Modern Average Global Sea-Surface Temperature

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Contents

Appendixes:

UNITED STATES DEPARTMENT OF THE INTERIOR
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This CD-ROM has been produced in accordance with the ISO 9660 CD-ROM standard and is therefore capable of being read on any computing platform that has appropriate CD-ROM drive hardware and software installed.

Introduction

The purpose of this data set is to provide paleoclimate researchers with a tool for estimating the average seasonal variation in sea-surface temperature (SST) throughout the modern world ocean and for estimating the modern monthly and weekly sea-surface temperature at any given oceanic location. It is expected that these data will be compared with temperature estimates derived from geological proxy measures such as faunal census analyses and stable isotopic analyses. The results can then be used to constrain general circulation models of climate change.

The data contained in this data set are derived from the NOAA Advanced Very High Resolution Radiometer Multichannel Sea Surface Temperature data (AVHRR MCSST), which are obtainable from the Distributed Active Archive Center at the Jet Propulsion Laboratory (JPL) in Pasadena, Calif. The JPL tapes contain weekly images of SST from October 1981 through December 1990 in nine regions of the world ocean: North Atlantic, Eastern North Atlantic, South Atlantic, Agulhas, Indian, Southeast Pacific, Southwest Pacific, Northeast Pacific, and Northwest Pacific.

This data set represents the results of calculations carried out on the NOAA data and also contains the source code of the programs that made the calculations. The objective was to derive the average sea-surface temperature of each month and week throughout the whole 10-year series, meaning, for example, that data from January of each year would be averaged together. The result is 12 monthly and 52 weekly images for each of the oceanic regions. Averaging the images in this way tends to reduce the number of grid cells that lack valid data and to suppress interannual variability.

As ancillary data, the ETOPO5 global gridded elevation and bathymetry data (Edwards, 1989) were interpolated to the resolution of the SST data; the interpolated topographic data are included.

The images are provided in three formats: a modified form of run-length encoding (MRLE), Graphics Interchange Format (GIF), and Macintosh PICT format.

Also included in the data set are programs that can retrieve seasonal temperature profiles at user-specified locations and that can decompress the data files. These nongraphical SST retrieval programs are provided in versions for UNIX, MS-DOS, and Macintosh computers. Graphical browse utilities are included for users of UNIX with the X Window System, 80386-based PC's, and Macintosh computers.

Data Set Structure

The structure of this data set is illustrated in the diagram below. Files are organized into three groups: contents information, core components, and derived components.

Contents Information

These files indicate the general character of the data set and are intended to help potential users decide whether to obtain the full data set or not. The information is provided in ASCII files and consists of a description in Directory Interchange Format (DIF) and an annotated list of files.

Core Components

Raw Data

These files contain the fundamental observations and portable program source code that is essential for using the raw data. Source code is provided here for two programs, one to retrieve SST values, given a list of SST data files and a list of geographic locations, and one to expand the compressed data files into the same format as the original JPL files. The SST data files themselves are provided as monthly and weekly averages.

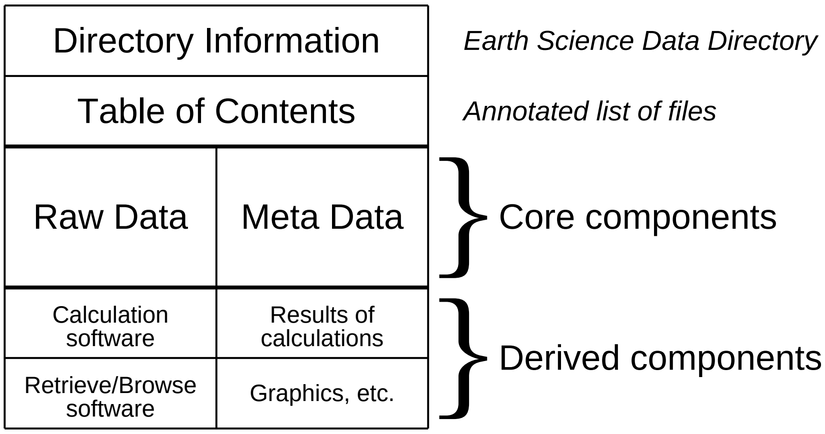
In addition to the SST data, gridded topographic data are provided at the same resolution.

Meta Data

These files contain information essential for understanding the observations but not necessary for using them. A text version of this report is included as metadata, as are the source code files of programs originally used to produce the data set, a program to convert the compressed SST image files into a portable format, and a program to display the relationship between pixel values and temperature.

Derived Components

These files describe details or provide capabilities that are not needed to access or interpret the fundamental data. They may be useful to some researchers. Graphical programs are provided to users of UNIX with the X Window System, 80386-based PC's, and for Macintosh users, permitting them to extract SST profiles and view individual SST images. Executable versions of all programs and source code for graphical programs are included here.



