AVHRR Sea Surface Temperature Grids Description

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Overview

This DVD folder contains gridded sea surface temperatures (SST) over the global oceans. The data were derived from the 5-channel Advanced Very High Resolution Radiometer (AVHRR) instrument on board the NOAA -7, -9, -11 and -14 polar orbiting satellites, using the 'NOAA/NASA Pathfinder SST' algorithm, version 4.1 for Jan-Dec 1990, Jan 1993 - Dec 1999, version 4.0 for Jan 1991 - Dec 1992, and interim version 4.1 for Jan 2000 - Dec 2001.

Two types of grids are included, whose difference is clarified later:

- 0.5-degree, 5-day binned (version WOCE-PODAAC-05d-v3.0)
- 1.0-degree, 5-day interpolated (version WOCE-PODAAC-10d-v3.0)

Data cover the period from January 1990 through December 2001.

Input Data

The input to these 5-day, 0.5-degree grids are the NOAA/NASA AVHRR Oceans Pathfinder Sea Surface Temperature Data, 'Best' data, at 0.5 degree resolution, nighttime only. 'Best' means that only those pixels which passed certain quality tests were used. The input dataset is described in the accompanying NOAA/NASA AVHRR Oceans Pathfinder Sea Surface Temperature Data Set User's Reference Manual, Version 4.0; Please note that version 4.1 of the Pathfinder SST algorithm was used for 1990,1993-1999, version 4.0 for 1991-1992, and interim version 4.1 for 2000-2001. See the Summary of AVHRR Pathfinder Versions for more details.

Briefly, the Pathfinder algorithm differs from the MCSST algorithm used since 1981 to process AVHRR in that it includes a number of additional instrument corrections, recovers about twice as many SST values in the presence of clouds as the original MCSST, and uses a 5 month moving window to estimate the coefficients for the central month (the coefficients are used to linearly combine the radiances at the 5 AVHRR frequencies into an SST estimate). It also differs from the widely-used Reynolds SST grids which use as input the MCSST calculation and then combine them with in-situ data using a mapping algorithm to estimate weekly, 1 degree grids (see Reynolds SST; the Reynolds data can be obtained by ftp).

Binned Grids

The **0.5-degree, 5-day binned (version WOCE-PODAAC-05d-v3.0)** grids were obtained by averaging these 0.5 x 0.5 degree grid nighttime Pathfinder data grids over 5 days. Since nighttime only temperatures are used, the maximum number of input values per pixel is 5. The five day periods begin on January 1, 1990. The specific dates, summary statistics on each grid, and browse images of each, can be found in the Table of AVHRR Grids with Summary Statistics. A Java program to animate a time series of images between any two dates is also available.

Interpolated Grids

The **1.0-degree, 5-day interpolated (version WOCE-PODAAC-10d-v3.0)** grids are obtained by a gaussian weighted average centered at the grid node. Specifically, the temperature T at latitude ϕ, longitude λ, time t is a linear combination of observed temperatures at points i as follows:

$$T(\phi,\lambda,t) = \Sigma_i \left[T(\phi_i, \lambda_i,t_i) * \exp(-0.6931 * ((\phi - \phi_i)^2/ w\phi^2 + (\lambda - \lambda_i)^2/ w\lambda^2 + (t - t_i)^2/w_t^2)) \right]$$

where $w\phi = 1$ deg, $w\lambda = 1$ deg, $w_t = 2$ days

The Σ is performed over all points i inside the volume

$|\phi - \phi_i| <= 2.5$ deg, $|\lambda - \lambda_i| <= 2.5$ deg, $|t - t_i| <= 5$ days

The first pentad is "centered" on January 3, 1990. The specific dates, summary statistics on each grid, and browse images of each, can be found in the Table of AVHRR Grids with Summary Statistics. A Java program to animate a time series of images between any two dates is also available.

For historical reasons, the output of the interpolation program is scaled to one byte integers. Therefore, the smallest temperature difference that can be seen from these grids is 0.15 .

