

QUALITY INFORMATION DOCUMENT

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Global Ocean OSTIA Near Real Time Level 4 Sea Surface Temperature Product SST-GLO-SST-L4-NRT-OBSERVATIONS-010-001

Issue: 1.4

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CHANGE RECORD

Issue	Date	§	Description of Change	Author	Validated By
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1.1	26/02/2015	1, 11	Revision after V5 acceptance	A. McLaren et al.	
1.2	May 1 2015	all	Change format to fit CMEMS graphical rules		L. Crosnier
1.3	February 23 2016	II.4, V	Update for new data sources	E. Fiedler	B. Hackett
1.4	October 24 2016	II.4, II.5.2, V	Update reference instrument.	S. Good, C. Mao	B. Hackett

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EXECUTIVE SUMMARY

I.1 Products covered by this document

This document describes the quality of the global ocean near real time SST product (SST-GLO-SST-L4-NRT-OBSERVATIONS-010-001). This product is a daily analysis ('level 4') on a 0.05° grid, produced using the Operational SST and Ice Analysis (OSTIA) system (Donlon at al., 2012) at the Met Office.

Time period	1 st Jan 2007-Present
Spatial resolution	0.05°
Minimum to maximum Longitude	-180° to 180°
Minimum to maximum Latitude	-90° to 90°
Daily fields in principle dataset	analysed SST, sea ice area fraction, mask, SST analysis error

Table 1. Details of the global ocean near real time SST product (SST-GLO-SST-L4-NRT-OBSERVATIONS-010-001).

I.2 Summary of the results

The accuracy of the SST analysis product has been assessed using a comparison to drifting buoy and near surface (3-5m) Argo data. Drifting buoy data is used in producing the SST product and therefore is not an independent dataset. However, only a subset of the available drifter data is used for validation. Argo data is independent of this product, but has a reduced coverage compared to drifting buoys. The drifting buoy data assessment was carried out for 2012 (in common with previous OSI-TAC validation assessments); the Argo assessment was carried out for 2013.

The mean difference relative to drifter data is very small, with a global mean difference of 0.06 K and regional mean differences of less than 0.1 K except in the Mediterranean and Arctic regions which suffer from a lack of available observations. The standard deviation of differences is 0.40 K globally with regional values ranging from 0.28 K in the South Pacific to 0.89 K in the Mediterranean.

Similarly, the mean difference relative to Argo data is very small, with a global mean difference of -0.06 K and regional mean differences ranging from 0.00 K in the Tropical Pacific to -0.17 K in the Southern Ocean. The standard deviation of Argo differences is 0.46 K globally, with lowest values of 0.29 K in the Tropical Pacific and highest values of 0.59 K in the South Atlantic.

The independent Argo observations were also used to assess the analysis error estimates. The standard deviation of the differences to Argo were compared to the analysis error estimates at the

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matchup locations. Results suggest that the analysis error is underestimated in all regions compared to Argo. However, this is contrary to a separate study which found that OSTIA reanalysis error estimates compared well with drifting buoy differences (Corlett et al., 2014) as discussed further in section IV.3. Further work is required to examine the difference in the methodologies for assessing the error estimates before a firm conclusion on the accuracy of the analysis error estimates can be provided.

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I.3 Estimated Accuracy Numbers

Global estimated accuracy numbers are provided for 2012 based on a comparison with drifting buoy data supplied by the MyOcean in-situ TAC.

Product name	Mean difference (K)	RMS difference (K)
SST_GLO_SST_L4_NRT_OBSERVATIONS_010_001 (OSTIA)	0.06	0.40

Table 2. Global difference statistics between SST analysis product and drifting buoy observations for 2012.

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II PRODUCTION SUBSYSTEM DESCRIPTION

II.1 Production centre

Met Office

II.2 Production subsystem

Operational SST and Ice Analysis (OSTIA) system

II.3 Product description

The level 4 product is a satellite and in-situ foundation SST analysis created by the OSTIA (Operational SST and Ice Analysis) system. The product is created daily on a global regular grid at 0.05° resolution and data is available back to 1st January 2007. The OSTIA product provides an estimate of the foundation SST which is the SST free of diurnal variability. In addition to the foundation SST the daily product contains sea ice fraction, land/sea ice/lake mask and an estimate of the SST analysis error.

