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Moderate-Resolution Sea Surface Temperature Data for the Nearshore North Pacific

By Meredith C. Payne, Deborah A. Reusser, Henry Lee II, and Cheryl A. Brown

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Conversion Factors

SI to Inch/Pound

Multiply	By	To obtain
	Length	
meter (m)	3.281	foot (ft)
meter (m)	1.094	yard (yd)
kilometer (km)	0.6214	mile (mi)
	Area	
square kilometer (km^2)	0.3861	square mile (mi^2)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:
°F=(1.8×°C)+32
Horizontal and vertical coordinate information is referenced to the World Geodetic System of 1984 (WGS 84).

Acronyms and Abbreviations

ArcGIS ESRI's GIS software
AVHRR Advanced Very High Resolution Radiometer
ESRI Environmental Systems Research Institute, Inc.
GIS Geographical Information System
GSHHS Global Self-consistent, Hierarchical, High-resolution Shoreline
HDF Hierarchical Data Format
IPCC Intergovernmental Panel on Climage Change**IR** Infrared
JPL Jet Propulsion Laboratory
MEOW Marine Ecoregions of the World
MGET Marine Geospatial Ecology Tools
NASA National Aeronautics and Space Administration
NIS Nonindigenous species
NOAA National Oceanographic and Atmospheric Administration
NODC National Oceanographic Data Center
PFSST V5x Pathfinder Sea Surface Temperature version 5.x
PO.DAAC Physical Oceanography Distributed Active Archive Center
SDS Scientific Data Set
SST Sea surface temperature
WGS 84 World Geodetic System, 1984

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Abstract

Coastal sea surface temperature (SST) is an important environmental characteristic in determining the suitability of habitat for nearshore marine and estuarine organisms. This publication describes and provides access to an easy-to-use coastal SST dataset for ecologists, biogeographers, oceanographers, and other scientists conducting research on nearshore marine habitats or processes. The data cover the Temperate Northern Pacific Ocean as defined by the "Marine Ecosystems of the World" (MEOW) biogeographic schema developed by The Nature Conservancy. The spatial resolution of the SST data is 4-km grid cells within 20 km of the shore. The data span a 29-year period – from September 1981 to December 2009. These SST data were derived from Advanced Very High Resolution Radiometer (AVHRR) instrument measurements compiled into monthly means as part of the Pathfinder versions 5.0 and 5.1 (PFSST V50 and V51) Project. The processing methods used to transform the data from their native Hierarchical Data Format Scientific Data Set (HDF SDS) to georeferenced, spatial datasets capable of being read into geographic information systems (GIS) software are explained. In addition, links are provided to examples of scripts involved in the data processing steps. The scripts were written in the Python programming language, which is supported by ESRI's ArcGIS version 9 or later. The processed data files are also provided in text (.csv) and Access 2003 Database (.mdb) formats. All data except the raster files include attributes identifying realm, province, and ecoregion as defined by the MEOW classification schema.

Introduction

Recent research indicates there has been a warming trend in Pacific Ocean temperatures over the last 50 years (IPCC, 2007). Nearshore regions along the North Pacific coast are particularly sensitive to this trend. In these nearshore regions, *in situ* SST measurements are typically made via buoys, but such measurements are irregular in both space and time. Satellite-based remote-sensing observations have the advantage of extensive spatial coverage and high repeatability that is not possible with field observations. The trade-off, however, is that satellite data generally have low spatial resolution compared with field measurements and therefore often cannot resolve smaller features important in coastal areas. Furthermore, high-resolution image products of large area often consist of an unmanageable amount of data, making them impractical for general use. However, a spatio-temporally

continuous near-coastal SST dataset can be used to address questions about nearshore environments in ways that are not possible with offshore SST measurements. Therefore, for climate change research in coastal and estuarine environments, a moderate resolution SST product that covers the near-coastal area while keeping file size reasonable is needed.

To fill this nearshore SST data gap, a three-decade, moderate-resolution (4 km) SST dataset was generated for the nearshore areas of the North Pacific, from Baja, California to the East China Sea. This dataset is based on SST measurements from the Advanced Very High Resolution Radiometer (AVHRR) Pathfinder v. 5 data. The AVHRR data provide a consistent set of SST measurements, of a known quality, for nearshore environments in the North Pacific. The methods used to generate the data are described here. Our intent is to provide these data as a readily-available product for researchers who are addressing questions about the effects of variations in temperature on the distribution of nearshore organisms.