Summary Properties

The accompanying figure shows averages over each 0.5-degree map of certain quantities, plotted as a function of time; latitudinal weights proportional to cos(lat) were applied, so these are true global areal averages: the upper panel has the standard deviation of temperature, the middle panel the mean, and the lower panel is simply the count of input data points to each grid.
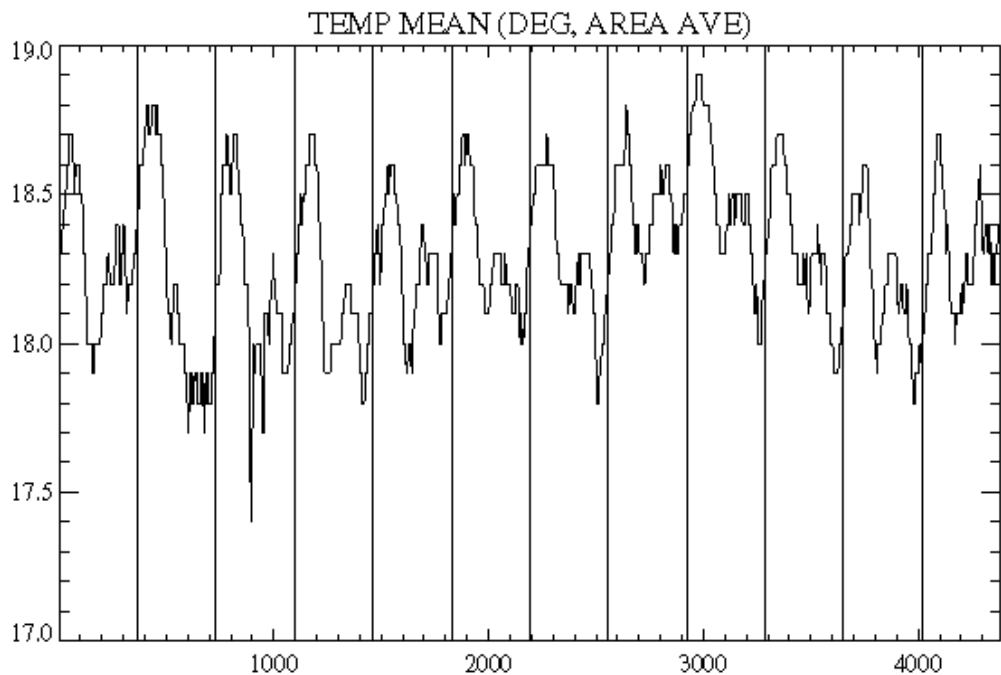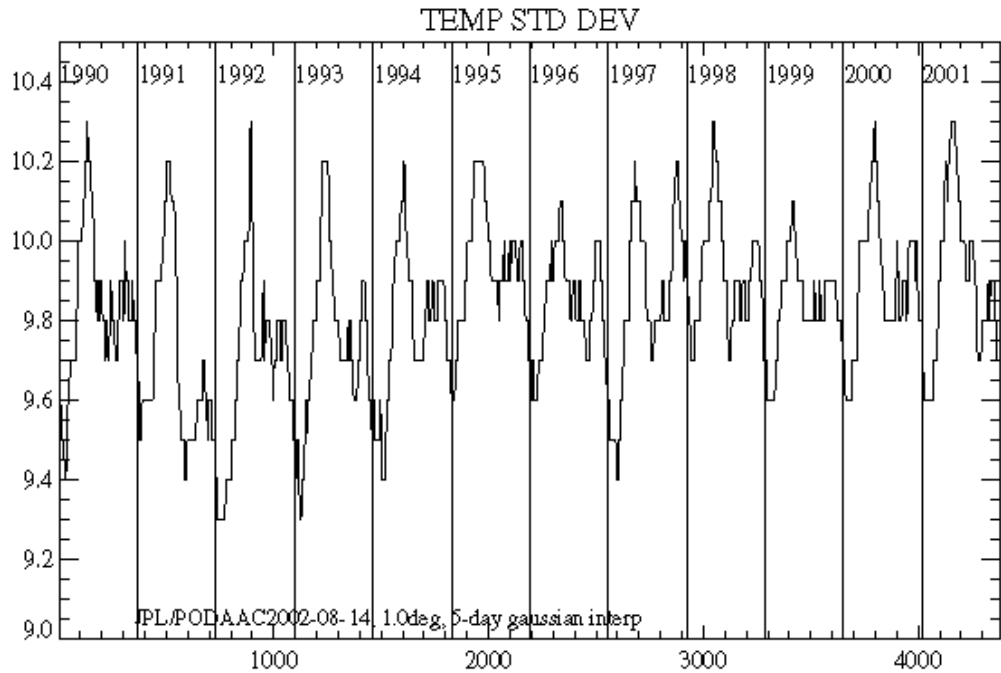
These plots illustrate the change in data processing for 1990,1993-1999 versus 1991-1992 versus 2000-2001: the 1991-92 data, dubbed version 4.0, were found to have inadequate flagging code; the problem was corrected during January 1998, and reprocessing started with data year 1994. Unfortunately, at the time this DVD folder was generated, the 1991-1992 had not yet been reprocessed with the new flags.