System Requirements

This data set is intended for use on MS-DOS, Macintosh, and UNIX computer systems. Included in the data set are simple programs to extract numerical values from the data files and more elaborate graphical display programs, which require more sophisticated hardware to use. Listed below are the minimum system requirements for each of the supported platforms; the additional memory and display capabilities required by the graphical software are noted.

MS-DOS

- IBM or compatible personal computer
- MS- or PC-DOS version 3.3 or later
- Microsoft MSCDEX version 2.1 or later
- CD-ROM drive with ISO 9660 software driver

The graphical display software requires the following:

- 80386 or 80486 CPU
- 4 megabytes of RAM configured as extended memory
- Super VGA graphics system with at least 640 x 400 in 256 colors. Video adapters based on the following chips are supported:
  - Paradise
  - Video 7
  - ATI Wondercard, ATI VGA Wonder
  - Oak Technologies
  - Trident
  - Genoa 6400 and 6600
  - Tseng Labs ET3000 and ET4000
  - Chips and Technologies

Macintosh

- Macintosh computer
- CD-ROM drive

The graphical display software requires the following:

- 4 megabytes of RAM
- 256-color display

UNIX

- ANSI-conformant C language compiler
- CD-ROM drive with ISO 9660 software driver

The graphical display software requires the following:

- 8 megabytes of RAM
- X Window System version 11, release 3 or later

Annotated List of Digital Files

Text Files

`report.txt`	Description of the structure and contents of the data set.
`magsst.dif`	Data set directory entry in DIF format.
`contents.txt`	Brief annotated list of files.

Program Source Files

UNIX versions of the programs differ significantly from MS-DOS and Macintosh versions because the latter two systems constrain the use of memory by applications. As a result, code developed for UNIX is simpler and may be more easily understood by a reader.

`calibrate.c`	Prints the relationship between SST image values and temperature in degrees Celsius.
`sum.c`	(UNIX) Calculates the average SST for a section of the region specified. Either weekly or monthly averages can be calculated.
`combine.c`	(UNIX) Combines files output by `sum.c`, producing image files of the same format as the original NOAA files.
`wr_mrle.c`	(UNIX) Compression of image files through modified run-length encoding.
`mrd_mrle.c`	(Macintosh and MS-DOS) Decompresses the images output by `wr_mrle`, producing a file with the original image format.
`urd_mrle.c`	(UNIX version)
`mrletoppm.c`	(UNIX) Converts a file from modified run-length encoding to a portable pixmap, which can be used with the *pbmplus* package, a freely available image translation utility.
`m_rtrv.c`	(Macintosh and MS-DOS) Character-based temperature retrieval program. Given a list of input data files and a request file containing locations, this program returns one temperature estimate per data file for each requested location.
`u_rtrv.c`	(UNIX version)
`see.c`	(UNIX) Graphical temperature retrieval program requiring X Windows version 11, release 3 or 4, based on *Xlib*. Allows interactive viewing of seasonal and geographic temperature data.
`see.icon`	Ancillary to `see.c`.
`quarter.c`	(UNIX) Reads an SST file in MRLE format and outputs a 256 × 256 pixel version of the same file, both in MRLE format and in portable pixmap format. The MRLE format output file has no header records. These output files are used as input to the Macintosh graphical browse utility.
`weekdate.c`	Prints a table showing the dates covered by weekly files.
`getdepth.c`	(UNIX) Interpolates `ETOPO5.IMG` to produce depth data at the same resolution as the SST data.
`depthppm.c`	(UNIX) Creates a portable pixmap from the output of `getdepth`.

Executable Program Files

Files listed below with extension `.hqx` are binary files that have been converted to ASCII using BinHex 4.0. This conversion is necessary because UNIX and MS-DOS file systems have no convenient way to store the resource fork of a Macintosh file.

`dos_rtrv.exe`	(MS-DOS) Character-based retrieval program.
`mac_rtrv.hqx`	(Macintosh) Character-based retrieval program.
`lookup.hqx`	(Macintosh) *Look up SST*, a character-based SST retrieval program.
`see.hqx`	(Macintosh) *See SST*, a graphical SST retrieval program.
`see.exe`	(Extended MS-DOS) Graphical SST retrieval program.
`dos4gw.exe`	DOS-extender that loads and executes `see.exe`.

Macintosh-Specific Source Code and Data

Because Macintosh files may have resource forks, which cannot be handled conveniently by MS-DOS and UNIX, archives of Macintosh-specific source files are made available. These are useful if, for example, your MS-DOS computer has a CD-ROM drive but your Macintosh does not. You can use the MS-DOS machine to transfer these archives from the CD-ROM to the Macintosh via floppy disk or a network and then unpack the archives on the Macintosh.

`look_sea.hqx`	Self-extracting archive of sources for *Look up SST*.
`see_sea.hqx`	Self-extracting archive of sources for *See SST*.
`sst_data.hqx`	Self-extracting archive of data for *See SST*.