Data Description

AVHRR SST Data

The Advanced Very High Resolution Radiometer (AVHRR) is a multi-generational, 6-channel instrument that has been flown on board a series of NOAA polar-orbiting satellites, and has been returning reliable SST data since 1981. Sea surface temperature is not measured directly; rather, it is the result of a differentiation of brightness temperatures recorded by two of the sensor's infrared (IR) channels (channels 4 and 5). It has been shown that atmospheric aerosols and particulates (for example, volcanic ash or Saharan dust) are sources for error in IR brightness temperature measurements, and potentially introduce a cold bias (Vazquez-Cuervo and others, 2004). However, one advantage of using satellite IR retrievals to derive SST is that the long IR wavelengths are less affected by atmospheric contaminants (such as cloud or fog). Another benefit of IR wavelength measurements is that daylight is not a requirement for data collection. And while nighttime AVHRR data have been preferred for some SST analyses, it has been shown that nighttime-only AVHRR Pathfinder data do not necessarily produce superior results with respect to reproducing *in situ* temperature measurements (Casey, 2002). Therefore, we chose to use the daytime series of the AVHRR Pathfinder 4 km dataset based on data availability. We found daytime data to be more abundant in our near-coastal regions of interest, especially in areas that experience frequent evening ground fog, such as the coasts of the states of Washington and Oregon.

The AVHRR Pathfinder v.5 (and later) datasets were developed jointly by the University of Miami Rosenstiel School of Marine and Atmospheric Science and the NOAA National Oceanographic Data Center (NODC) as a more accurate, downscaled (9.28 to 4 km) version of a previous global AVHRR dataset (Vazquez-Cuervo and others, 1998). We obtained the version 5 (PFSST V50) raster data from the NASA JPL Physical Oceanography Distributed Active Archive Center (PO.DAAC) (ftp://podaac.jpl.nasa.gov/pub/sea_surface_temperature/avhrr/pathfinder/data_v5/). AVHRR products (PFSST V50 and PFSST V51) are also available through the NODC (ftp://data.nodc.noaa.gov/pub/data.nodc/pathfinder). The source data were provided in HDF-SDS (Hierarchical Data Format Scientific Data Set) format. For a detailed description of the AVHRR and Pathfinder algorithms, we direct the reader to Vazquez-Cuervo and others (1998; 2010) and Kilpatrick and others (2001).

AVHRR Data Quality

The PFSST data include a quality flag product in which each SST pixel is designated a value ranging from 0 (worst quality) to 7 (best quality). These quality flags convey the level of confidence attributed to the SST value calculated for each pixel location. The level of confidence is evaluated on pixel-by-pixel performance with respect to a number of tests that estimate validity and consistency of brightness temperature readings, sun angle effects, and cloudiness, which are combined to establish an overall quality rating. The version 4 Pathfinder release of the SST dataset (PFSST V41) included a standard product called "best SST," or "BSST." BSST data includes pixels with quality flags greater than 3 (Kilpatrick and others, 2001). We generated an analogous SST product from the PFSST data by disregarding SST values with corresponding quality flag values of less than 4. Despite the rigors of the flagging algorithms, a small number of pixels with illegitimate jumps in SST gradient have been detected (Evans and others, 2009). These jumps in the SST gradient must be detected and removed by the user depending on their data requirements.

Data Accuracy

Currently the only reports on accuracy of Pathfinder SST values are linked to specific studies across a variety of spatial and temporal resolutions, pathfinder versions, and quality flag thresholds. In general, the temperature values are reported to have RMS errors between 0.1 and 1.0 °C (Vazquez-Cuervo and others, 2010; Xu and Ignatov, 2010, Kearns and others, 2000; Kirkpatrick and others, 2001) when compared to *in situ* temperatures. However, it must be cautioned that *in situ* temperature data derived from multiple sources, such as moored buoys and shipboard observations, are prone to large random errors and rarely have excellent agreement amongst them (e.g. Kearns and others, 2000). Furthermore, *in situ* measurements are of bulk temperatures (typically taken between 1 – 3 meters depth) rather than true sea surface temperature. Lastly, comparison to *in situ* data sources such as buoys and the National Centers for Environmental Prediction (NCEP; Reynolds and others, 2002) are somewhat contrived as these data (Reynolds and others, 2002) provide critical calibration and validation for the PFSST data product (Kilpatrick and others, 2001; Vazquez-Cuervo and others, 2010). In practice, when the scaling algorithm provided with the AVHRR data is applied, the resulting SST values imply a 1/1000 of a degree precision, a level of precision that is beyond the limitations of the original processing algorithm. Based on these considerations, the accuracy of the nearshore SST data is approximately 0.5 °C (personal communication, Jorge Vazquez-Cuervo, February 3, 2011).