The product also contains four additional datasets derived from the daily analysis fields. These are on a lower resolution grid (0.25° resolution) and consist of:

- Daily anomalies relative to the Pathfinder climatology
- Daily satellite SST bias fields
- Monthly means of the daily SST analysis
- Seasonal means of the daily SST analysis

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II.3.1 SST Level 4 reprocessing Chain and Algorithms

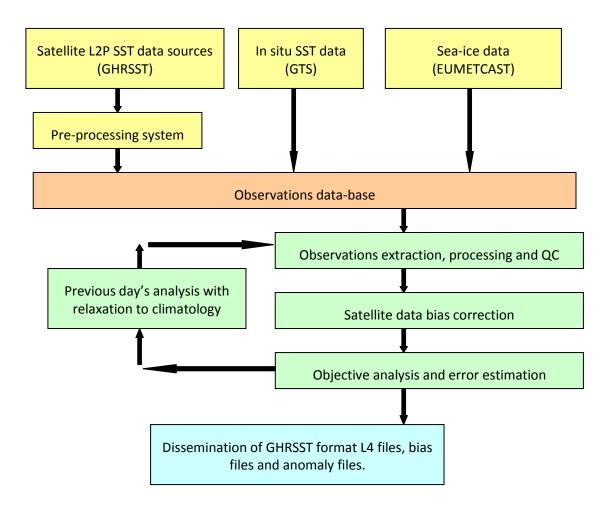


Figure II.1: Schematic diagram of the operational OSTIA processing chain at the Met Office.

The Operational Sea surface Temperature and Ice Analysis (OSTIA) system is run daily in the operational suite at the Met Office. Products are available to users by 08:00 UTC.

Figure II.1 shows the different steps for the creation of the OSTIA products at the Met Office. Each step of this processing is described below. Further information is contained in Donlon et al. (2012).

II.4 Collection of inputs

The following inputs are collected for input to OSTIA:

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SST satellite data: The original L2P data from different producers (including NASA, NOAA, IFREMER, EUMETSAT OSI-SAF, ESA) in GHRSST compliant format are collected. Currently the format of the collected data is a combination of GHRSST GDS V1.6 **[RD-3]** and the new GHRSST GDS V2.0 **[RD-4]** formats.

All L2P data are provided with Sensor Specific Error Statistics (SSES_bias and SSES_std variables) that give an estimate of the systematic and random errors at pixel level. In addition, quality level flags are provided.

The L2P data used in OSTIA include: infra-red data from the AVHRR instruments on board NOAA, MetOp-A and MetOp-B satellites, IASI data on MetOp-A (prior to 29th September 2014), SEVIRI on board the MSG-3 satellite, GOES Imager data on board the GOES-13 satellite, AATSR on board ENVISAT (prior to 8th April 2012) and VIIRS data on board Suomi NPP (after 15th March 2016). Microwave data from the TMI instrument on board TRMM (prior to 14th February 2015), the AMSR-E instrument on board Aqua (prior to 4th October 2011) and the AMSR2 instrument on board GCOM-W1 (after 15th March 2016) are also used.

In situ SST data from ships, drifting and moored buoys are used in OSTIA.

Ice concentration data from the EUMETSAT OSI-SAF are used in OSTIA for the ocean. Since mid-April 2013 NCEP data have also been used for ice in inland waters.

Climatologies: the SST climatology used in the OSTIA background relaxation step has been derived from the OSTIA reanalysis (SST-GLO-SST-L4-REP-OBS-010-011), produced as part of MyOcean. The SST climatology used in generating the anomaly fields is the Pathfinder climatology.

Lake Surface Water Temperature (LSWT) data is available within the GHRSST L2P files from NOAA, MetOp-A and MetOp-B AVHRR instruments, AATSR (prior to 8th April 2012), and MetOp-A IASI (prior to 14th February 2015). These data are processed by the data providers using the SST algorithms rather than lake-specific algorithms (which take into account the emissivity and altitude of the lakes) and are therefore less accurate than the data over the open ocean. In situ data over lakes are also available over the GTS, mainly for the Great Lakes.