MS-DOS-Specific Source Code

The graphical SST retrieval program `see.c` is provided in source and executable versions for the extended MS-DOS platform. This program requires an 80386 or 80486 CPU and a super VGA card capable of displaying 256 colors at a spatial resolution of 640 × 400 or greater. It relies on the Watcom version of the DOS-extender `DOS/4G` by Rational Systems, Inc., called `DOS4GW`, which is included on the disc.

`see.c`	Main source code module.
`cursor.c`	Routine to draw a cursor on the super VGA screen.
`doskeys.h`	Definitions of keystrokes.
`add1.asm`	Routines for adjusting color cells and reading `etopo5`.
`bios.asm`	Routines to get information from the BIOS.
`mouse.asm`	Routines to handle low-level interactions with the mouse driver.
`keyboard.asm`	Routines to handle keyboard input.
`lfl9x16.fon`	Font for use in 800 × 600 and 1024 × 768 modes.

Data Files

The data are stored in subdirectories according to the region they portray. Each file is compressed with modified run-length encoding, as output by the program `wr_mrle`, whose source is included.

`na/`	North Atlantic
`nae/`	North Atlantic East, including the Mediterranean Sea
`sa/`	South Atlantic
`nep/`	Northeast Pacific
`nwp/`	Northwest Pacific
`sep/`	Southeast Pacific

`swp/`	Southwest Pacific
`io/`	Indian
`ag/`	Agulhas region (South Africa)

Monthly files are named as `m_`*mon*.*reg*, where *mon* is the three-letter abbreviation for the month, and *reg* is the two- or three-letter abbreviation for the region. A list of monthly files is included, called `monthly.`*reg*, with the appropriate region code substituted for *reg*.

Each monthly directory has subdirectories `gif`, `pict`, and `weekly`. The `gif` subdirectory contains files in the Graphics Image Format (GIF) of CompuServe, Inc., and those files are named as `m_`*mon reg*`.gif`, where *mon* is the month and *reg* is the region code. The `pict` subdirectory contains files in the Macintosh PICT image format, and those files are named as `m_`*mon reg*`.pic`, where *mon* is the month and *reg* is the region code.

The `weekly` subdirectory contains weekly average SST images for the region. The weekly files are named as `week`*00*.*reg* where *reg* is the region code and *00* is replaced by the week number, beginning with 00 and ending with 51.

Each weekly directory has subdirectories `gif` and `pict`. The weekly `gif` subdirectory contains files in the Graphics Image Format (GIF), and those files are named as `w_`*00 reg*`.gif`, where *reg* is the region code and *00* is replaced with the week number, from 00 to 51. The weekly `pict` subdirectory contains files in the Macintosh PICT image format, and those files are named as `w_`*00 reg*`.pic`, where *reg* is the region code and *00* is replaced with the week number, from 00 to 51.

The gridded elevation and bathymetry data are included for each region in binary files named `etopo5.`*reg* and `etopo5q.`*reg*, where *reg* is the appropriate region abbreviation. Those files named `etopo5` are at the full 512 × 512 resolution, while those named `etopo5q` are quarter-sized images at half resolution (256 × 256 pixels). The `gif` and `pict` subdirectories contain the same topographic data files in the corresponding image formats.

Note that the elevation and bathymetry data require two bytes per pixel, and the data files `etopo5.*` and `etopo5q.*` are *big-endian*, meaning they follow a most-significant-byte-first ordering scheme. For an example of how these data should be handled on 80x86-based computers, see the file `add1.asm` in the directory `Derived/dos/dos_see`.

Example: This list describes the data files pertaining to the North Atlantic Ocean. The slash character (`/`) is used as a path separator corresponding to the backslash in MS-DOS and the colon in Macintosh.

```
na/
    m_jan.na,...,m_dec.na            Average monthly SST, MRLE format.
    monthly.na                       List of monthly MRLE files.
    etopo5.na                        Topography (512 × 512).
    etopo5q.na                       Topography (256 × 256).
    gif/
        etopona.gif                  Topography (512 × 512 GIF format).
        etopqna.gif                  Topography (256 × 256 GIF format).
        m_janna.gif,...,m_decna.gif  Average monthly SST, GIF format.
    pict/
        etopona.pic                  Topography (512 × 512 PICT format).
```

```
    etopqna.pic                   Topography (256 × 256 PICT format).
    m_janna.pic,...,m_decna.pic   Average monthly SST, PICT format.
weekly/
    week00.na,...,week51.na       Average weekly SST, MRLE format.
    weekly.na                     List of weekly MRLE files.
    gif/
        w_00na.gif,...,w_51na.gif Average weekly SST, GIF format.
    pict/
        w_00na.pic,...,w_51na.pic Average weekly SST, PICT format.
```

Each of the nine regional data directories thus contains 200 files as follows:

Description	*Count*	*Example*
SST monthly averages (`MRLE`)	12	`m_jan.na`
SST monthly index	1	`monthly.na`
SST monthly averages (`GIF`)	12	`m_janna.gif`
SST monthly averages (`PICT`)	12	`m_janna.pic`
SST weekly averages (`MRLE`)	52	`week00.na`
SST weekly index	1	`weekly.na`
SST weekly averages (`GIF`)	52	`w_00na.gif`
SST weekly averages (`PICT`)	52	`w_00na.pic`
Topography 512×512 (raw)	1	`etopo5.na`
Topography 512×512 (`GIF`)	1	`etopona.gif`
Topography 512×512 (`PICT`)	1	`etopona.pic`
Topography 256×256 (raw)	1	`etopo5q.na`
Topography 256×256 (`GIF`)	1	`etopqna.gif`
Topography 256×256 (`PICT`)	1	`etopqna.pic`
Total	200	

Programming Notes

This data set was developed using a Data General AViiON 300CD workstation running the DG/UX version of UNIX. Due to the large amount of memory required, some of the programs whose source code is included will not run under MS-DOS and would require substantial customization to be run on a Macintosh.

The portable programs are the character-based temperature retrieval program (`u_rtrv.c` and `m_rtrv.c`), the calibration printing program (`calibrat.c`), and the data file decompression utility (`urd_mrle.c` and `mrd_mrle.c`). Extensions to the C programming language that are peculiar to the compilers are kept to a minimum; these extensions relate mostly to pointers (MS-DOS uses segmented pointers) and memory allocation. THINK C lacks a `stricmp` library function, so this was conditionally coded in `m_rtrv.c`.

The compilers used to build the programs are listed below.

System	*Compiler version and vendor*
MS-DOS	Turbo C 2.01 small memory model
Extended DOS	Watcom C/386 version 9.01, with DOS4GW
Macintosh	THINK C 5.0.4
DG/UX	GNU C 1.96

The nonportable programs consist of `see.c`, a UNIX application whose user interface is based on X Windows, *Look up SST* and *See SST*, Macintosh applications that use the Macintosh Toolbox, and the extended-DOS version of `see.c`, which uses Microsoft-compatible graphics library functions, as supplied with the Watcom compiler.

Data Sources

The original NOAA AVHRR MCSST data set can be obtained from

NASA Ocean Data System
MS 300-320
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, CA 91109
Tel: (818) 354–0906
FAX: (818) 393–6720

The original data come on nine nine-track tapes, 6250 bpi VAX backup format, each containing 467 weekly SST files. Each file is binary and 257.5 kbytes in length.

The gridded elevation and bathymetry data were interpolated (using the program `getdepth`, whose source `getdepth.c` is included) from the ETOPO5 data set of Edwards (1989), available from NOAA on CD-ROM. The full data set citation is described in the NOAA Global Ecosystems Database documentation manual as follows:

NOAA/NGDC. 1992. *Integrated Global Elevation and Bathymetry.* Digital Data. NOAA/NGDC/WDC-A, Boulder, Colo. Digital raster data on a 5-minute geographic (lat/long) 2160 x 4320 grid. In: *Global Ecosystems Database Version 1.0: Disc A.* Boulder, CO: NOAA National Geophysical Data Center. 1 independent single-attribute spatial layer on CD-ROM. 18.6 MB. [First published in 1989.]

Technical Contacts

The principal technical contact is the author of all programs and documentation contained in this data set. Questions regarding the operation of these programs, the contents of the CD-ROM, and the relevant source code should be directed to

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References

Edwards, M.H. 1989, Global Gridded Elevation and Bathymetry (*ETOPO5*): Digital raster data on a 5-minute geographic (lat/long) 2160×4320 (centroid-registered) grid. Boulder, Colo.: NOAA National Geophysical Data Center. 9-track tape, 18.6 megabytes.

McClain, E.P., Pichel, W.G., and Walton, C.C., 1985, Comparative performance of AVHRR-based multichannel sea surface temperatures: Journal of Geophysical Research, v. 90, p. 11587-11601.

Smith, E., 1991, A user's guide to the NOAA Advanced Very High Resolution Radiometer Multichannel Sea Surface Temperature data set produced by the University of Miami/ Rosenstiel School of Marine and Atmospheric Science: Distributed by the Distributed Active Archive Center, Jet Propulsion Laboratory, Pasadena, California. 17 p.

Appendix A: Relationship of Pixel Values to Temperature

These tables relate pixel values, which are eight-bit unsigned numbers, to the corresponding sea-surface temperatures in degrees Celsius. The pixel values are indicated by hexadecimal numbers expressed in the notation of the C programming language; `0x11` denotes the decimal number 17, `0x0A` represents decimal 10, `0xFF` represents decimal 255, and so forth.

In the tables, the column *c* indicates the most significant hexadecimal digit of the pixel value, and the row *r* indicates the least signficant digit.

