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Abstract : This document summarises the SST data produced and used by the ESA SST CCI project and describes where the data can be obtained.

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**EUROPEAN SPACE AGENCY
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AMENDMENT RECORD

This document shall be amended by releasing a new edition of the document in its entirety. The Amendment Record Sheet below records the history and issue status of this document.

AMENDMENT RECORD SHEET

ISSUE	DATE	REASON FOR CHANGE
1	30 September 2013	Definitive issue

RECORD OF CHANGES IN THIS ISSUE

Issue	Page/Sec.	Reason	Change
0.9			First complete version.
0.10		Internal review	Revised following comments from other project partners (S. A. Good)
1		Internal review	Definitive release

QUICK START GUIDE TO THE ESA SST CCI DATA ARCHIVE

Introduction

The ESA SST CCI product has produced new sea surface temperature (SST) products from satellite data. It has also made use of various other SST datasets. The ESA SST CCI products and (where permission has been granted) the other data that have been used are available for download from:

http://badc.nerc.ac.uk/view/neodc.nerc.ac.uk_ATOM_DE_6b503ac8-d294-11e2-8d19-00163e251233

This webpage contains instructions about how to access the data and links to documents describing them. Information can also be found below.

Organisation of the archive

The data archive has four main subdirectories. These are:

- **It** – the ESA SST CCI long term product; the aim for this product was to achieve a long, stable record of SST from satellites. The original SST data are available as well as a daily combination of data with gaps filled in.
- **dm** – the ESA SST CCI demonstration products; these are two 3-month sets of data that experimentally exploit extra satellite data than the long term product. As with the long term product the original data and a daily product are available.
- **comparison** – a collection of gridded SST products from other data producers.
- **gmpe** – a collection of infilled SST products on a common grid and stored together in daily files.

Data format

All data files are NetCDF format.

Data licence

All the data that are available from the ESA SST CCI webpage are provided under the Creative Commons Attribution 3.0 licence (<http://creativecommons.org/licenses/by/3.0/>).

Further information and how to contact us

For help on using the ESA SST CCI products and/or using NetCDF files see the product user guide, the latest version of which can be found at <http://www.esa-sst-cci.org/PUG/documents.htm>. Information about other data used by the project is contained in this document.

If these do not help, visit the websites listed for each data source or, for ESA SST CCI data, contact science.leader@esa-sst-cci.org. We also welcome any feedback about ESA SST CCI data to this address.



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1. INTRODUCTION

1.1 Purpose and scope

This document summarises the data produced and used by the ESA SST CCI project, many of which are made available at:

http://badc.nerc.ac.uk/view/neodc.nerc.ac.uk_ATOM_DE_6b503ac8-d294-11e2-8d19-00163e251233

The data produced by the project itself are described only briefly here as a detailed description is available in the product user guide (see the latest version available at <http://www.esa-sst-cci.org/PUG/documents.htm>). SST data from external sources are summarised in turn.

Where data are made available by the project, the location of the data is given. For data that are not available the user is directed to the data originators in order to obtain them.

1.2 References

The following documents are referenced in this document:

ID	Title
RD.72	Rayner, N. A., et al. (2006), Improved analyses of changes and uncertainties in sea surface temperature measured in situ since the mid-nineteenth century: The HadSST2 dataset, <i>Journal of Climate</i> , 19(3), 446-469.
RD.87	GHRSSST Science Team, cited 2010: The Recommended GHRSSST Data Specification (GDS) Revision 2.0 Technical Specifications. [Available online at http://www.ghrsst.org/modules/documents/documents/GDS2.0_TechnicalSpecifications_v2.0.pdf .]
RD.171	CCI Phase 1 (SST) (2010), User Requirements Document, Reference SST_CCI-URD-UKMO-001; http://www.esa-sst-cci.org/sites/default/files/documents/admin/public/SST_cci_URD_UKMO-001_Issue_2.pdf
RD.325	ESA SST CCI Product User Guide (2013).
RD.326	Atkinson, C. P., N. A. Rayner, J. Robert-Jones, and R. O. Smith (2013), Assessing the quality of sea surface temperature observations from drifting buoys and ships on a platform-by-platform basis, <i>J. Geophys. Res. Oceans</i> , 118, doi:10.1002/jgrc.20257.

1.3 Acronyms

The following SST-specific acronyms are used in this report.

Acronym	Definition
(A)ATSR	(Advanced) Along-Track Scanning Radiometer
AMSR-E	Advanced Microwave Scanning Radiometer – Earth Observing System
ASCII	American Standard Code for Information Interchange
AVHRR	Advanced Very High Resolution Radiometer
CCI	Climate Change Initiative
CDR	Climate Data Record
CMC	Canadian Meteorological Center
COBE	Centennial <i>in situ</i> observation based estimates
ERSST	Extended Reconstruction SST
ESA	European Space Agency
GDS	GHRSSST Data Processing Specification
GHRSSST	Group for High-Resolution SST
GMPE	GHRSSST Multi Product Ensemble
GT MBA	Global Tropical Moored Buoy Array
HadSST	The Met Office Hadley Centre dataset of gridded <i>in situ</i> temperature anomalies
HadISST	The Met Office Hadley Centre sea ice and sea surface temperature dataset
ICOADS	International Comprehensive Ocean-Atmosphere Data Set
ISAR	Inverse Synthetic-Aperture Radar
JMA	Japan Meteorological Agency
L2P	Level 2 Preprocessed data
L3U	Level 3 Uncollated data
L4	Level 4 data
M-AERI	Marine-Atmosphere Emitted Radiance Interferometer
MGDSST	Merged satellite and <i>in situ</i> data Global Daily SSTs in the global ocean
NetCDF	Network Common Data Format
NCDC	National Climate Data Center
NCEP	National Center for Environmental Prediction
NOAA	National Oceanic and Atmospheric Administration
NOCS	National Oceanographic Centre Southampton