A postscript version of this figure is also available.
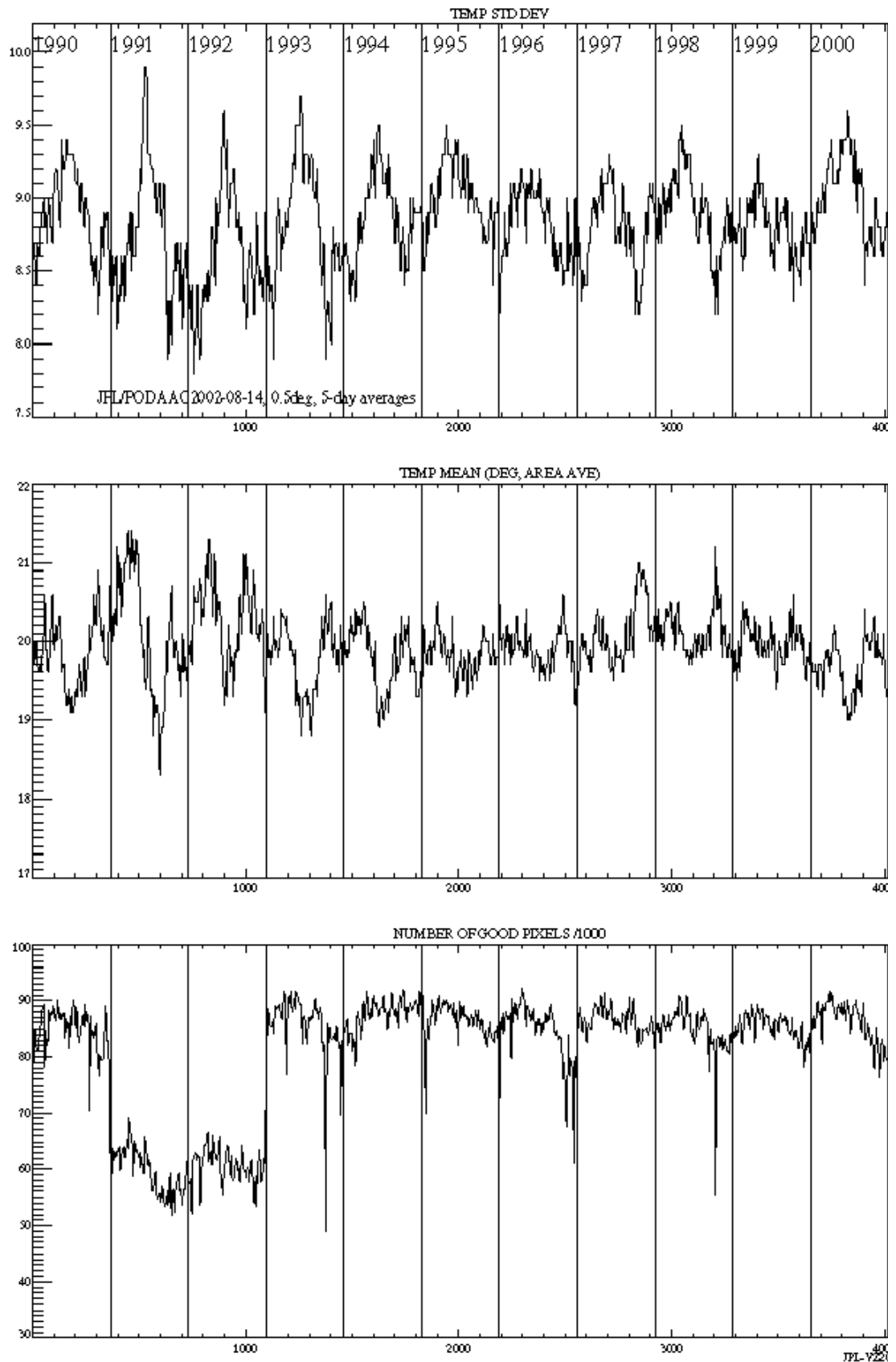
The figures corresponding to the 1.0-degree interpolated grids are significantly different from the binned-grid statistics. The standard deviations are higher because the data gaps are due to clouds which obscure the same regions of