	0x0*r*	0x1*r*	0x2*r*	0x3*r*	0x4*r*	0x5*r*	0x6*r*	0x7*r*
0x*c*0	-2.1	1.1	4.3	7.5	10.7	13.9	17.1	20.3
0x*c*1	-1.9	1.3	4.5	7.7	10.9	14.1	17.3	20.5
0x*c*2	-1.7	1.5	4.7	7.9	11.1	14.3	17.5	20.7
0x*c*3	-1.5	1.7	4.9	8.1	11.3	14.5	17.7	20.9
0x*c*4	-1.3	1.9	5.1	8.3	11.5	14.7	17.9	21.1
0x*c*5	-1.1	2.1	5.3	8.5	11.7	14.9	18.1	21.3
0x*c*6	-0.9	2.3	5.5	8.7	11.9	15.1	18.3	21.5
0x*c*7	-0.7	2.5	5.7	8.9	12.1	15.3	18.5	21.7
0x*c*8	-0.5	2.7	5.9	9.1	12.3	15.5	18.7	21.9
0x*c*9	-0.3	2.9	6.1	9.3	12.5	15.7	18.9	22.1
0x*c*A	-0.1	3.1	6.3	9.5	12.7	15.9	19.1	22.3
0x*c*B	0.1	3.3	6.5	9.7	12.9	16.1	19.3	22.5
0x*c*C	0.3	3.5	6.7	9.9	13.1	16.3	19.5	22.7
0x*c*D	0.5	3.7	6.9	10.1	13.3	16.5	19.7	22.9
0x*c*E	0.7	3.9	7.1	10.3	13.5	16.7	19.9	23.1
0x*c*F	0.9	4.1	7.3	10.5	13.7	16.9	20.1	23.3

	0x8*r*	0x9*r*	0xA*r*	0xB*r*	0xC*r*	0xD*r*	0xE*r*	0xF*r*
0x*c*0	23.5	26.7	29.9	33.1	36.3	39.5	42.7	45.9
0x*c*1	23.7	26.9	30.1	33.3	36.5	39.7	42.9	46.1
0x*c*2	23.9	27.1	30.3	33.5	36.7	39.9	43.1	46.3
0x*c*3	24.1	27.3	30.5	33.7	36.9	40.1	43.3	46.5
0x*c*4	24.3	27.5	30.7	33.9	37.1	40.3	43.5	46.7
0x*c*5	24.5	27.7	30.9	34.1	37.3	40.5	43.7	46.9
0x*c*6	24.7	27.9	31.1	34.3	37.5	40.7	43.9	47.1
0x*c*7	24.9	28.1	31.3	34.5	37.7	40.9	44.1	47.3
0x*c*8	25.1	28.3	31.5	34.7	37.9	41.1	44.3	47.5
0x*c*9	25.3	28.5	31.7	34.9	38.1	41.3	44.5	47.7
0x*c*A	25.5	28.7	31.9	35.1	38.3	41.5	44.7	47.9
0x*c*B	25.7	28.9	32.1	35.3	38.5	41.7	44.9	48.1
0x*c*C	25.9	29.1	32.3	35.5	38.7	41.9	45.1	48.3
0x*c*D	26.1	29.3	32.5	35.7	38.9	42.1	45.3	48.5
0x*c*E	26.3	29.5	32.7	35.9	39.1	42.3	45.5	48.7
0x*c*F	26.5	29.7	32.9	36.1	39.3	42.5	45.7	48.9

Appendix B: *Dates Spanned by Weekly Files*

This table shows the dates encompassed by numbered weeks of a typical year (that is, not a leap year). Note that the last week contains 8 days; in leap years this week contains 9, and all weeks following `week08` are offset by 1 day from the dates shown in this table.

`week00`	Jan 1 — Jan 7	`week26`	Jul 2 — Jul 8
`week01`	Jan 8 — Jan 14	`week27`	Jul 9 — Jul 15
`week02`	Jan 15 — Jan 21	`week28`	Jul 16 — Jul 22
`week03`	Jan 22 — Jan 28	`week29`	Jul 23 — Jul 29
`week04`	Jan 29 — Feb 4	`week30`	Jul 30 — Aug 5
`week05`	Feb 5 — Feb 11	`week31`	Aug 6 — Aug 12
`week06`	Feb 12 — Feb 18	`week32`	Aug 13 — Aug 19
`week07`	Feb 19 — Feb 25	`week33`	Aug 20 — Aug 26
`week08`	Feb 26 — Mar 4	`week34`	Aug 27 — Sep 2
`week09`	Mar 5 — Mar 11	`week35`	Sep 3 — Sep 9
`week10`	Mar 12 — Mar 18	`week36`	Sep 10 — Sep 16
`week11`	Mar 19 — Mar 25	`week37`	Sep 17 — Sep 23
`week12`	Mar 26 — Apr 1	`week38`	Sep 24 — Sep 30
`week13`	Apr 2 — Apr 8	`week39`	Oct 1 — Oct 7
`week14`	Apr 9 — Apr 15	`week40`	Oct 8 — Oct 14
`week15`	Apr 16 — Apr 22	`week41`	Oct 15 — Oct 21
`week16`	Apr 23 — Apr 29	`week42`	Oct 22 — Oct 28
`week17`	Apr 30 — May 6	`week43`	Oct 29 — Nov 4
`week18`	May 7 — May 13	`week44`	Nov 5 — Nov 11
`week19`	May 14 — May 20	`week45`	Nov 12 — Nov 18
`week20`	May 21 — May 27	`week46`	Nov 19 — Nov 25
`week21`	May 28 — Jun 3	`week47`	Nov 26 — Dec 2
`week22`	Jun 4 — Jun 10	`week48`	Dec 3 — Dec 9
`week23`	Jun 11 — Jun 17	`week49`	Dec 10 — Dec 16
`week24`	Jun 18 — Jun 24	`week50`	Dec 17 — Dec 23
`week25`	Jun 25 — Jul 1	`week51`	Dec 24 — Dec 31