Acronym	Definition
OSTIA	Operational Sea Surface Temperature and Sea Ice Analysis
OI	Optimal Interpolation
PI	Principal Investigator
PIRATA	Prediction and Research Moored Array in the Atlantic
RAMA	Research Moored Array for African-Asian-Australian Monsoon Analysis and Prediction
SEVIRI	Spinning Enhanced Visible and Infrared Imager
SISTeR	Scanning Infrared Sea Surface Temperature Radiometer
SST	Sea Surface Temperature
STFC	Science and Technology Facilities Council
TAO/TRITON	Tropical Atmosphere Ocean/Triangle Trans-Ocean Buoy Network project
TMI	Tropical Rainfall Measuring Mission (TRMM) Microwave Imager

1.4 Document structure

At the beginning of the document is a quick start guide to finding data in the ESA SST CCI online archive.

The remainder of this document has the structure summarised below.

Section 2 The ESA SST CCI data.

Section 3 SST data from external sources.

2. ESA SST CCI DATA

Users are encouraged to read the latest version of the ESA SST CCI product user guide (which can be found at <http://www.esa-sst-cci.org/PUG/documents.htm>; [RD.325]) to find out about the data. A summary of the products, taken from that document, is below.

The ESA SST CCI project has produced two SST products, each of which consist of sets of data from single satellite instruments (or series of instrument) and daily analyses formed by combining data from all the instruments and infilling any gaps. In brief, the two products are:

2.1 The 'long term' product

Stable, low-bias SST data starting during 1991 and continuing through to the end of 2010 and consisting of

1. Data from the ATSR series of sensors (level 3 uncollated (L3U) data: a single orbit of data per file on a 0.05° regular latitude-longitude grid and from the AVHRR series of sensors (level 2 pre-processed (L2P) data: single orbit of data per file on an irregular grid with grid cell spacing about 4 km) (starts August 1991).

Each file contains two sets of SSTs. The first set provides a measure of the temperature of the skin of the water at the time it was observed; the second set are estimates of the temperature at 20 cm depth and at either 1030 h or 2230 h local time (provision of data at 20 cm depth was one of the requirements revealed by the user requirements gathering exercise [RD.171]). They have uncertainty estimates that have been broken down into different components and a total uncertainty for each SST value.

The SST data are suitable for many uses, such as the study of temporal and spatial variability and comparison to or initialisation of numerical models. Owing to the orbital drift of some satellites, the 20 cm SSTs are better suited to the study of long term SST change than the skin SSTs as they have been adjusted so that they all represent the same point in the diurnal cycle.

2. Daily combinations of the orbit data described above, using optimal interpolation to provide SSTs where there were no observations (level 4 (L4) analysis: single file per day on a 0.05° regular latitude-longitude grid) (starts September 1991).

The SSTs correspond approximately to the daily average of the temperature of the water at 20 cm depth. Uncertainty estimates are provided. An example use of these data is as a boundary condition for a numerical model.

On the online archive, long term data products are in the directory 'lt'.

2.2 The 'demonstration' products

Data covering two periods of three months, experimentally exploiting a larger number of sensors, are also available. This product aims to demonstrate results using a broader sample of the modern satellite observing system. Data from Advanced ATSR (AATSR), AVHRR, SEVIRI, AMSR-E and the Tropical Rainfall Measuring Mission Microwave Imager (TMI) are included.

On the online archive, demonstration data products are in the directory 'dm'.

3. SST DATA FROM EXTERNAL SOURCES

The ESA SST CCI project has made use of various data products sourced from outside the project. These are characterised as either 'reference data' or 'comparison data'. Reference data are point observations or gridded versions of point observations (such as from drifting buoys) and have been used for development, testing or validation of the ESA SST CCI products. Comparison data are all gridded (in many cases with data gaps infilled) products that are being used to determine how consistent the ESA SST CCI data are with other products. Comparisons are also performed in the framework of a 'GMPE' (GHRSSST Multi-product Ensemble), which is a combination of level 4 products.

Where permission has been granted the project has placed the comparison, reference and GMPE data on the internet for download from the same place as the ESA SST CCI products (http://badc.nerc.ac.uk/view/neodc.nerc.ac.uk_ATOM_DE_6b503ac8-d294-11e2-8d19-00163e251233). All the data that are available from this webpage are provided under the Creative Commons Attribution 3.0 licence (<http://creativecommons.org/licenses/by/3.0/>). This allows free use of the data provided an acknowledgment to the data creators is given. Where permission has not been granted for the project to distribute data, we instead provide links to the data in this document.

The following sections summarise the data and indicates how to obtain them and where to find further information. Where data are provided from the ESA SST CCI webpages information on data format and how to acknowledge the data is also provided.

All data provided from the ESA SST CCI webpages are in NetCDF format. As this is a common format they are readable using many different tools. See RD.325 for details.