II.5 Algorithms for L4 production

II.5.1 Quality control and pre-processing of input data

All satellite and in situ SST data valid for a particular day, with a 6-hour overlap on the days either side, are extracted from the Met Office observations data-base. The input SST data undergo various QC and processing steps:

- only satellite data which have a quality flag of 4 and higher are accepted, except for AATSR data where only data of quality 5 are accepted.
- a Bayesian statistical check against the background field is carried out for all input data using the same error covariance information used to perform the objective analysis later in the process.
- a diurnal check is carried out whereby day-time data (determined using a solar zenith angle calculation) with a wind-speed of less than 6m/s are rejected.

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• the SSES biases supplied with the GHRSST data are removed from each pixel and the SSES standard deviation values are passed on to the next steps in the analysis chain.

• for the AATSR data, a skin-to-bulk correction factor is applied.

II.5.2 Bias correction of input satellite data

Satellite data can be biased for several reasons, including: atmospheric water vapour; atmospheric aerosol (dust); surface changes (e.g. extreme roughness); instrument calibration problems. These biases can lead to biases in the analysis if they are not treated in some way. OSTIA uses a bias correction system based on match-up statistics between satellite and reference measurements (which are assumed to be unbiased). The reference data-set is currently specified to be all in situ data and a high quality satellite dataset. Prior to 8th April 2012 AATSR data was included in the reference data-set. After 17th January 2013, a high-quality subset of MetOp-A AVHRR data was used,. From 8th November 2016 nighttime VIIRS SSTs were used for the bias correction. For each satellite observation type to be calibrated:

- match-ups are calculated between each reference data point and the satellite data-set (valid on the same day) with a spatial radius of 25 km.
- A large scale objective analysis is calculated for each satellite observation type using the match-ups as pseudo-observations of the bias, and a background from the previous day's bias analysis. The horizontal correlation scales are set to be 700 km for this bias analysis.
- The bias analysis field is interpolated back to the satellite observation locations, and the bias is subtracted from the satellite observation.

The outcome of this process is a new version of the L2 satellite data, which has been bias-corrected.

II.5.3 Creation of the L4 analysis and error estimate

• The main SST analysis uses a persistence based approach using the previous analysis field as a **background with a relaxation to climatology**. The background field ** at grid point ** and time ** is defined as

$$x_{i,k}^{b} = \lambda_{i,k} \left(x_{i,k-1}^{a} - x_{i,k-1}^{c} \right) + x_{i,k}^{c}$$
 (1)

where $\frac{1}{2}$ is a scalar less than 1, $\frac{1}{2}$ is the previous analysis, and $\frac{1}{2}$ is a reference climatology valid for the same time of year as time $\frac{1}{2}$. For each grid point and at each analysis time, a relaxation time scale is derived in order to determine $\frac{1}{2}$. For ice-free areas this time scale is 30 days. SSTs under ice are relaxed toward 271.35 K with a shorter time scale which varies from 17.5 days to ~5 days linearly with ice concentration from 50% to 100%. A digital Gaussian filter with a half-width of 4.7 km is applied to the background field to remove small scale noise.

 The background field calculated using equation (1) and the bias corrected measurements (described previously) are then used to produce an analysis using a multi-scale Optimal Interpolation (OI) type scheme. An iterative procedure is used to calculate the OI solution that is both efficient and flexible when processing large numbers of observations.

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• The **background error covariance matrix** is split into two components. Prior to 17th January 2013, one component had spatial correlation scales specified as 10 km and the other had spatial correlation scales of 100 km. Both components of the error had spatially varying variances. On 17th January 2013 the background error covariances were improved; both components of the background error variance fields now vary seasonally and the spatial correlations length scales are anisotropic and vary latitudinally. The shorter (mesoscale) length scales vary from 15 km to 40 km while the longer (synoptic) length scales vary from 200 km to 450 km.

- The observation error covariance matrix is assumed to be a diagonal matrix (observation
 errors are uncorrelated with each other). The diagonal elements are specified using the SSES
 standard deviation values supplied with the GHRSST data. For in-situ data the diagonal
 elements are spatially varying observation errors that are specified a priori.
- The observation operator is used to transform from the analysis grid to observation space. A number of different observation operators have been developed for use in OSTIA in order to represent the full range of satellite observation footprints. In the case of microwave data for instance, the observation footprint is larger than the model grid, and the background gridded values which fall within the observation footprint are used to estimate the model equivalent of the observation.
- Each SST analysis value is accompanied by an uncertainty estimate, known as an analysis error. Various methods of approximating analysis error exist. The OSTIA system uses an analysis quality (AQ) optimal interpolation approach to produce this estimate. In this scheme, a second optimal interpolation analysis is performed that is identical to the main SST analysis except that all observations are given a value of 1.0, the background field is set to zero. The error estimates used in the main analysis (background & observational) are preserved. This field is then combined with the background error variance estimates described above to produce an analysis error estimate at each grid point.