Appendix C: *User's Guide to Included Programs*

`dos_rtrv.exe`
`mac_rtrv`

These programs, for MS-DOS-based computers and the Macintosh, are compiled versions of the character-based temperature retrieval program `m_rtrv.c`. The purpose of this program is to search through a list of input SST files and extract the temperature from each file that corresponds to a particular location. Typically the input file list will consist of a monthly sequence of files for a particular region; the result is a yearly temperature profile for each requested location.

Compilation

None required; these are executable images.

Preparation of Input Files

Two input files are needed. Both should be plain ASCII, with each line terminated in the manner customary for the platform (that is, carriage return only on the Macintosh, carriage return followed by line feed on the PC).

The *list* file should contain the names of SST data files from which temperatures will be extracted. Each line in the file should contain one name. On the PC, the file specification may include a directory designation; this form is not valid on the Macintosh. Because of this limitation, the Macintosh version `mac_rtrv` must be run from the folder that contains the data files.

The *request* file should contain the geographic locations for which SST data are to be retrieved. Each location should be specified by latitude and longitude in degrees. The numbers should be given in plain decimal notation, not scientific notation, and they may include the letters N, S, E, or W to indicate the octant containing the location. If the letters are not specified, the sign of the latitude and longitude will be used to determine the octant. Positive values of latitude are in the Northern Hemisphere, negative values in the Southern Hemisphere. Positive values of longitude are east of the Prime Meridian, negative values are west of the Prime Meridian. Longitude values greater than 180 degrees are permitted; obviously this places them in the opposite hemisphere.

Execution

These programs are controlled by a command line. On the Macintosh, the user will be prompted for the appropriate command line after double-clicking the application's icon. Valid options are listed below.

`-i` *list file*	Specify the name of the file containing the list of SST files to be searched.
`-r` *request file*	Specify the name of the file containing the locations for which SST data are to be extracted.
`-o` *output file*	Specify the name of the file to which results will be written. The file, if it exists, will be overwritten.
`-v`	(verbose) Cause the program to report its activities fully.
`-a`	(averaging) Cause the program to average the SST values of the nine grid points nearest the location requested.

`-f TEXT` *or* `TAB` *or* `CSV` Specify the format of the output file.

The list file, request file, and output file are required. If the user does not specify these in the command line, the program will prompt for them until the user supplies acceptable file names.

Examples:

```
dos_rtrv -i monthly.na -o my_temps -r my_cores -v -a
```

The SST files to be searched will be those whose names are listed in `monthly.na`, the output will be written to the file `my_temps`, and the locations are listed in file `my_cores`. The listing should be verbose, and the reported values will be the averages of the nine grid cells surrounding each requested location.

```
dos_rtrv -v
```

The input file list, output file name, and request file name will be obtained through a dialog with the user. The listing will be verbose, and the values reported will be the actual values found in the grid cells that contain the requested locations, not the averages of neighboring SST values.

Interpretation of Output Files

The output file will have one line for each location specified in the request file. Each line begins with the location explicitly given, followed by `T:` and a list of temperature values, one for each file in the input file list. Temperature is given in degrees Celsius. Missing values are given as -99.0. Values can be missing because (1) the location specified does not lie within the region covered by the input file, (2) the location specified is on land, or (3) the location given is covered by clouds or ice. The retrieval program gives no indication which of these is the cause of the missing data.

Specifying `-f TAB` or `-f CSV` causes the output file to be written in tab-delimited format or comma-separated values format, respectively. These formats are easier to import into spreadsheet or data base programs.

Look up SST

This program is a Macintosh-specific version of the character-based SST retrieval programs above. This version makes extensive use of the Macintosh Toolbox, and its user interface is more like standard Macintosh applications.

The purpose of this program is to search through a list of input SST files and extract the temperature from each file that corresponds to a particular location. Typically the input file list will consist of a monthly or weekly sequence of files for a particular region; the result is a yearly temperature profile for each requested location.