3.1 Reference data

Point observations have been used by the project for the development and assessment of the SST retrieval algorithms and are required for referencing together the data from the ATSR and AVHRR series of instruments. They are also used for validation of the ESA SST CCI products.

The observations are from various sources and have different characteristics. For example *in situ* radiometers on board cruise ships provide estimates of the skin SST (the same ~10µm layer of the ocean that many of the satellite instruments are sensitive to) while drifting buoys provide wider coverage than the radiometers but nominally at 20 cm depth.

Below is a list of reference data types followed by sections giving more information about each:

- Argo floats (Section 3.1.1).
- Drifting buoys (Section 3.1.2).
- Global tropical moored buoys (Section 3.1.3).
- HadSST3 (Section 3.1.4).
- Ship-borne infra-red radiometers (Section 3.1.5).

3.1.1 Argo float data

Brief description	Argo floats are autonomous instruments that record profiles of temperature and salinity down to 2000 m depth. The Argo float array reached its target of 3000 active floats in 2007. For the purpose of the ESA SST CCI project, near surface Argo data were extracted from the Met Office's EN4 dataset.
Produced by	Argo is an international collaboration involving many countries. EN4 was produced by the Met Office Hadley Centre.
Time span of data	2000 – present.
Spatial sampling	There are now approximately 3000 active floats across the world ocean, which corresponds to 1 float per 3°.
Frequency of data	Typically, each float records a profile every 10 days.
Location of data at NEODC	Not available – see source of data below.
Source of data (alternative download location)	The data can be downloaded directly from the Argo project's global data assembly centres: http://www.coriolis.eu.org/ and http://www.usgodae.org/argo/argo.html . The Met Office EN4 dataset is not yet publicly available. A previous version can be found at http://www.metoffice.gov.uk/hadobs/en3/ .
Where to find information about the data	http://www.argo.net/ .
Citation to use if using the data	See originator's webpages.
Data file format and description	See originator's webpages.

3.1.2 Drifting buoy data

Brief description	Drifting buoys are autonomous instruments that collect SST measurements at a nominal depth of 20 cm. Drifting buoy data were extracted from the ICOADS 2.5 dataset and basic Met Office Hadley Centre quality control applied [RD.72]. Additional quality control was carried out by tracking buoy data over time [RD.326].
Produced by	ICOADS is produced by NOAA.
Time span of data	1991 – 2010.

Spatial sampling	The scientific design for the global surface drifting buoy array originally called for 1250 buoys to be maintained worldwide, with one buoy approximately every 500 kilometres over the entire global ocean. This was achieved in 2005 (see http://www.jcommops.org/dbcp/ for more information). The exact number and spatial distribution of drifting buoys will be variable in time.
Frequency of data	Typically hourly but can vary.
Location of data at NEODC	Not available – see source of data below.
Source of data (alternative download location)	ICOADS is available at http://icoads.noaa.gov/ . The quality controlled drifting buoy data used by the project are available for private and research purposes on request from the Met Office Hadley Centre (email nick.rayner@metoffice.gov.uk for information).
Where to find information about the data	http://icoads.noaa.gov/ .
Citation to use if using the data	See http://icoads.noaa.gov/ if using data directly from ICOADS. For basic Met Office Hadley Centre quality control: Rayner, N. A., P. Brohan, D. E. Parker, C. K. Folland, J. J. Kennedy, M. Vanicek, T. J. Ansell, and S. F. B. Tett (2006), Improved analyses of changes and uncertainties in sea surface temperature measured in situ since the mid-nineteenth century: The HadSST2 dataset, <i>J. Climate</i> , 19, 446-469, doi:10.1175/JCLI3637.1. For tracking Met Office Hadley Centre quality control: Atkinson, C. P., N. A. Rayner, J. Roberts-Jones, and R. O. Smith (2013), Assessing the quality of sea surface temperature observations from drifting buoys and ships on a platform-by-platform basis, <i>J. Geophys. Res. Oceans</i> , 118, doi:10.1002/jgrc.20257
Data file format and description	Contact originators for information.

3.1.3 Global tropical moored buoy data

Brief description	The Global Tropical Moored Buoy Array (GT MBA) is a multi-national effort to provide data in real-time for climate research and forecasting. Major components include the TAO/TRITON array in the Pacific, PIRATA in the Atlantic, and RAMA in the Indian Ocean (e.g. see http://www.pmel.noaa.gov/tao/index.shtml). In general, GT MBA buoys collect SST at nominal depths of 1.0 or 1.5 (TRITON) metres. Moored buoy data (including GT MBA) were extracted from the ICOADS 2.5 dataset and basic Met Office Hadley Centre quality control applied [RD.72].
Produced by	ICOADS is produced by NOAA
Time span of data	1991-2010
Spatial sampling	GT MBA buoys are located in the tropics, forming a grid-like pattern with spacing typically of order 10° longitude and order <5° latitude (e.g. see http://www.pmel.noaa.gov/tao/global/global.html)
Frequency of data	Typically hourly but can vary.
Location of data at NEODC	Not available – see source of data below.
Source of data (alternative download location)	ICOADS is available at http://icoads.noaa.gov/ . The quality controlled moored buoy data used by the project are available for private and research purposes on request from the Met Office Hadley Centre (email nick.rayner@metoffice.gov.uk for information).
Where to find information about the data	http://icoads.noaa.gov/ .
Citation to use if using the data	See http://icoads.noaa.gov/ if using data directly from ICOADS. For basic Met Office Hadley Centre quality control: Rayner, N. A., P. Brohan, D. E. Parker, C. K. Folland, J. J. Kennedy, M. Vanicek, T. J. Ansell, and S. F. B. Tett (2006), Improved analyses of changes and uncertainties in sea surface temperature measured in situ since the mid-nineteenth century: The HadSST2 dataset, <i>J. Climate</i> , 19, 446-469, doi:10.1175/JCLI3637.1.
Data file format and description	