the ocean much of the time, systematically in certain higher and lower energy regions of the ocean. The mean temperature values are lower because a greater number of interpolated lower temperatures (higher latitudes) are included.
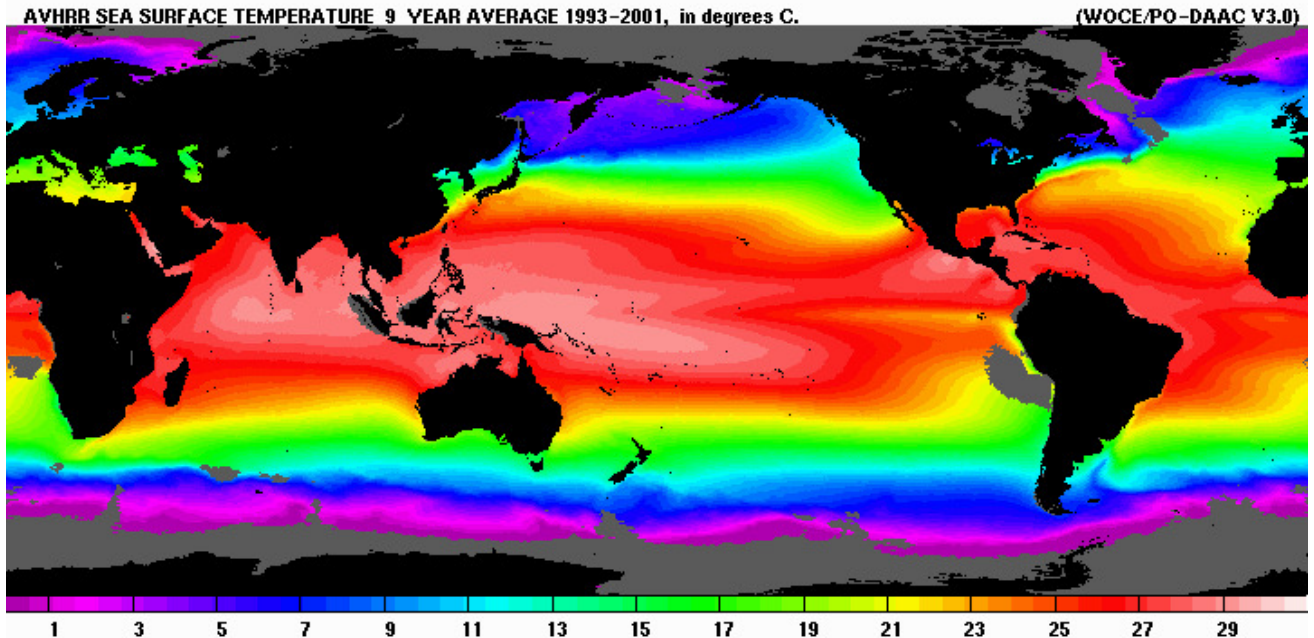
A postscript version of this figure is also available.