Coastal SST Product

We selected AVHRR data for their global coverage at moderate resolution (4 km), their long data record (~30 years) relative to other satellite missions , and their substantial level of processing, including extensive calibration and atmospheric correction. The data represent a time-series of monthly mean sea surface temperatures over the last 29 years. The data presented here encompass the nearshore region of the entire North Pacific, from the coast to approximately 16 km from the shoreline, as defined by the Global Self-consistent, Hierarchical, High-resolution Shoreline (GSHHS) version 1.3 (Wessel and Smith, 1996). In some places, the data appear jagged, or "moth-eaten," immediately adjacent to the coast. There are two reasons for this. The first is that satellite data for some regions of the coast are missing or are unusable due to low quality. The second reason for the jagged appearance of the data is that the Pathfinder developers used a MOD12Q1 land mask, which has a 1-km resolution rather than the 0.2-km resolution of the GSHHS. As detailed below, we processed the data using a number of tools to

create several nearshore SST products, including georeferenced North Pacific SST shape and raster files, along with their metadata, and Access 2003 Databases.

Data Processing

The steps taken to convert AVHRR data to nearshore SST data are detailed in flow-chart form in Figure 1. As the focus was on nearshore environments, the study area in each ecoregion is limited to within approximately 16 km of the coastline (fig. 2). The grid cell resolution of the AVHRR PFSST data was 4 km² and the offshore distance was determined by counting four grid cells seaward of the coastline defined by the Global Self-consistent, Hierarchical, High-resolution Shoreline (GSHHS) dataset (Wessel and Smith, 1996).

The Marine Geospatial Ecology Tools v. 0.8 (MGET) were used to convert the Pathfinder PFSST V5 and V5.1 data from its native HDF-SDS format to ArcGIS GRID raster format (Roberts and others, 2010). MGET was developed by Duke University's Marine Geospatial Ecology Laboratory for exploring spatial aspects of ecological data and is integrated into the ESRI ArcGIS environment for use in conjunction with other geoprocessing tools, including Python, Matlab, R, and C++. The MGET extension is available at *http://code.env.duke.edu/projects/mget*. HDF to GRID conversion is a two step process. The georeferencing (header information) parameters for data conversion must be extracted first using MGET or another HDF tool. The extracted parameters are then used in the MGET conversion tool to create ArcGIS rasters (GRIDs).

A parallel processing path is followed whereby a HDF SST file, which contains the mean SSTs recorded by the AVHRR instrument over a one-month period, and its corresponding HDF Quality (hereafter qual) file are transformed (by MGET) into ArcGIS GRIDs. The SST GRIDs were then scaled using the equation provided in the AVHRR header in order to obtain SST values in degrees Celsius. Application of this scaling equation on floating point data created variable precision of the SST values (RASTERVALU) from 0 to 8 digits. The SST values were not rounded or truncated during the data processing. The qual value GRIDs were transformed into binary masks in which pixels of flag values ≥ 4 were converted into 1s and those with values 0-3 were converted to 0s (as discussed in the data description). The monthly SST data were produced by applying the qual mask to the SST GRID raster to eliminate SST values with corresponding quality flag values of less than 4. The next step was to eliminate implausible SST values (< -2.0 °C) that occasionally appear at the higher latitudes.

The ArcToolbox buffering tool (available with the ArcInfo version of the ESRI software) was used to create a buffer to isolate SST raster pixels within 16 km of the GSHHS shoreline. This buffer is essentially a polygon shapefile that functions as a clipping feature. It was used to crop the global SST rasters to the North Pacific nearshore extent. These nearshore raster data are available for download from the "downloads" page of this website (click "downloads" on the left-side menu).

For each nearshore raster data file, a point shapefile was created in which each point represents the centroid of a corresponding grid cell and was assigned the associated SST value. The Spatial Analyst ArcGIS extension "Extract Values to Points" tool was used to collect these point values. These steps were systematically repeated to generate a point shapefile of near-coastal SST values—one for each month of each year in the 1981-2009 record. To ensure consistent results, the processes of reading in the native SST HDF files through the point extraction step was automated through a combination of using the ModelBuilder tool within ArcGIS and manual scripting in the Python 2.5 language. Each individual monthly mean file contains approximately 40,000 points. In the datasets offered here, we include the points having NoData values, designated as "-9999." As previously described, the lack of data at these points can be due to glint, sea-ice cover, atmospheric obscuration, or the coarseness of the

MODIS land mask used in comparison to the GSHHS shoreline. All SST values are recorded in degrees Celsius and are found under the "RASTERVALU" heading. In addition to the nearshore raster dataset, and nearshore point shapefile dataset (also available in .csv format), a dataset is provided consisting of four Access databases created by exporting the ArcGIS .dbf files directly into Access databases (.mdb format) using the RODBC package in R. The Access 2003 databases are divided by Marine Province (Warm Temperate Northwest Pacific, Cold Temperate Northwest Pacific, Warm Temperate Northeast Pacific, Cold Temperate Northeast Pacific, see Figure 3). This division was necessary due to the 2 GB size constraint on each Access 2003 database. The Access databases are also publically available through the download links provided on the left-hand side bar.