3.1.4 HadSST3

Brief description	Monthly gridded fields of SST from <i>in situ</i> observations at various depths. Adjustments have been made to minimise the effect of changing instrumentation over time and uncertainty is quantified by providing many different possible realisations of the data.
Produced by	Met Office Hadley Centre.
Time span of data	1850 – present.
Spatial sampling	The data are presented on a 5° regular latitude longitude grid.
Frequency of data	Monthly.
Location of data at NEODC	Not available – see source of data below.
Source of data (alternative download location)	http://www.metoffice.gov.uk/hadobs/hadsst3/ .
Where to find information about the data	http://www.metoffice.gov.uk/hadobs/hadsst3/ .
Citation to use if using the data	See originator's website.
Data file format and description	See originator's website (NetCDF and ASCII versions are available).

3.1.5 Ship-borne infra-red radiometers

Brief description	Skin SST estimates from infra-red radiometers mounted on board ships.
Produced by	ISAR – Ian Robinson (University of Southampton) M-AERI – Peter Minnett (University of Miami) SISTeR – Tim Nightingale (STFC)
Time span of data	1999 – present.
Spatial sampling	Typically, each measurement covers < 1-km depending on integration time
Frequency of data	Typically, each instrument samples < 10 minutes while deployed in non-precipitating conditions
Location of data at NEODC	Not yet available – see source of data below.
Source of data (alternative download location)	Contact instrument PI.
Where to find information about the data	Contact instrument PI.

Citation to use if using the data	Contact instrument PI.
Data file format and description	Contact instrument PI.

3.2 Comparison data

The comparison data sets are used to assess the consistency of ESA SST CCI products with other similar products. For example trends in the different products are being compared.

Most of the comparison datasets use statistical methods to infill data gaps such as optimal interpolation. They vary considerably in their spatial and temporal resolution. Below is a list of the comparison datasets followed by sections that provide details of each:

- AVHRR Pathfinder v5.2 (Section 3.2.1).
- COBE SST (Section 3.2.2).
- ERSST v3b (Section 3.2.3).
- Gridded version of the reference data (Section 3.2.4).
- HadISST v1 (Section 3.2.5).
- Kaplan extended v2 (Section 3.2.6).
- Karspeck (Section 3.2.7).
- MyOcean OSTIA reanalysis (Section 3.2.8).
- NOAA OI SST analysis v2 (Section 3.2.9).
- NOAA OI 0.25 degree AVHRR (Section 3.2.10).
- NOAA OI 0.25 degree AVHRR+AMSR-E (Section 3.2.11).
- NOCS surface flux dataset v2.0 (Section 3.2.12).

3.2.1 AVHRR Pathfinder v5.2

Brief description	The Pathfinder dataset is a reprocessing of AVHRR series data using a consistent algorithm. It is a long term, global SST dataset. Day and night data are collated to give twice daily SST fields.
Produced by	NODC.
Time span of data	1981 – 2011.
Spatial grid	4 km.
Frequency of data	Twice daily (day/night).
Location of data at NEODC	http://neodc.nerc.ac.uk/browse/neodc/esacci_sst/data/comparison/AVHRR_Pathfinder
Source of data (alternative download location)	ftp.nodc.noaa.gov/pub/data.nodc/pathfinder/Version5.2

Where to find information about the data	http://www.nodc.noaa.gov/SatelliteData/pathfinder4km/
Citation to use if using the data	<p>As defined at http://www.nodc.noaa.gov/SatelliteData/pathfinder4km/, use of these data should be acknowledged using the text:</p> <p>"These data were provided by GHRSSST and the US National Oceanographic Data Center. This project was supported in part by a grant from the NOAA Climate Data Record (CDR) Program for satellites".</p> <p>and cite</p> <p>Casey, K.S., T.B. Brandon, P. Cornillon, and R. Evans (2010). "The Past, Present and Future of the AVHRR Pathfinder SST Program", in Oceanography from Space: Revisited, eds. V. Barale, J.F.R. Gower, and L. Alberotanza, Springer. DOI: 10.1007/978-90-481-8681-5_16.</p>
Data file format and description	<p>NetCDF format following the specifications described in [RD.87]. This specification is very similar to that used for the ESA SST CCI products for level 3 data.</p> <p>An example filename is: 19811220152842-NODC-L3C_GHRSSST-SSTskin-AVHRR_Pathfinder-PFV5.2_NOAA07_G_1981354_day-v02.0-fv01.0.nc. The first eight digits provide the date (four digits for the year followed by two digits each for the month and the day). Later in the filename this information is repeated in the form YYYYDDD (four digits for year and three digits for the day of the year). This is followed by either <i>_day</i> or <i>_night</i>, which reveals which of the two daily SST collations is in the file.</p> <p>Key variables in the NetCDF files are:</p> <ul style="list-style-type: none"> • <i>sea_surface_temperature</i> The SST data array. • <i>lat</i> The latitudes of the SSTs. • <i>lon</i> The longitudes of the SSTs. • <i>quality_level</i> An indicator of the quality of each SST between 1 (bad) to 5 (best quality); the <i>pathfinder_quality_level</i> variable provides the original quality flags produced by the Pathfinder project. • <i>l2p_flags</i> Information such as whether a location is over land, ice etc.