II.5.4 Creation of the anomaly field

The SST analysis field described in the previous section is interpolated to a ¼ degree latitude/longitude grid. The Pathfinder climatology for the relevant date (derived from the PATHFINDER SST 5-daily climatology produced by Casey and Cornillon, 1999) is then subtracted to produce an anomaly field.

II.5.5 Creation of the monthly and seasonal mean fields

At the end of each month, a monthly mean of the daily L4 analyses is produced. Similarly, seasonal means are produced at the end of each season, with seasons defined as: December-February; March-May; June-August; September-November. The daily SST analyses are first interpolated to a ¼ degree latitude/longitude grid and then the mean values are calculated. The standard deviation of the daily SST analyses over the month or season is also calculated and provided in the mean files.

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III VALIDATION FRAMEWORK

An independent data source should be used to assess the true accuracy of an analysis. However, to deliberately withhold available data from an analysis can impact on the accuracy of the final product. This makes the validation of an SST reanalysis very challenging. Therefore, in this validation study, two assessments of the accuracy of the SST analysis are made. The first is to a subset of available drifting buoys which are not independent (because they are assimilated into the analysis), but have a good spatial coverage and have been used to validate other OSI-TAC products (so this allows easy comparison of accuracy between products). The second is to near-surface Argo data which are independent of the analysis (i.e. Argo data are not assimilated), but offer a reduced number of observations relative to drifting buoys.

The analysis product includes an uncertainty estimate which is also validated here. The validation compares the uncertainty values to the differences between near surface Argo data and the analysis.

III.1 Drifting buoy comparison

This validation study uses drifting buoy measurements provided by the MyOcean IN-situ TAC for the year 2012. These measurements are a subset of the in-situ measurements that are used in the OSTIA processing. The analysis minus observation differences are calculated by bi-linearly interpolating the analysis to the observation locations for that day. The mean and standard deviation of these differences are then averaged globally and over various regions (as shown in figure III.1).

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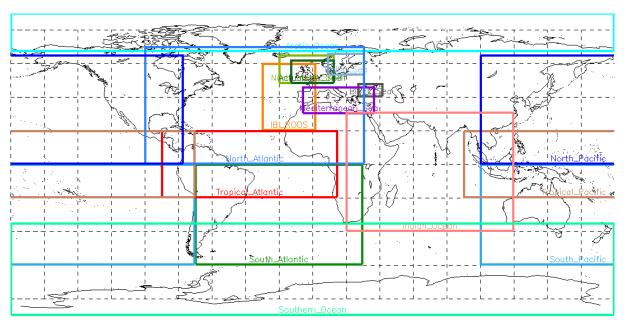


Figure III.1: Geographical regions used in the validation

III.2 Near-surface Argo comparison

Argo data have a high level of accuracy with an uncertainty value of 0.005 K (Oka and Ando, 2004) and although the Argo data coverage is less than drifting buoys, Argo floats now cover the majority of the world's oceans. Argo data has also been shown to agree well with drifting buoy data (e.g. Figure 1 in Fiedler et al., 2014). Near-surface Argo data has also previously been used to validate SST products (e.g. Martin et al., 2012; Corlett et al., 2014; Fiedler et al., 2014).

The accuracy of the analysis is assessed by comparison to Argo data using the shallowest available observations between 3-5m depth for the year 2013. The Argo data used here were obtained from the EN4 data-set (www.metoffice.gov.uk/hadobs/en4); Good et al., 2013). The analysis was bilinearly interpolated to the Argo data locations. The mean and standard deviation of the Argo minus analysis differences were then calculated for the whole globe and over various ocean regions (as defined in figure III.1).

III.3 Analysis error validation

The standard deviation of the Argo minus analysis differences described above in section III.2 is also used to validate the analysis error estimate. The analysis error estimate was interpolated to the Argo data locations. Comparisons were made with the standard deviations for the whole globe and over various ocean regions. The analysis error estimates were also binned based on the magnitude of the analysis error and the standard deviation of the matchups corresponding to these estimates was

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found. Data between 5 February 2014 and 30 November 2014 were used in order to validate the newest implementation of the analysis error estimate calculation.