Downloads

GIS Data Catalog

This report contains Geographic Information System (GIS) data in georeferenced vector (point) and raster format. The vector (point) data are available in Environmental Systems Research Institute (ESRI) shapefile format and in comma-separated text (*.csv) files. Shapefiles generally include *.shp, *.shx, *.xml, and *.dbf files at a minimum. All of these data files also include the *.prj files, which contain the dataset projection information. The corresponding 4-km resolution raster data are available in ESRI GRID format.

The GIS files have been bundled by year. Each data type (shp, GRID, csv) has a compressed WinRAR zip file—one for each year, hence every zip file may contain up to 12 months of data. In addition to the spatial data, we provide Federal Geographic Data Committee (FGDC) -compliant metadata in text and HTML formats. The metadata text files are bundled with their corresponding zip files, and the metadata HTML information can be viewed in your web browser by clicking the appropriate link in the table below.

To download the data, right-click on the appropriate filename link in the '**Filename**' column (that corresponds to the desired data type) in the table below. Then select '**Save Target As...**' to save a compressed WinRAR file to your local hard drive. The download zipped file size is indicated under the '**file size**' column. All downloaded files are of type ".zip". The File Type description in the Table below indicates the type of files found within the downloadable zip files.

Filename	Description	File Type	File Size	Metadata
	2009			
NPacSST2009rast.zip	North Pacific Nearshore monthly mean SST data for 2009 in ESRI GRID raster format.	ESRI GRID	1.7 MB	Available online
NPacSST2009pt.zip	North Pacific Nearshore monthly mean SST data for 2009 in ESRI (point) shapefile format.	ESRI shapefile (*.shp)	10 MB	Available online
NPacSST2009csv.zip	North Pacific Nearshore monthly mean SST data for 2009 .csv format.	Comma-separated text file (*.csv)	3.8 MB	Available online
	2008			
NPacSST2008rast.zip	North Pacific Nearshore monthly mean SST data for 2008 in ESRI GRID raster format.	ESRI GRID	1.7 MB	Available online
NPacSST2008pt.zip	North Pacific Nearshore monthly mean SST data for 2008 in ESRI (point) shapefile	ESRI shapefile (*.shp)	10 MB	Available online

	format.			
NPacSST2008csv.zip	North Pacific Nearshore monthly mean SST data for 2008 .csv format.	Comma-separated text file (*.csv)	3.8 MB	Available online
	2007			
NPacSST2007rast.zip	North Pacific Nearshore monthly mean SST data for 2007 in ESRI GRID raster format.	ESRI GRID	1.8 MB	Available online
NPacSST2007pt.zip	North Pacific Nearshore monthly mean SST data for 2007 in ESRI (point) shapefile format.	ESRI shapefile (*.shp)	10 MB	Available online
NPacSST2007csv.zip	North Pacific Nearshore monthly mean SST data for 2007 .csv format.	Comma-separated text file (*.csv)	3.8 MB	Available online
	2006			
NPacSST2006rast.zip	North Pacific Nearshore monthly mean SST data for 2006 in ESRI GRID raster format.	ESRI GRID	1.7 MB	Available online
NPacSST2006pt.zip	North Pacific Nearshore monthly mean SST data for 2006 in ESRI (point) shapefile format.	ESRI shapefile (*.shp)	10 MB	Available online
NPacSST2006csv.zip	North Pacific Nearshore monthly mean SST data for 2006 .csv format.	Comma-separated text file (*.csv)	3.8 MB	Available online
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NPacSST2005pt.zip	North Pacific Nearshore monthly mean SST data for 2005 in ESRI (point) shapefile format.	ESRI shapefile (*.shp)	10 MB	Available online
NPacSST2005csv.zip	North Pacific Nearshore monthly mean SST data for 2005 .csv format.	Comma-separated text file (*.csv)	3.8 MB	Available online
	2004			
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NPacSST2004pt.zip	North Pacific Nearshore monthly mean SST data for 2004 in ESRI (point) shapefile format.	ESRI shapefile (*.shp)	10 MB	Available online
NPacSST2004csv.zip	North Pacific Nearshore monthly mean SST data for 2004 .csv format.	Comma-separated text file (*.csv)	3.8 MB	Available online
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NPacSST1984csv.zip	North Pacific Nearshore monthly mean SST data for 1984 .csv format.	Comma-separated text file (*.csv)	3.8 MB	Available online
		1983		
NPacSST1983rast.zip	North Pacific Nearshore monthly mean SST data for 1983 in ESRI GRID raster format.	ESRI GRID	1.7 MB	Available online
NPacSST1983pt.zip	North Pacific Nearshore monthly mean SST data for 1983 in ESRI (point) shapefile format.	ESRI shapefile (*.shp)	10 MB	Available online
NPacSST1983csv.zip	North Pacific Nearshore monthly mean SST data for 1983 .csv format.	Comma-separated text file (*.csv)	3.8 MB	Available online
		1982		
NPacSST1982rast.zip	North Pacific Nearshore monthly mean SST data for 1982 in ESRI GRID raster format.	ESRI GRID	1.7 MB	Available online