3.2.2 COBE SST

Brief description	Optimally interpolated in situ data. Daily analyses are formed from quality controlled observations from the seven days centred on the date being analysed. Monthly averages of the data are made available.
Produced by	JMA.
Time span of data	January 1981 – June 2013
Spatial grid	1° regular latitude longitude grid.
Frequency of data	Monthly.
Location of data at NEODC	http://neodc.nerc.ac.uk/browse/neodc/esacci_sst/data/comparison/COBE-SST
Source of data (alternative download location)	http://ds.data.jma.go.jp/tcc/tcc/products/el_nino/cobesst/cobe-sst.html
Where to find information about the data	http://ds.data.jma.go.jp/tcc/tcc/products/el_nino/cobesst_doc.html
Citation to use if using the data	Ishii, M., A. Shouji, S. Sugimoto, and T. Matsumoto, 2005: Objective Analyses of Sea-Surface Temperature and Marine Meteorological Variables for the 20th Century using ICOADS and the Kobe Collection. <i>Int. J. Climatol.</i> , 25, 865-879.
Data file format and description	The COBE-SST files have been converted to NetCDF from the original GRIB format. The filenames have the form sstYYYYMM.nc where YYYY is the year and MM is the month. The key variables in the files are: <ul style="list-style-type: none"> • <i>WTMP</i> The SST data array. • <i>latitude</i> The latitudes of the SSTs. • <i>longitude</i> The longitudes of the SSTs.

3.2.3 ERSST v3b

Brief description	Version 3b of the Extended Reconstructed Sea Surface Temperature (ERSST) dataset. Reconstructions of SSTs are formed from in situ data only; anomalies from the 1971-2000 average are also provided.
Produced by	NCDC.
Time span of data	January 1854 – June 2013.
Spatial grid	2° regular latitude longitude grid.
Frequency of data	Monthly.

Location of data at NEODC	http://neodc.nerc.ac.uk/browse/neodc/esacci_sst/data/comparison/COBE-SST
Source of data (alternative download location)	ftp://ftp.ncdc.noaa.gov/pub/data/cmb/ersst/v3b/netcdf
Where to find information about the data	http://www.ncdc.noaa.gov/ersst/
Citation to use if using the data	Smith, T.M., R. W. Reynolds, T. C. Peterson, and J. Lawrimore, 2008: Improvements to NOAA's historical merged land-ocean surface temperature analysis (1880-2006). J. Climate, 21, 2283-2296.
Data file format and description	<p>NetCDF data files with names of the form <i>ersst.YYYYMM.nc</i>, where YYYY is the year and MM is the month.</p> <p>With the files the key variables are:</p> <ul style="list-style-type: none"> • <i>sst</i> The SST data. • <i>err</i> Standard deviation of errors in the SST data. • <i>anom</i> SST anomalies relative to the 1971-2000 climatology from Xue, Y., T. M. Smith, and R. W. Reynolds, 2003: Interdecadal changes of 30-yr SST normals during 1871-2000. J. Climate, 16, 1601-1612. • <i>lat</i> Latitudes of the data points. • <i>lon</i> Longitudes of the data points.

3.2.4 Gridded version of the reference data

Brief description	A gridded version of the reference data set excluding radiometer measurements. It includes ship and buoy data that have been quality controlled using the methods described in RD.326 and near-surface observations from Argo floats. The observations have been gridded according to the methods described in RD.72 and are presented on a monthly grid of anomalies relative to a 1961-1990 average.
Produced by	The ESA SST CCI project.
Time span of data	1991 – 2010.
Spatial grid	5° regular latitude longitude grid.
Frequency of data	Monthly.
Location of data at NEODC	http://neodc.nerc.ac.uk/browse/neodc/esacci_sst/data/comparison/gridded_reference_data
Source of data (alternative download location)	None.

Where to find information about the data	Contact the ESA SST CCI project if more information is required.
Citation to use if using the data	See details of how to reference ESA SST CCI data in RD.325.
Data file format and description	The data are in a single NetCDF format file. The key variables in the file are: <ul style="list-style-type: none"> • <i>sst_anomalies</i> SST anomalies relative to the 1961-1990 average. • <i>latitude</i> Latitudes of the grid points. • <i>longitude</i> Longitudes of the grid points. • <i>time</i> Time points in units of hours since midnight on 01 January 1970.

3.2.5 HadISST v1

Brief description	Reconstructed SST fields from in situ and AVHRR satellite data. The reconstruction method is a two stage reduced-space optimal interpolation. Following this local detail is restored by superimposing observations back onto the reconstructions.
Produced by	Met Office Hadley Centre.
Time span of data	1870 – present.
Spatial grid	1° regular latitude longitude grid.
Frequency of data	Monthly.
Location of data at NEODC	Not available – see source of data below.
Source of data (alternative download location)	http://www-hc/~hadobs/www.hadobs.org/hadisst/data/download.html
Where to find information about the data	http://www-hc/~hadobs/www.hadobs.org/hadisst/
Citation to use if using the data	Rayner, N. A.; Parker, D. E.; Horton, E. B.; Folland, C. K.; Alexander, L. V.; Rowell, D. P.; Kent, E. C.; Kaplan, A. (2003) Global analyses of sea surface temperature, sea ice, and night marine air temperature since the late nineteenth century J. Geophys. Res. Vol. 108, No. D14, 4407 10.1029/2002JD002670
Data file format and description	See originator's website.