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IV VALIDATION RESULTS

IV.1 Drifting buoy comparison

Table IV.1 details the mean and standard deviation of the analysis minus drifting buoy differences for the whole globe and for individual ocean regions. The mean difference is less than 0.1 K in all regions except the Mediterranean and Arctic regions which suffer from a lack of available observations. The standard deviation varies between regions with the lowest value (suggesting highest accuracy) in the South Pacific and higher values in the North Atlantic and the Mediterranean.

Region	Mean difference (K)	Standard deviation of differences (K)	Number of observations
Global	0.06	0.40	7886293
Mediterranean	0.11	0.89	153646
North Atlantic	0.06	0.47	2290814
Tropical Atlantic	0.06	0.40	443619
South Atlantic	0.06	0.36	994086
North Pacific	0.04	0.36	1581671
Tropical Pacific	0.06	0.35	1162456
South Pacific	0.06	0.28	1669106
Indian Ocean	0.07	0.45	684185
Southern Ocean	0.06	0.33	1342172
Arctic	0.17	0.40	153676
North West Shelf	0.08	0.32	132256

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IV.2 Table IV.1: Global and regional mean (OSTIA minus observations) and standard deviation differences between OSTIA and drifting buoy data (from the MyOcean IN-Situ TAC) for 1 Jan 2012 to 31 Dec 2012.Near-surface Argo comparison

Table IV.2 details the mean and standard deviation of the analysis minus Argo differences for the whole globe and for individual ocean regions. Note that the Arctic and North West Shelf regions are not included in table IV.2 due to the lack of Argo observations in these regions. The results for the Mediterranean should also be treated with caution due to the low number of observations in the comparison.

The global statistics are comparable to the drifting buoy comparison with a small mean difference and a standard deviation of less then 0.5 K. The regional breakdown shows that some regions are more accurate than others, with the South Atlantic being the region with the poorest accuracy in this comparison.

Region	Mean difference (K)	Standard deviation of differences (K)	Total number of observations
Global	-0.06	0.46	87947
Mediterranean Sea	0.01	0.35	1768
North Atlantic	-0.09	0.45	15299
Tropical Atlantic	-0.12	0.33	6155
South Atlantic	-0.11	0.59	7797
North Pacific	-0.05	0.50	27329
Tropical Pacific	0.00	0.29	23771
South Pacific	-0.03	0.37	22581
Indian Ocean	-0.02	0.36	14960
Southern Ocean	-0.17	0.55	16931

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IV.3 Table IV.2: Global and regional mean (analysis minus observation) and standard deviation of differences between the OSTIA and near surface Argo data (from the EN4 dataset) for 1 Jan 2013 to 31 Dec 2013. Analysis error validation

Table IV.3 details the standard deviation of the analysis minus Argo differences for the whole globe and for individual ocean regions for 5 February to 30 November 2014. Also shown is the mean OSTIA analysis error estimate at the observation locations. These dates were chosen in order to validate the most recent data after a correction to the analysis error estimate calculation was implemented. Note that the Arctic and North West Shelf regions are not included in table IV.3 due to the lack of Argo observations in these regions. The results for the Mediterranean should also be treated with caution due to the low number of observations in the comparison. The results demonstrate that globally and in all regions the OSTIA analysis error is underestimated compared to the Argo matchup standard deviations.

Region	Argo – OSTIA standard deviation (K)	Mean OSTIA analysis error (K)	Difference (K)	Total number of observations
Global	0.472	0.260	0.212	79550
Mediterranean Sea	0.419	0.308	0.111	1844
North Atlantic	0.535	0.279	0.256	14405
Tropical Atlantic	0.431	0.220	0.211	6557
South Atlantic	0.563	0.282	0.281	6498
North Pacific	0.463	0.271	0.192	28437
Tropical Pacific	0.305	0.214	0.091	21807
South Pacific	0.384	0.222	0.162	20178
Indian Ocean	0.376	0.235	0.141	9538
Southern Ocean	0.531	0.306	0.225	15321

Table IV.3: Global and regional standard deviation of differences between OSTIA and near-surface Argo data (from the EN4 dataset) with mean OSTIA analysis error at Argo locations, for 5 Feb 2014 to 30 Nov 2014.