TEMP STD DEV

JPL/PODAAC 2002-08-14, 1.0deg, 5-day gaussian interp

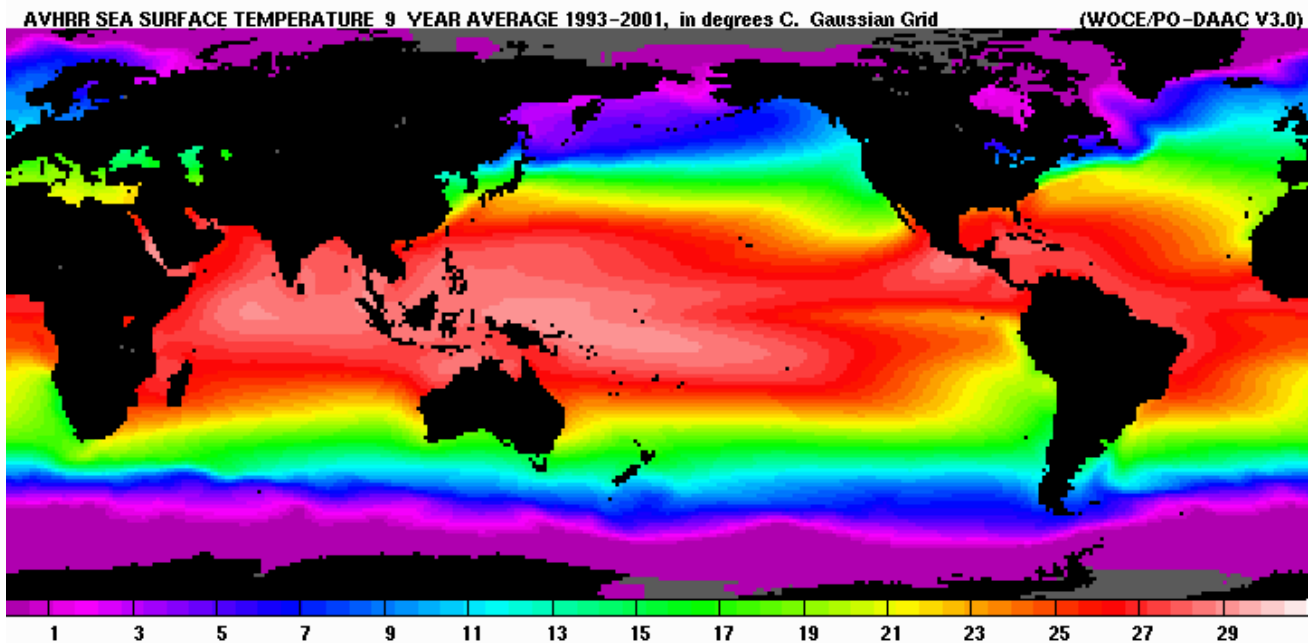TEMP MEAN (DEG, AREA AVE)

JPL-VZ 2002 Aug 4

9-YEAR MEAN MAPS

Included below is the 9-year (1993-2001) mean sea surface temperature. It is included here for compatibility with the sea level data also in this collection. However, the sea level data are anomalies from their 9 year mean, while these SSTs are full values. To compute the corresponding anomaly, the user should substract the 9-year average 0.5 deg map or the 9-year average 1.0 deg map from the corresponding full 5 day SST.