Compilation

Using the freely available BinHex utility, the archive `look_sea.hqx` can be unpacked to provide project files and source files compatible with THINK C version 5.0. The executable code was compiled with optimizations but with 68020 and 68881 instruction generation turned off.

Preparation of Input Files

Two input files are needed. Both should be plain ASCII, with each line terminated with a carriage return only.

The *list* file should contain the names of SST data files from which temperatures will be extracted. Each line in the file should contain one name. It is most convenient for the list file to reside in the directory containing the SST files.

The *request* file should contain the geographic locations for which SST data are to be retrieved. Each location should be specified by latitude and longitude in degrees. The numbers should be given in plain decimal notation, not scientific notation, and they may include the letters N, S, E, or W to indicate the octant containing the location. If the letters are not specified, the sign of the latitude and longitude will be used to determine the octant. Positive values of latitude are in the Northern Hemisphere, negative values in the Southern Hemisphere. Positive values of longitude are east of the Prime Meridian, negative values are west of the Prime Meridian. Longitude values greater than 180 degrees are permitted; obviously this places them in the opposite hemisphere.

Execution

When the program is invoked, a modal dialog will prompt the user for the names of the input and output files and provide a mechanism for selecting the output file format, enabling nine-pixel averaging, and selecting verbose operation. If the user cancels this dialog, the program will terminate without carrying out any action.

The request of the user is then filled, and the program will ask the user for the locations of data files only if it cannot find those files itself. If the user has selected the *verbose* option, a log of the program's activities is displayed when the requests are processed.

Filling requests for SST data places significant demands on both CPU time and disk I/O. Although the program yields control to the operating system often during execution, the user will notice infrequent screen updates and poor response to mouse and disk events until the requested SST data have been retrieved.

Upon successful completion of the requested retrieval, the program awaits another request, which the user may initiate by selecting *New* from the *File* menu. To terminate the program, select *Quit* from the *File* menu or cancel the request dialog.

Interpretation of Output Files

The output file will have its *Creator* attribute set to `XCEL`, and its *Type* will be `TEXT`. This scheme allows the user to view the contents of the file by double-clicking its icon, assuming that *Microsoft Excel* is present.

The output file will have one line for each location specified in the request file. Each line begins with the location explicitly given, followed by a list of temperature values, one for each file in the input file list. Temperature is given in degrees Celsius. Missing values are given as -99.0. Values can be missing because (1) the location specified does not lie within the region covered by the input file, (2) the location specified is on land, or (3) the location given is covered by clouds or ice. The retrieval program gives no indication which of these is the cause of the missing data.

The default column separator is the tab character. specifying `TEXT` or `Comma` in the request dialog causes the output values to be separated by spaces or commas, respectively. These formats can also be imported into spreadsheet or data base programs with a little more effort.

`mrd_mrle.c`
`urd_mrle.c`

These files are source code for a program that decompresses the SST files. Given an SST file compressed by modified run-length encoding (MRLE), this program decodes the file and produces an image whose format is essentially the same as that of the files NOAA distributes.

Compilation

On a UNIX system, an ANSI-conformant compiler is required (or, at least, one that respects parameter type lists in function definitions and declarations). For the Data General AViiON, this compiler is `gcc` without the `-traditional` switch. On the PC, the Turbo C command-line compiler produces the desired result. On the Macintosh, THINK C 5.0 was used; ANSI conventions should be enabled, and the ANSI library should be linked in. Optimizations may be enabled in all three compilers.

Preparation of Input Files

The input files are given in the data set.

Execution

The input file and output file are specified as command-line arguments as follows:

```
mrd_mrle m_jan.na m_jan.out
```

Here the input file is `m_jan.na`, assumed to be compressed by modified run-length encoding. The output file is `m_jan.out`.

Interpretation of Output Files

The NOAA format has three 512-byte header records followed by 512 data records each of length 512 bytes. The data records contain temperature values stored as numbers from 0 to 255. To calculate the temperature in degrees Celsius, multiply the byte value by 0.2 and subtract 2.1.

The user's guide to the NOAA AVHRR MCSST data set does not indicate the format of the header records. Consequently, these records are filled with zeros in the present data set.

`see.c` (UNIX version)

This program is the graphical browse and retrieval tool for UNIX. It calls the X Windows library `Xlib` to produce graphical output under X Windows version 11 and should work under releases 3 or 4. It has not yet been tested under release 5.

This program displays one region at a time and allows the user to switch from one month to another by using keystrokes. Yearly temperature profiles are obtained by using the mouse to click on a point in the image. The arrow keys can be used to move the current location on a one-pixel-per-keystroke basis.

Compilation

The source is written in standard C and requires an ANSI-conformant compiler or, at least, one that respects parameter type lists in function definitions and declarations. For the Data General AViiON, this compiler is `gcc` without the `-traditional` switch. On a SUN system with OpenWindows, this compiler is `acc`, not `cc`. Optimization may be enabled.