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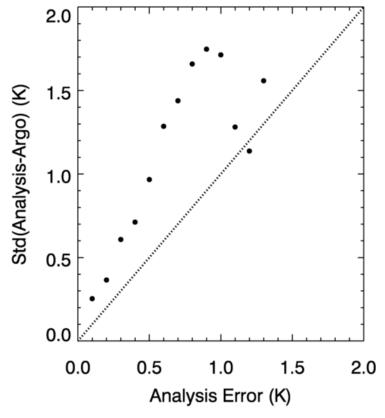


Figure IV.3: Standard deviation of OSTIA and Argo SST differences with OSTIA analysis error at Argo locations in 0.1 K bins, 5 Feb 2014 to 30 Nov 2014. Dashed line is 1:1 relationship and assumes error in Argo observations is 0.0 K or negligible.

For Figure IV.3 the analysis error data is binned and compared with the standard deviation of matchups at the locations of the data within the bins. Figure IV.3 indicates that there is some correspondence between the analysis error and the Argo matchup differences with the analysis error generally increasing with increasing Argo difference. However, the analysis error is underestimated compared to Argo matchups at all magnitudes of the analysis error.

It should be noted that this finding is contrary to the findings of the ESA SST Climate Change Initiative (CCI) project which showed that the error estimates from the L4 product (which was generated with a reanalysis version of the OSTIA system) agreed well with drifting buoy matchup differences (Corlett et al., 2014). However, the SST CCI assessment compared the *robust* standard deviation of the drifting buoy matchup differences rather than the standard deviation as used in the above plot. It was possible to use drifting buoy data in SST CCI comparison as this data source was not used in generating the SST CCI L4 product and as such was an independent data source. The analysis error estimates in the near-real time product and the SST CCI analysis product are expected to be very similar. Therefore, further work is required to examine the difference in the methodologies for assessing the error estimates before a firm conclusion on the accuracy of the analysis error estimates can be provided.

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V QUALITY CHANGES SINCE PREVIOUS VERSION

OSTIA system changes (post-2012) which have had a significant impact on accuracy or the product contents:

8th April 2012:

Loss of AATSR on board ENVISAT, which had previously been used in the analysis and as a reference dataset to bias correct other input satellite data. In a test for March 2012, withholding AATSR data caused the global standard deviation of Argo –OSTIA differences to increase from 0.47 K to 0.53 K.

17th January 2013:

A number of improvements were made to improve the accuracy of the product and the feature resolution. The changes were:

- Update of the background error covariances in the OSTIA system:
 - New updated seasonal background error variances are used for both the mesoscale and synoptic scale components of the background errors.
 - Latitudinally varying anisotropic correlation length scales are used.
 - o For in situ observations, type dependant measurement errors have been implemented which are added to spatially varying representivity errors.
 - The number of iterations of the assimilation has been increased from 10 to 100 iterations to ensure convergence.
 - The change increases the accuracy of the OSTIA SST analysis globally and regionally with respect to both assimilated (drifter and AATSR) data and with respect to independent ARGO observations. The table below presents global RMSE (in K), except for ARGO statistics which are standard deviation (in K), for March 2012. (The bias values are shown in brackets.) The feature resolution of the SST analysis has also improved due to the updates to error covariance parameters.

Validation type	OSTIA Control	OSTIA Updated
Drifter o-b	0.52 (-0.01)	0.37 (0.00)
AATSR o-b	0.45 (0.04)	0.37 (0.03)
ARGO o-a	0.47 (0.03)	0.43 (0.04)

The new estimates result in longer correlation length scales in the SST analysis. This causes information from SST observations to propagate further under the sea-ice and affects the consistency between the SST and sea-ice fields. However, overall the new background error estimates improve the OSTIA SST analysis in the Arctic (with the drifter o-b RMSE decreasing from 0.58 K to 0.45 K).

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• The reference data set used for the bias correction of the satellite data was expanded to include a subset of the most accurate MetOp AVHRR SST data (based on low satellite zenith angle). This replaces AATSR data which was included in the reference data set prior to its loss on 8th April 2012. The use of a subset of MetOp AVHRR data together with the in-situ data as a reference dataset increases the accuracy of the OSTIA SST analysis globally and regionally with respect to independent ARGO observations; the global standard deviation for March 2012 decreased from 0.53 K to 0.50 K.