3.2.6 Kaplan extended v2

Brief description	Empirical orthogonal functions are used to interpolate in situ observations (before 1981) and to reproject NCEP OI data (combinations of in situ and satellite data) (1981 onwards).
Produced by	Alexey Kaplan (Columbia University; http://rainbow.ldeo.columbia.edu/~alexeyk/).
Time span of data	January 1856 – June 2013.
Spatial grid	5° regular latitude longitude grid.
Frequency of data	Monthly.
Location of data at NEODC	http://neodc.nerc.ac.uk/browse/neodc/esacci_sst/data/comparison/Kaplan_extended
Source of data (alternative download location)	http://iridl.ldeo.columbia.edu/SOURCES/.KAPLAN/.EXTENDED/v2/.ssta/
Where to find information about the data	http://iridl.ldeo.columbia.edu/SOURCES/.KAPLAN/.EXTENDED/dataset_documentation.html
Citation to use if using the data	Kaplan, A., M. Cane, Y. Kushnir, A. Clement, M. Blumenthal, and B. Rajagopalan, Analyses of global sea surface temperature 1856-1991, <i>Journal of Geophysical Research</i> , 103, 18,567-18,589, 1998 R. W. Reynolds, T. M. Smith. Improved global sea surface temperature analyses.. <i>J. Climate</i> 7, 1994
Data file format and description	A single NetCDF file contains all the data. Key variables are: <ul style="list-style-type: none"> • <i>ssta</i> SST anomalies relative to 1951-1980. • X Longitudes of the grid points. • Y Latitudes of the grid points. • T Date, in months since 1 January 1960.

3.2.7 Karspeck

Brief description	North Atlantic dataset of expected value and ensemble realisations of historical SST. A large scale reconstruction of SST has been augmented to improve the representation of mid-scale variability and its uncertainty.
Produced by	Alicia Karspeck (UCAR).
Time span of data	January 1850 – March 2008.
Spatial grid	1° regular latitude longitude grid covering the North Atlantic Ocean.
Frequency of data	Monthly.

Location of data at NEODC	http://neodc.nerc.ac.uk/browse/neodc/esacci_sst/data/comparison/Karspeck
Source of data (alternative download location)	http://rainbow.ldeo.columbia.edu/~alexeyk/KKS2011supp/
Where to find information about the data	http://onlinelibrary.wiley.com/doi/10.1002/qj.900/full http://rainbow.ldeo.columbia.edu/~alexeyk/KKS2011supp/
Citation to use if using the data	Karspeck, A.R., A.Kaplan, S.R.Sain, 2012: Bayesian modelling and ensemble reconstruction of mid-scale spatial variability in North Atlantic sea-surface temperatures for 1850-2008. Quarterly Journal of the Royal Meteorological Society, 138, 234-248. doi: 10.1002/qj.900.
Data file format and description	<p>Two files are provided. <code>expected_ssta_total.cdf</code> contains the expected values from the combination of the large scale and mid scale SST reconstructions. <code>ensemble_ssta_total_20mem.cdf</code> contains an ensemble of 20 realisations of the SST, created by drawing samples from the posterior distribution of the mid scale reconstruction combined with the expected values from the large scale reconstructions. Further data describing the mid scale reconstruction are available from the originator website.</p> <p>Both files are NetCDF format and have the following key variables:</p> <ul style="list-style-type: none"> • <i>ssta</i> SST anomaly relative to the 1961-1990 average. • <i>X</i> Longitudes of the SSTs. • <i>Y</i> Latitudes of the SSTs. • <i>T</i> Time of the SSTs in months relative to 1 January 1960. • <i>MEM</i> Ensemble member (<code>ensemble_ssta_total_20mem.cdf</code> only).

3.2.8 MyOcean OSTIA reanalysis

Brief description	In situ and satellite (ATSR and AVHRR) data are combined and infilled using optimal interpolation to give daily estimates of foundation SST. The analysis is performed using the Met Office Operation Sea Surface Temperature and Sea Ice (OSTIA) system.
Produced by	Met Office.
Time span of data	1985 – 2007 .
Spatial grid	0.05° regular latitude longitude grid.

Frequency of data	Daily.
Location of data at NEODC	Not available in its original form. It can be obtained in its original form from the source below.
Source of data (alternative download location)	http://www.myocean.eu/web/69-myocean-interactive-catalogue.php/?option=com_csw&view=details&product_id=SST_GLO_SST_L4_REP_OBSERVATIONS_010_011
Where to find information about the data	As above.
Citation to use if using the data	Roberts-Jones, J., E. Fiedler and M. Martin, 2012: Daily, global, high resolution SST and sea-ice reanalysis for 1985-2007 using the OSTIA system, J. Climate, 25, 6215-6232, doi:10.1175/JCLI-D-11-00648.1.
Data file format and description	The data are in NetCDF format and follow the GHRSSST data specification. See originator's website for more information.

