Indian Basin	29
5	Baltic Sea	1	33	Coral Sea	29
6	Black Sea	1	34	East Indian Ocean	29
7	Red Sea	1	35	Central Indian Ocean	29
8	Persian Gulf	1	36	Southwest Atlantic	29
9	Hudson Bay	1	37	Southeast Atlantic	29
10	Southern Ocean	1	38	Southeast Pacific	29
11	Arctic Ocean	1	39	Guatemala Basin	29
12	Sea of Japan	1	40	East Caroline Basin	30
13	Kara Sea	8	41	Marianas Basin	30
14	Sulu Sea	10	42	Philippine Sea	30
15	Baffin Bay	14	43	Arabian Sea	30
16	East Mediterranean	16	44	Chile Basin	30
17	West Mediterranean	19	45	Somali Basin	30
18	Sea of Okhotsk	19	46	Mascarene Basin	30
19	Banda Sea	23	47	Crosat Basin	30
20	Caribbean Sea	23	48	Guinea Basin	30
21	Andaman Basin	25	49	Brazil Basin	31
22	North Caribbean	26	50	Argentine Basin	31
23	Gulf of Mexico	26	51	Tasman Sea	30
24	Beaufort Sea	28	52	Atlantic Indian Basin	31
25	South China Sea	28	53	Caspian Sea	1
26	Barents Sea	28	56	Bay of Bengal	1
27	Celebes Sea	25	57	Java Sea	6
28	Aleutian Basin	28			

Figure 1. Directory structure for the temperature data in WOA98-01. Bold denotes directories, italics denotes file names. "xx" denotes time period, 13-16 for the seasons, and 01-12 for the monthly files.

readme.htm
readme.wpd
readme.txt
coordin1.gif
coordin5.gif

programs
analysis.for
analysis.c
analysis.exe

mask
basin.msk
landsea.msk

temperat

annual	**seasonal**	**monthly**	
t00an1.gz	*txxan1.gz*	*txxan1.gz*	***an1***= one-degree analyzed field
t00dd1.gz	*txxdd1.gz*	*txxdd1.gz*	***dd1***= one-degree data distribution
t00dd5.gz	*txxdd5.gz*	*txxdd5.gz*	***dd5***= five-degree data distribution
t00gp1.gz	*txxgp1.gz*	*txxgp1.gz*	***gp1***= one-degree grid points containing data within the influence region
t00mn1.gz	*txxmn1.gz*	*txxmn1.gz*	***mn1***= unanalyzed one-degree mean
t00mn5.gz	*txxmn5.gz*	*txxmn5.gz*	***mn5***= unanalyzed five-degree mean
t00oa1.gz	*txxoa1.gz*	*txxoa1.gz*	***oa1***= observed mean minus analyzed
t00sd1.gz	*txxsd1.gz*	*txxsd1.gz*	***sd1***= one-degree standard deviation
t00sd5.gz	*txxsd5.gz*	*txxsd5.gz*	***sd5***= five-degree standard deviation
t00se1.gz	*txxse1.gz*	*txxse1.gz*	***se1***= one-degree standard error
t00se5.gz	*txxse5.gz*	*txxse5.gz*	***se5***=five-degree standard error
	txxma1.gz	*txxma1.gz*	***ma1***= seasonal or monthly mean minus annual fields

utils
gzip

gzip124.exe
gzip-1.2.4.tar.Z

Figure 2. One-degree horizontal co-ordinate system of the analyzed fields.

Each element (i,j) of an analyzed field dimensioned (360,180), is considered to represent the value at the center of a one degree latitude - longitude square.