0.5 Degree 9-Year Mean

AVHRR SEA SURFACE TEMPERATURE 9 YEAR AVERAGE 1993-2001, in degrees C. (WOCE/PO-DAAC V3.0)

1.0 Degree Gaussian Interpolated 9-Year Mean

AVHRR SEA SURFACE TEMPERATURE 9 YEAR AVERAGE 1993-2001, in degrees C. Gaussian Grid (WOCE/PO-DAAC V3.0)

Data Format

The data are stored in NetCDF (network Common Data Form). The NetCDF software was developed at the Unidata Program Center in Boulder, Colorado. Freely available software and user support can be obtained from the Unidata netCDF Home Page. A NetCDF primer written by Nathan Bindoff provides an introduction on how to read and understand netCDF files.

All data files contain the following variables:

- **woce_date**
  The woce_date represents the *center day* of the averaging period, in the format YYYYMMDD.

- **woce_time**
  The woce_time is the nominal *center time* of the of the averaging period. The units are in Universal Time Coordinate, using the time convention HHMMSS.DD.

- **time**

The time represents the Julian day equivalent of the woce_date, set to 0 for 1990-01-01.

- **latitude**
  The units are in positive degrees for north latitude, negative degrees for south latitude. The format consists of a 4-byte signed real array of dimension 360. The grid nodes are centered on -89.75, -89.25, etc.

- **longitude**
  The units are in positive degrees. The format consists of a 4-byte signed real array of dimension 720. The grid nodes are centered on 0.25, 0.75, etc.

- **depth**
  The units are in meters. This value is set to zero.

- **sea_surface_temperature**
  Sea surface temperatures are in degrees C after the scale_factor and add_offset attribute values are applied. The format consists of a 2-byte SIGNED INTEGER array of dimension 720 x 360 (0.5 degree grids) and 360 x 180 (1.0 degree grids). The value 32767 indicates *missing* data; the value 32766 indicates *land*.

- **bin_count**
  (This variable only exists for the 0.5 degree grids)
  The bin_count contains the number of data points per bin. The format consists of a 1-byte array of dimension 720 x 360. The value 0 indicates *land* or *missing* data.

See the SST 0.5° Variables and Attributes and SST 1.0° Variables and Attributes for more detail.

The filenames for the NetCDF files are of the form sst05d19900103.nc or sst10d19900103.nc, depending on whether they are 0.5-deg binned, or 1.0-deg interpolated; this is a WOCE Data Products Committee agreement. However, the filenames for the corresponding GIF files are sst05d0002.gif or sst10d0002.gif, where the date is given in cumulative days, with day 0000=1990-01-01, because the data animation software expects monotonically increasing numbers in the filename. The correspondence between both conventions is in the Table of SST statistics (0.5-deg) or the Table of SST statistics (1.0-deg)

Uncompressing Data Files

In order to conserve space, the data files have been compressed. These files end with the suffix ".gz" which stands for "GNU zip" (gzip). gzip was written by Jean-loup Gailly (jloup@gzip.org), and Mark Adler for the decompression code.

gunzip will decompress files created by gzip. On Windows 95, 98, 2000 or NT use *Winzip* or *pkzip* to decompress `.gz` files. On Mac systems *Stuffit* will decompress `.gz` files. For more information on gzip, please refer to the gzip home page at http://www.gzip.org

More Information

The NOAA/NASA AVHRR Oceans Pathfinder SST User's Reference Manual has much more information about the Pathfinder SST data, various algorithms, etc. It is also worth checking the latest version of the same manual, at the PO.DAAC Web site for any updates or errors discovered in either the Manual or the data after this DVD folder was generated. To avoid confusion, however, it is important to keep in mind that the data and formats described therein are the input to the processing described above.

[DVD FOLDER HOME] [NOAA/NASA AVHRR Oceans Pathfinder SST User's Reference Manual]