3.2.9 NOAA OI SST analysis v2

Brief description	Weekly optimum interpolation analysis of in situ and satellite SSTs. Satellite data are adjusted for biases prior to the analysis.
Produced by	NOAA.
Time span of data	1981 – present.
Spatial grid	1° regular latitude longitude grid.
Frequency of data	Weekly and monthly data are available.
Location of data at NEODC	Not available – see source of data below.
Source of data (alternative download location)	http://www.esrl.noaa.gov/psd/data/gridded/data.noaa.oisst.v2.html (for NetCDF format data).
Where to find information about the data	http://www.emc.ncep.noaa.gov/research/cmb/sst_analysis/
Citation to use if using the data	See originator's website.
Data file format and description	See originator's website.

3.2.10 NOAA OI 0.25° AVHRR SST analysis

Brief description	Optimum interpolation analysis of in situ data and AVHRR satellite data. Satellite data are bias adjusted using the in situ data as the reference.
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Produced by	NOAA NCDC.
Time span of data	1981 – present.
Spatial grid	0.25° regular latitude longitude grid.
Frequency of data	Daily.
Location of data at NEODC	http://neodc.nerc.ac.uk/browse/neodc/esacci_sst/data/comparison/DailyOI-AVHRR
Source of data (alternative download location)	http://www.ncdc.noaa.gov/cdr/operationalcdrs.html (data in GHRSSST data specification format are also available; see http://www.nodc.noaa.gov/SatelliteData/ghrsst/)
Where to find information about the data	http://www.ncdc.noaa.gov/oa/climate/research/sst/oi-daily-information.php
Citation to use if using the data	<p>From http://www1.ncdc.noaa.gov/pub/data/sds/cdr/use_stmts/CDR_Fair_Use Stmt_Sea_Surface_Temperature_Optimum_Interpolation.pdf the acknowledgement or citation to use is</p> <p>Acknowledgement Request: The OISST CDR used in this study was acquired from NOAA's National Climatic Data Center (http://www.ncdc.noaa.gov). This CDR was originally developed by Richard Reynolds and colleagues for the NOAA's CDR Program.</p> <p>Citation Request: Reynolds, R. W., T. M. Smith, C. Liu, D. B. Chelton, K. S. Casey and M. G. Schlax, 2007: Daily High-resolution Blended Analyses for sea surface temperature. <i>J. Climate</i>, 20, 5473--5496.</p> <p>Reynolds, R.W. 2009. What's new in version 2. Available online at http://www.ncdc.noaa.gov/oa/climate/research/sst/papers/oisst_daily_v02r00_version2-features.pdf.</p>
Data file format and description	<p>NetCDF format with key variables:</p> <ul style="list-style-type: none"> • <i>sst</i> The SST data. • <i>anom</i> SST anomalies. • <i>err</i> Error standard deviation of the SSTs. • <i>lat</i> Latitudes of the grid points. • <i>lon</i> Longitudes of the grid points.

3.2.11 NOAA OI 0.25 degree AVHRR+AMSR-E SST analysis

Brief description	Optimum interpolation analysis of in situ data, and AVHRR and AMSR-E satellite data. Satellite data are bias adjusted using the in situ data as the reference.
Produced by	NOAA NCDC.
Time span of data	2002 – 2011.
Spatial grid	0.25° regular latitude longitude grid.
Frequency of data	Daily.
Location of data at NEODC	http://neodc.nerc.ac.uk/browse/neodc/esacci_sst/data/comparison/DailyOI-AVHRR+AMSRE
Source of data (alternative download location)	http://www.ncdc.noaa.gov/cdr/operationalcders.html (data in GHRSSST data specification format are also available; see http://www.nodc.noaa.gov/SatelliteData/ghrsst/)
Where to find information about the data	http://www.ncdc.noaa.gov/oa/climate/research/sst/oi-daily-information.php
Citation to use if using the data	From http://www1.ncdc.noaa.gov/pub/data/sds/cdr/use_stmts/CDR_Fair_Use Stmt_Sea_Surface_Temperature_Optimum_Interpolation.pdf the acknowledgement or citation to use is Acknowledgement Request: The OISST CDR used in this study was acquired from NOAA's National Climatic Data Center (http://www.ncdc.noaa.gov). This CDR was originally developed by Richard Reynolds and colleagues for the NOAA's CDR Program. Citation Request: Reynolds, R. W., T. M. Smith, C. Liu, D. B. Chelton, K. S. Casey and M. G. Schlax, 2007: Daily High--resolution Blended Analyses for sea surface temperature. J. Climate, 20, 5473--5496. Reynolds, R.W. 2009. What's new in version 2. Available online at http://www.ncdc.noaa.gov/oa/climate/research/sst/papers/oisst_daily_v02r00_version2-features.pdf .
Data file format and description	NetCDF format with key variables: <ul style="list-style-type: none"> • <i>sst</i> The SST data. • <i>anom</i> SST anomalies. • <i>err</i> Error standard deviation of the SSTs. • <i>lat</i> Latitudes of the grid points. • <i>lon</i> Longitudes of the grid points.