- Change in the minimum quality flag of the geostationary satellite SST data used in the OSTIA
 analysis (SEVIRI/MSG data; GOES-E data). This change is negligible in terms of the global and
 regional RMSE and mean bias validation statistics of the OSTIA analysis. Using data flagged as
 lower quality increases the data coverage of the geostationary satellite observations which
 improves the SST locally. Of particular relevance to European users is the improved SEVIRI
 coverage on the North West European Shelf.
- Set a minimum SST on the OSTIA SST analysis. This change will have negligible impact in terms of the global and regional RMSE and mean bias validation statistics of the OSTIA analysis. It will however stop negative increments pushing the analysed SST below a minimum temperature (set as -2°C).

17th April 2013:

Lake ice was added to OSTIA ice field using NCEP data for ice in inland waters. This change includes a slight relaxation to 0°C under lake ice but otherwise there is no effect on global ocean SST.

11th November 2013:

A change was made to the OSTIA system to routinely produce monthly and seasonal mean files of the L4 product.

5th February 2014:

A change was made to OSTIA to correct the computation of the analysis error estimates in the system. This fixes a problem in the system that was present during the period 17 Jan 2013 to 4 Feb 2014 and will have caused the analysis error to be overestimated during this time. The SST analysis and sea ice fields were unaffected by this correction.

23rd February 2016:

The high quality subset of MetOp-A AVHRR observations used in the bias correction reference dataset was updated to MetOp-B AVHRR due to an upstream change in data availability.

15th **March 2016:** Two new global SST datasets were included in the OSTIA analysis: an infra-red dataset from the VIIRS instrument and a microwave dataset from the AMSR2 instrument. The inclusion of these datasets has led to an improvement in the OSTIA analysis accuracy. The table below shows a comparison between accuracy statistics for the old and updated analyses for January 2016, using near surface Argo observations (from the EN4 database) as a reference.

8th November 2016: Nighttime ACSPO VIIRS SST product is used in OSTIA for as the satellite reference for the bias correction, replacing MetOp-A AVHRR data. From the test run over the period of 09 December 2015 – 11 January 2016, this change has led to an improvement if the OSTIA analysis accuracy. Table V.2 shows a comparison between the accuracy statistics for the old (Control) and

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updated (VIIRSG_ref) analyses for the test period, using near surface Argo observations (from the EN4 database) as a reference.

Dogion	Mean dif	ference (K)	Standard o	Total number	
Region	Old analysis	with VIIRS and AMSR2	Old analysis	with VIIRS and AMSR2	of Argo observations
Global	0.12	0.11	0.49	0.42	9580
North Atlantic	0.23	0.21	0.60	0.47	1720
Tropical Atlantic	0.14	0.14	0.27	0.25	837
South Atlantic	0.02	0.03	0.60	0.50	727
North Pacific	0.20	0.17	0.47	0.41	2973
Tropical Pacific	0.08	0.06	0.32	0.27	2479
South Pacific	0.03	0.03	0.40	0.35	2696
Indian Ocean	0.04	0.05	0.34	0.30	1316
Southern Ocean	0.07	0.06	0.52	0.45	2172

Table V.1: Global and regional mean (analysis minus observation) and standard deviation of differences between near surface Argo data (from the EN4 dataset) and the old and updated OSTIA analyses for January 2016.

Region	Mean difference (K)		Standard d differer	Total number of Argo	
	Control	VIIRSG_ref	Control	VIIRSG_ref	observations
Global	0.12	0.06	0.44	0.40	10432

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North Atlantic	0.22	0.05	0.46	0.45	1929
Tropical Atlantic	0.17	0.11	0.23	0.21	899
South Atlantic	0.08	0.08	0.48	0.45	798
North Pacific	0.20	0.09	0.49	0.46	3384
Tropical Pacific	0.08	0.07	0.25	0.21	2707
South Pacific	0.03	0.07	0.32	0.29	2796
Indian Ocean	0.03	0.09	0.29	0.27	1296
Southern Ocean	0.07	0.04	0.45	0.43	2182

Table V.2: Global and regional mean (analysis minus observation) and standard deviation of differences between near surface Argo data (from the EN4 dataset) and the old and updated OSTIA analyses for 09 December 2015 – 11 January 2016.

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