The source should be linked with `Xlib` and the math library. These are typically included using `-lX11 -lm` switches.

Preparation of Input Files

The input files are given in the data set. They consist of monthly files for a region and a file containing a list of monthly files. The program is currently limited to using 12 or fewer files at a time. Note that the input file list for `see` may be the same as the input file list for `m_rtrv` and `u_rtrv`.

Execution

Invoke `see` by giving the input file list as the argument, for example:

```
see monthly.na &
```

The names of files listed in `monthly` will appear in the upper right corner of the main window. The first file listed will be displayed in the large subwindow, and the smaller subwindow will be blank. When the mouse is clicked in the image, the appropriate temperature profile will be displayed in the smaller subwindow. To view another file, use the `Page Down` key or the `Page Up` key to move the highlight bar to the desired file and press `Enter`. The first time an image is called up it will be drawn slowly; it is then saved as an image, after which recall is much quicker. To impose a grid on the image at every 10 degrees of latitude and longitude, press G. To cycle through the files automatically, press `F2`. To exit from the program, press `Alt-X` or `Alt-Q`.

`see` assumes that the keystrokes described above can be generated by your X server. With a different X server, some of the required signals may be produced by different keys. To determine what key will generate `Mod1`, run `xmodmap`.

Listed below are the actions that are initiated by keystrokes and the X KeySyms that produce those actions. An X KeySym is a name for a key that is known to the compiler through the header file `keysymdefs.h`. For example, the X KeySym for the "a" key is `XK_a`, and the X KeySym for the left arrow key is `XK_Left`.

Action	X KeySym combination
Exit	`Mod1Mask` and `XK_q` or `Mod1Mask` and `XK_x`
Toggle Grid	`XK_G` or `XK_g`
Move Up	`XK_KP_8` or `XK_Up`
Move Down	`XK_KP_2` or `XK_Down`
Move Left	`XK_KP_4` or `XK_Left`
Move Right	`XK_KP_6` or `XK_Right`
First File	`XK_KP_7` or `XK_Home`
Last File	`XK_KP_1` or `XK_End`
Previous File	`XK_KP_9` or `XK_Prior`
Next File	`XK_KP_3` or `XK_Next`
View File	`XK_Return` or `XK_KP_Enter`
Cycle Files	`XK_F2`
no action	any other keys

Interpretation of Output Files

`see` produces no output file.

`see.exe` (Extended DOS version)

This program is a graphical utility for MS-DOS users. It operates essentially like the unix program `see.c`. It requires an 80386 or 80486 processor with at least 4 megabytes of RAM and a super VGA card capable of displaying 256 colors with 640 × 400 pixels or more. It does not require a numeric coprocessor.

Compilation

`see.exe` was developed with version 9.01 of Watcom C/386 and relies on the DOS-extender DOS4GW version 1.8 from Rational Systems, Inc. The source files include some assembly language; version 2.0 of Borland International's Turbo Assembler was used to assemble them. A make file is included in the directory `Derived/dos/dos_see`.

Preparation of Input Files

The input files are given in the data set. They consist of monthly files for a region and a file containing a list of monthly files. The program is currently limited to using 12 or fewer files at a time. Note that the input file list for `see.exe` may be the same as the input file list for `m_rtrv` and `u_rtrv`.

Execution

Invoke `see` by giving the input file list as the argument, for example:

```
see monthly.na
```

The names of files listed in `monthly.na` will appear in the upper right corner of the main window. The first file listed will be displayed in the large subwindow, and the smaller subwindow will be blank. When the mouse is clicked in the image, the appropriate temperature profile will be displayed in the smaller subwindow. To view another file, use the `Page Down` key or the `Page Up` key to move the highlight bar to the desired file. To impose a grid on the image at every 10 degrees of latitude and longitude, press G. To exit from the program, press `Alt-X`. A brief help message is shown if you press `F1`.

Interpretation of Output Files

`see.exe` produces no output file.

See SST (Macintosh version)

This program is a graphical utility for Macintosh users. It operates essentially like the UNIX program `see.c`.

Compilation

`See SST` was developed with version 5.0.4 of *THINK C* by Symantec, Inc. A project file is included in the directory `/Derived/mac/MacSee`.

Preparation of Input Files

This program reads special SST files prepared specifically for it. The data fork of each file contains a MRLE-format SST image 256 × 256 pixels in size, with no header records. The resource fork contains the corresponding PICT image. To determine which input files to read, `See SST` reads a text file containing the names of the SST files.

Execution

To run `See SST`, double-click the application or one of its specially formatted data files. You are prompted to locate a text file containing the names of SST files to read. Navigate through the standard file dialogs and open the appropriate text file. At this point, operation of `See SST` is the same as its UNIX cousin `see.c`.

To exit `See SST`, close its window or select *Quit* from the *File* menu.

Interpretation of Output Files

`See SST` produces no output file.

Appendix D: *List of Trademarks*

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