3.2.12 NOCS surface flux dataset v2.0

Brief description	Optimally interpolated dataset of SST and other surface variables based on in situ data.
Produced by	NOCS.
Time span of data	1973 – 2011.
Spatial grid	1° regular latitude longitude grid.
Frequency of data	Monthly.
Location of data at NEODC	Not available – see source of data below.
Source of data (alternative download location)	http://rda.ucar.edu/datasets/ds260.3/
Where to find information about the data	http://www.noc.soton.ac.uk/ooc/CLIMATOLOGY/noc2.php
Citation to use if using the data	See originator's website.
Data file format and description	See originator's website.

3.3 The GHR SST Multi-product Ensemble (GMPE)

3.3.1 Description

The ESA SST CCI project is conducting intercomparisons between level 4 products within the framework of a GHR SST Multi-product Ensemble (GMPE). GMPE files contain the median and standard deviation of the product ensemble. Anomalies of the level 4 SST analyses relative to the ensemble median are also provided. Statistics from a GMPE of operational SST data can be seen at http://ghrsst-pp.metoffice.com/pages/latest_analysis/sst_monitor/daily/ens/index.html.

All the data in the GMPE files are regridded onto a common 0.25° regular latitude longitude grid and there are SST fields for each day. The GMPE for the ESA SST CCI long term product covers the period September 1991 to December 2010. GMPE files are also available for ESA SST CCI demonstration product 1 (which covers June to August 2007).

3.3.2 Obtaining the GMPE files

The GMPE data files are provided from the ESA SST CCI webpages at: http://neodc.nerc.ac.uk/browse/neodc/esacci_sst/data/gmpe.

3.3.3 File description

The GMPE is formed of daily NetCDF files containing various fields including the median of the ensemble, the anomaly of each ensemble member from that median and the SST gradients from each product. Where we do not have permission to redistribute data, the anomaly and gradient fields are filled with the miss-

ing data indicator (which is found in the `_FillValue` attribute to the variables and is set to -32768). The `median_type` variable, which reveals which analysis supplied the median at each location, has also been filled with the missing data value.

File names for the GMPE files are in the form 20101231120000-UKMO-L4_GHRSST-SST-GMPEREAN-GLOB-v02.0-fv02.0.nc. The first eight digits give the year (first four digits) followed by the month and the day (two digits each). For the period June to August 2007 there are GMPE files that contain the ESA SST CCI demonstration product 1 in addition to the analyses compared over the full period of the long term product. These have `GLOB_DM` in their file names in place of `GLOB`.

Within the files the key variables are:

- *analysed_sst* The median of the ensemble of products.
- *standard_deviation* The standard deviation of the ensemble.
- *anomaly_fields* Anomalies relative to the median for each ensemble member.
- *gradient_fields* Gradients of the SST fields for each ensemble member.
- *lat* Latitudes of the grid points.
- *lon* Longitudes of the grid points.
- *analysis_number* The number of members of the ensemble that were available.
- *field_name* A list of the products that make up the ensemble.

3.3.4 Analyses contained in the GMPE

The GMPE files are composed of the products that are listed below. More details are given in the sections indicated.

- CMC (Section 3.3.4.1).
- ESA SST CCI level 4 data (Section 2).
- HadISST v2 (Section 3.3.4.2).
- MGDSSST (Section 3.3.4.3).
- MyOcean OSTIA reanalysis (Section 3.2.8)
- NOAA OI 0.25 degree AVHRR (Section 3.2.10).

3.3.4.1 Canadian Meteorological Center (CMC) reanalysis SSTs

Brief description	Global analysis of in situ observations using optimum interpolation. The in situ observations are first quality controlled and an attempt is made to remove biases in data from ships. The analysis is daily and is generated on a 0.9° grid.
Produced by	Bruce Brasnett (CMC)
Anomaly data provided in the GMPE files?	Yes.

Source of data (alternative download location)	Contact originator for information.
Where to find information about the data	http://journals.ametsoc.org/doi/abs/10.1175/1520-0426%281997%29014%3C0925%3AAGAOSS%3E2.0.CO%3B2
Citation for the data	Brasnett, Bruce, 1997: A Global Analysis of Sea Surface Temperature for Numerical Weather Prediction. J. Atmos. Oceanic Technol., 14, 925–937. doi: <a href="http://dx.doi.org/10.1175/1520-0426(1997)014<0925:AGAOSS>2.0.CO;2">http://dx.doi.org/10.1175/1520-0426(1997)014<0925:AGAOSS>2.0.CO;2

3.3.4.2 HadISST v2

Brief description	Global reconstructions of SST with uncertainties represented using an ensemble of realisations. Reconstructions are achieved using a variational Bayesian principal component analysis technique augmented by optimal interpolation to restore localised details.
Produced by	Met Office Hadley Centre.
Anomaly data provided in the GMPE files?	No.
Source of data (alternative download location)	Not currently available – see earlier version at http://www.metoffice.gov.uk/hadobs/hadisst/
Where to find information about the data	Not currently available – see earlier version at http://www.metoffice.gov.uk/hadobs/hadisst/
Citation for the data	Not applicable.

3.3.4.3 Merged satellite and in situ data Global Daily SSTs in the global ocean (MGDSST)

Brief description	Optimal interpolation analysis of in situ observations and AVHRR and AMSR-E satellite data. In situ SSTs are used to bias correct satellite data.
Produced by	JMA
Anomaly data provided in the GMPE files?	No.
Source of data (alternative download location)	Contact producer.
Where to find information about the data	http://goos.kishou.go.jp/rtrdb/mgdsst.html
Citation for the data	Obtain from originator.