NPacSST1982pt.zip	North Pacific Nearshore monthly mean SST data for 1982 in ESRI (point) shapefile format.	ESRI shapefile (*.shp)	10 MB	Available online
NPacSST1982csv.zip	North Pacific Nearshore monthly mean SST data for 1982 .csv format.	Comma-separated text file (*.csv)	3.8 MB	Available online
	1981*			
NPacSST1981rast.zip	North Pacific Nearshore monthly mean SST data for 1981 in ESRI GRID raster format.	ESRI GRID	641 KB	Available online
NPacSST1981pt.zip	North Pacific Nearshore monthly mean SST data for 1981 in ESRI (point) shapefile format.	ESRI shapefile (*.shp)	3.4 MB	Available online
NPacSST1981csv.zip	North Pacific Nearshore monthly mean SST data for 1981 .csv format.	Comma-separated text file (*.csv)	1.3 MB	Available online

*These files contain only the four months of data that are available for 1981. 09/1981 – 12/1981.

Access Databases

The nearshore North Pacific SST data are available for download as MS Access databases (in 2003 .mdb format). Unlike the GIS data, these data are not ordered by year. Rather, they are arranged by geographical province (fig. 3). Each province database includes all of the individual monthly tables over all available years (September 1981 — December 2009) for points located within the specified province. To download the databases, click on the appropriate province name in the table below.

Province	Description	File Type	File Size	Metadata
Cold Temperate Northeast Pacific	Access 2003 database containing Nearshore SSTs of the Cold Temperate Northeast Pacific Ocean Province over the period 9/1981 - 12/2009.	.mdb	590 MB	Available online
Cold Temperate Northwest Pacific	Access 2003 database containing Nearshore SSTs of the Cold Temperate Northwest Pacific Ocean Province over the period 9/1981 - 12/2009.	.mdb	1.8 GB	Available online
Warm Temperate Northeast Pacific	Access 2003 database containing Nearshore SSTs of the Warm Temperate Northeast Pacific Ocean Province over the period 9/1981 - 12/2009.	.mdb	1.1 GB	Available online
Warm Temperate Northwest Pacific	Access 2003 database containing Nearshore SSTs of the Warm Temperate Northwest Pacific Ocean Province over the period 9/1981 - 12/2009.	.mdb	454 MB	Available online

Scripts

Here a number of scripts are provided that were developed to process the SST data. The scripts are written in the Python Language. Python is a freely-available, open-source scripting language that is object oriented and is supported by ArcGIS as a framework for creating and executing Geoprocessor tasks. Python also runs as a stand-alone programming language. The scripts were built using Python release 2.5.1, which is included with ESRI's ArcGIS 9.3.1. ArcGIS 9.3.x also supports Python version 2.5.4, but does not support later Python versions. Python is downloadable from *http://www.python.org/download/releases/2.5.4/*.

The PythonWin development environment provides a Graphic User Interface (GUI) for the python scripting editor. PythonWin is located in the "Python for Windows extensions" bundle available at *http://sourceforge.net/projects/pywin32/*. To use the scripts provided, the user will need access to ArcGIS 9.x software and install the Marine Geospatial Ecology Tools (MGET). MGET is available at

http://code.env.duke.edu/projects/mget. The first step involved in preparing HDF SDS files for conversion to ArcGIS GRID files (preceding use of the processing scripts) is a manual renaming of the files to conform to ArcGIS specifications; specifically, the rasters may have filenames no longer than 13 characters and must begin with a letter (they may not begin with a number or symbol). The original HDF filenames violate both of these rules. As file naming conventions are a personal preference, a name-converting script is not provided here. However, for clarity of the processing scripts provided, note that our file-naming convention is "sstallyyyymm.hdf" for SST rasters, and "qualyyyymm.hdf" for quality rasters (where y = year and m = month).

These scripts can be modified to the users' needs or run in sequence (as presented below) to obtain a similar dataset to those made available in this report. The point and polygon shapefile included in the data processing steps of the scripts are available for download in zipped form from the table below.