Longitude denoted by the variable "i", varies from 1 at 0.5 E to 360 at 0.5 W

Latitude denoted by the variable "j", varies from 1 at 89.5 S to 180 at 89.5 N

The point (1,1) is the value at 0.5 E, 89.5 S
The point (218,20) is the value at 142.5 W, 70.5 S

The point (360,91) is the value at 0.5 W, 0.5 N

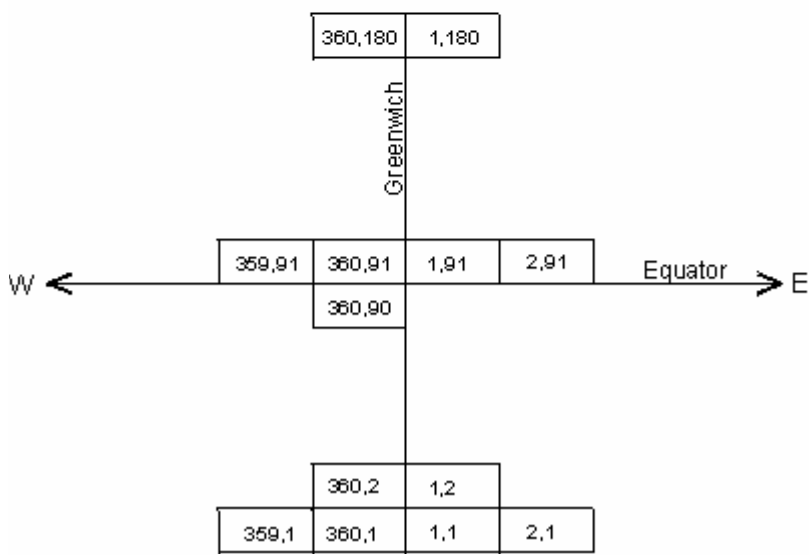
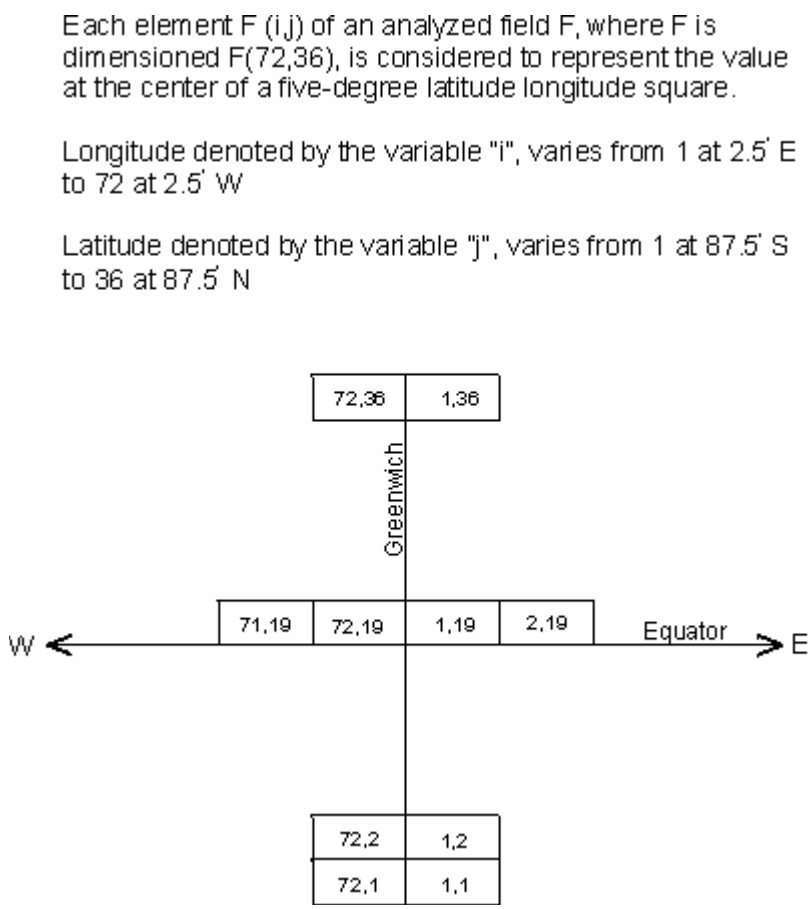
Figure 3. Five-degree horizontal co-ordinate system of the analyzed fields.