Python Scripts

Script	Description	File Type
SST_HDF2ArcRaster.py	This script imports AVHRR Pathfinder SST data in HDF SDS format and converts them into georeferenced, scaled, SST rasters in ArcGIS GRID format with the help of the Marine Geospatial Ecology Tools (MGET).	.py
Qual_HDF2ArcRaster.py	This script imports AVHRR Pathfinder quality flag data in HDF SDS format and converts them into georeferenced, scaled, SST rasters in ArcGIS GRID format with the help of the Marine Geospatial Ecology Tools (MGET).	.py
CreateBSST.py	This script uses the SST and Qual ArcGIS grids constructed with the "SST_HDF2ArcRaster.py" and "Qual_HDF2ArcRaster.py" scripts to apply a quality constraint to the SST data.	.py
NPac_ns_SST.py	The purpose of this script is to clip the global SST grids to a nearshore region (20 km offshore) of the North Pacific Ocean. A clipping polygon shapefile, "lowres_TNP_coast_Buffer.shp" is provided below.	.py
NPac_ns_SST_pts.py	This script uses the nearshore grids created with the "NPac_ns_SST.py" script. It employs the ArcGIS Spatial Analyst extension, "Extract Values to Points" tool to extract SSTs from a nearshore SST raster underlying the 'TNP_pts.shp' point shapefile provided below that traces the perimeter of the Temperate Northern Pacific.	.py

Shapefiles

Filename	Description	File Type	File Size	Metadata
lowres_TNP_coast_Buffer.zip	Polygon shapefile used in the 'NPac_ns_SST.py' script to clip georeferenced global SST rasters to a nearshore (< 20 km from shoreline) North Pacific SST raster.	ESRI shapefile (*.shp)	2.3 MB	Available online
TNP_pts.zip	Point shapefile used in the 'NPac_ns_SST_pts.py' script to extract nearshore SST point values from nearshore raster grid cells. The attribute table for NPac_pts.shp also includes relational information to MEOW*	ESRI shapefile (*.shp)	14.4 MB	Available online

*Marine Ecosystems of the World (Spalding and others, 2007)

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Research Center. The information in this document has been funded in part by the U.S. Environmental Protection Agency. However, approval does not signify that the contents reflect the views of the U.S. EPA.

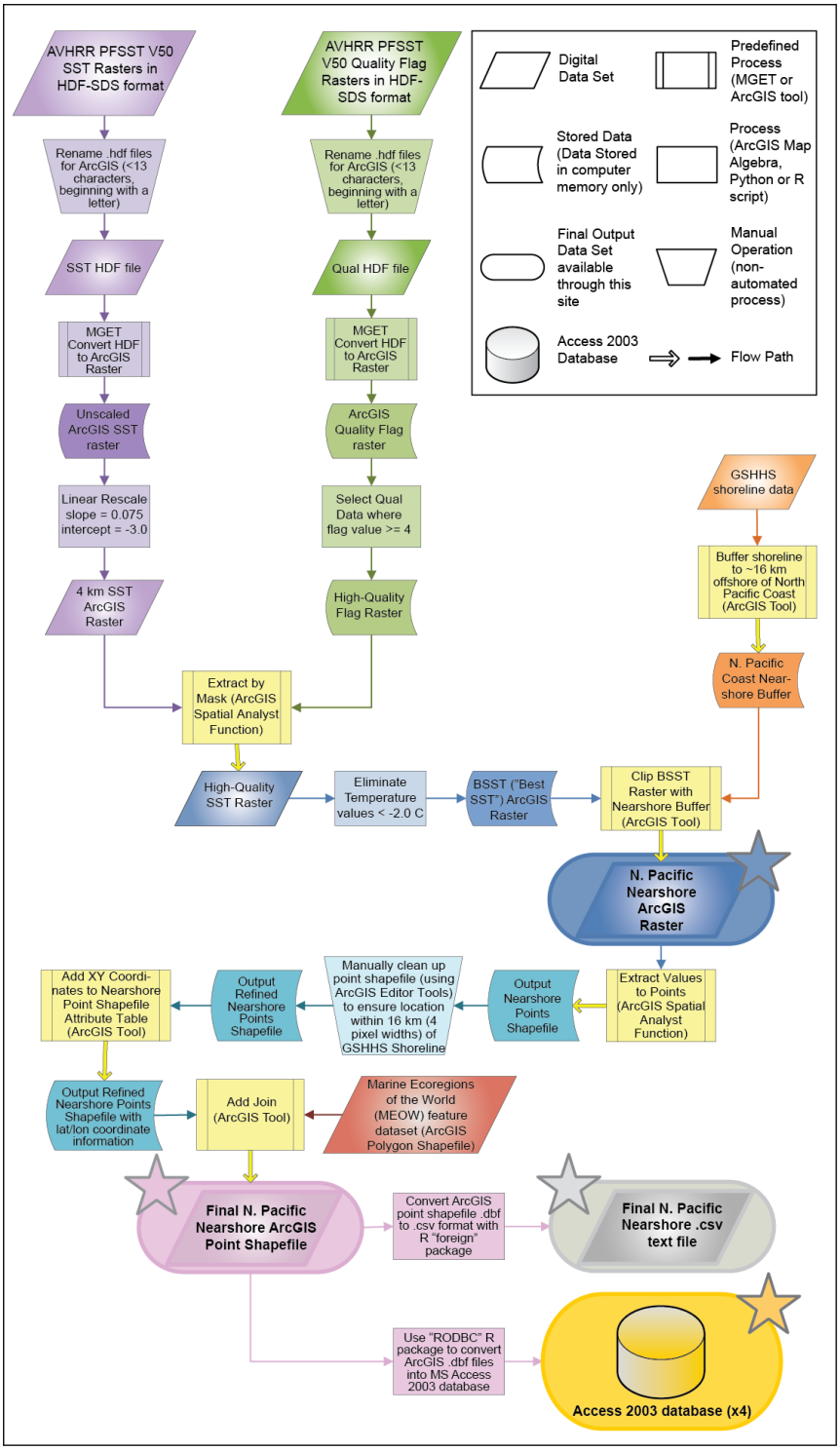

Figure 1. Flowchart detailing the data processing steps taken to convert AVHRR Pathfinder 4 km HDF data into North Pacific nearshore SST data in the form of ESRI GRIDs, ESRI shapefiles, text .csv files, and Access 2003 Databases. The flowchart color scheme emphasizes the relation of a particular input to its processes and outputs by using the same shades. New inputs or inputs derived through the combination of previous outputs have unique colors. Yellow rectangular boxes denote pre-existing (canned) MGET or ArcGIS tools used in processing. The final products marked with star symbols represent the datasets available through this report.

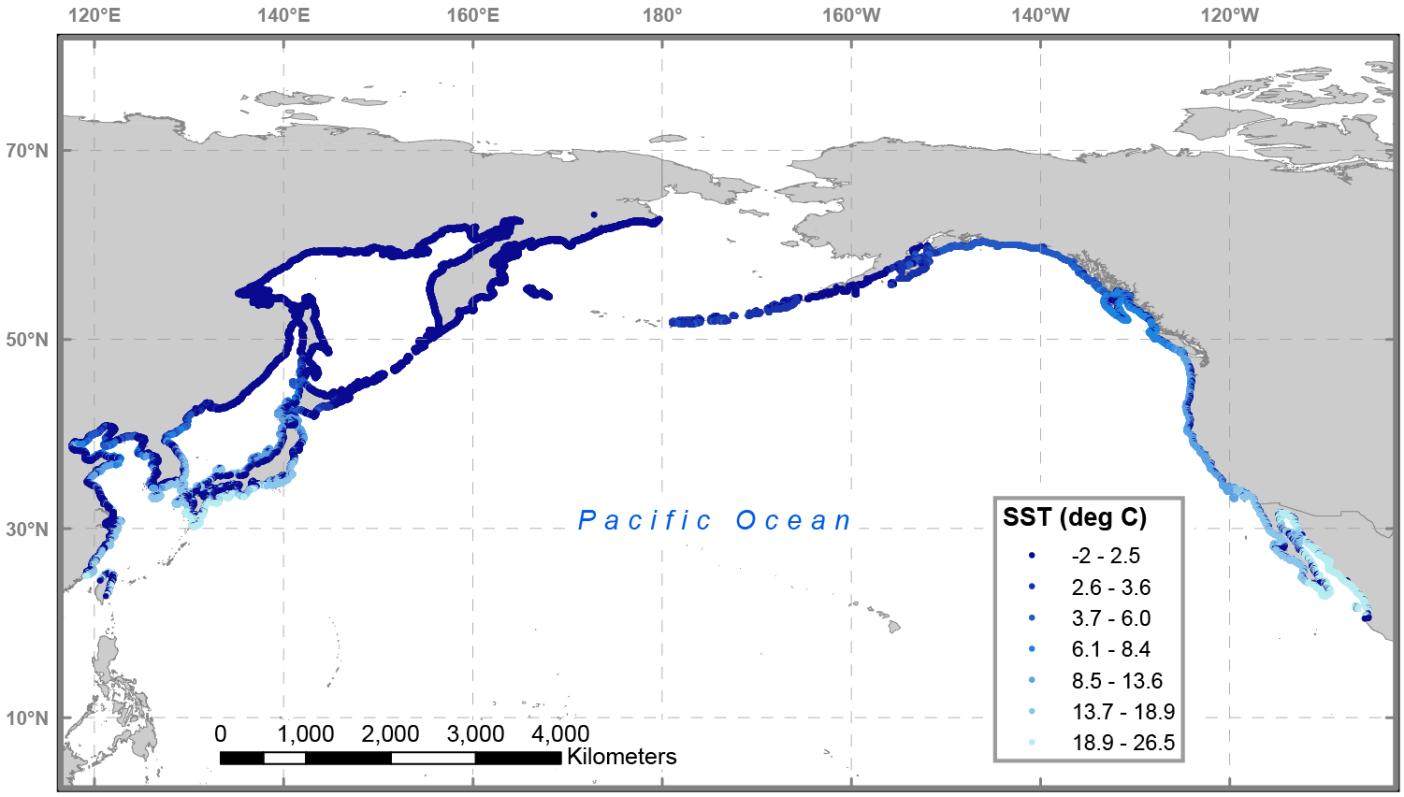

Figure 2. Example of a monthly mean SST map (April 2009) of the North Pacific Ocean nearshore region. Resolution is 4 km. The color gradient along the nearshore corresponds to the SSTs at those locations.

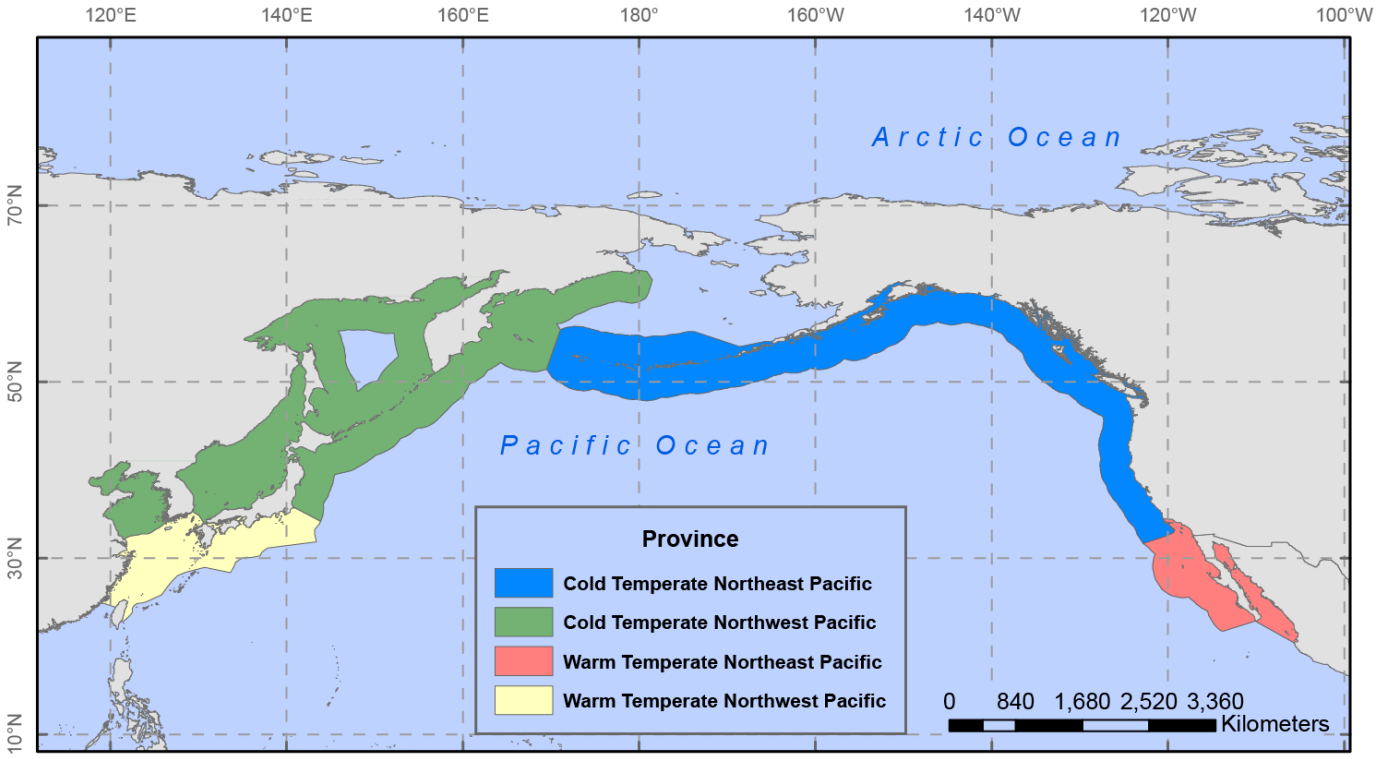

Figure 3. Map of the four Marine Ecosystem of the World (MEOW) Provinces that comprise the Temperate Northern Pacific and Arctic Realms (Spalding and others, 2007). The Cold Temperate Northeast Pacific includes the Aleutian Islands and the Pacific coast of North America, from Alaska to Southern California. The Warm Temperate Northeast Pacific contains the Baja Region. The Cold Temperate Northwest Pacific includes the Kamchatka coast of the Bering Sea and the Kuril Islands as well as the inland seas of Okhotsk, Japan, and the Yellow Sea, and much of the Japanese coast. Lastly, the Warm Temperate Northwest Pacific encompasses the East China Sea, the south coast of Korea and the Pacific coasts of Kyushu, Shikoku, and part of the Honshu Islands of Japan.

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