PRODUCT USER MANUAL

For Reprocessed Level 4 SST products over the Mediterranean and Black Seas

SST_MED_SST_L4_REP_OBSERVATIONS_010_021

SST_BS_SST_L4_REP_OBSERVATIONS_010_022

Issue: 1.4

Contributors: Bruno Buongiorno Nardelli (CNR), Andrea Pisano (CNR), Cristina Tronconi (CNR).

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CHANGE RECORD

Issue	Date	§	Description of Change	Author	Validated By
1.0	5 May 2014	All	First version of document	B.Buongiorno Nardelli	L. Crosnier
1.1	May 1 2015	All	Change fomat to fit CMEMS graphical rules		L. Crosnier
1.2	January 2015	All	Rebranded from MyOcean to CMEMS	B. Buongiorno Nardelli	
1.3	26/08/2016	All	Added description of interim REP data for recent years	B.Buongiorno Nardelli, A. Pisano, C.Tronconi	
1.4	12/09/2018	All	Update to Pathfinder V.5.3	B.Buongiorno Nardelli, A. Pisano, C.Tronconi	

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GLOSSARY AND ABBREVIATIONS

MFC	Monitoring and Forecasting Centre
Med	Mediterranean
NetCDF	Network Common Data Form
CF	Climate Forecast (convention for NetCDF)
SSS	Sea surface salinity.
SSC	Sea surface currents
SSH	Sea surface height
RMS	Root mean square
SDN	SeaDataNet (climatology)
CHL	Chlorophyll
SLA	Sea Level Anomalies
PC	Production Center
PU	Production Unit
Meridional Velocity	West to East component of the horizontal velocity vector
Zonal Velocity	South to North component of the horizontal velocity vector
ftp	Protocol to download files
OpenDAP	Open-Source Project for a Network Data Access Protocol. Protocol to download subset of data from a n-dimensional gridded dataset (ie: 4 dimensions: lon-lat,depth,time)
Subsetter	CMEMS service tool to download a NetCDF file of a selected geographical box using values of longitude an latitude, and time range
Directgetfile	CMEMS service tool (FTP like) to download a NetCDF file

I INTRODUCTION

I.1 Scope

This document describes the Reprocessed Mediterranean Sea (REP MED) and Black Sea (REP BLK) L4 SST products.

I.2 Purpose

This document provides to CMEMS users practical information on the REP MED and REP BLK L4 SST products provided by the CNR-ISAC-GOS (Consiglio Nazionale delle Ricerche, Istituto di Scienze dell'Atmosfera e del Clima - Gruppo di Oceanografia da Satellite, Italy).

REP MED and REP BLK L4 SST data correspond to daily (nighttime) gridded optimally interpolated satellite estimates of the foundation SST over the Mediterranean Sea and Black Sea, based on the new AVHRR Pathfinder Version 5.3 (PFV53) dataset produced by the NOAA National Centers for Environmental Information (NCEI) (https://data.nodc.noaa.gov/cgi-bin/iso?id=gov.noaa.nodc:AVHRR_Pathfinder-NCEI-L3C-v5.3) for the period 1981-2014 and on a bias-corrected version of the CMEMS NRT UHR L4 data for the period 2015-2017 (SST-MED-SST-L4-NRT-OBSERVATIONS-010-004, SST-BS-SST-L4-NRT-OBSERVATIONS-010-006), hereafter recalled as *Interim* REP L4 data. The PFV53 data are an updated version of Pathfinder Version 5.2 in **[RD-11]**. REP MED and BLK L4 were interpolated on the original Pathfinder grid (at 4 km x 4 km spatial resolution) and are representative of night SST values (00:00 UTC). They extend and improve previous reprocessed L4 datasets based on 1985-2005 Pathfinder V4 (described in **[RD-3]** and **[RD-6]**). Section III describes in better detail the processing steps and the algorithms used to obtain the REP MED and BLK L4 SST products.

Some general characteristics of the products and datasets are given in section IV, the detailed description of the netCDF format used being provided in Annex 1.

Section V provides information on the access to archived products.

II HOW TO DOWNLOAD A PRODUCT

II.1 Download a product through the CMEMS Web Portal Ftp Service

You first need to register. Please find below the registration steps: http://marine.copernicus.eu/web/34-products-and-services-faq.php#1

Once registered, the CMEMS FAQ http://marine.copernicus.eu/web/34-products-and-services-faq.php will guide you on how to download a product through the CMEMS Web Portal FTP Service.

II.2 Download a product through the CMEMS Web Portal Direct Get File Service

You first need to register. Please find below the registration steps: http://marine.copernicus.eu/web/34-products-and-services-faq.php#1

Once registered, the CMEMS FAQ http://marine.copernicus.eu/web/34-products-and-services-faq.php will guide you on how to download a product through the CMEMS Web Portal Direct Get File Service.

II.3 Download a product through the CMEMS Web Portal Subsetter Service

You first need to register. Please find below the registration steps: http://marine.copernicus.eu/web/34-products-and-services-faq.php#1

Once registered, the CMEMS FAQ http://marine.copernicus.eu/web/34-products-and-services-faq.php will guide you on how to download a product through the CMEMS Web Portal Subsetter Service.

III APPLICABLE AND REFERENCE DOCUMENTS

III.1 Reference Documents

Ref.	Document Name	Document Reference	Issue	Date
[RD-1]	FP7 call : WORK PROGRAMME 2007 COOPERATION **THEME 9 : SPACE**			
[RD-2]	**DRAFT GUIDE FOR APPLICANTS** *Theme 9: SPACE* COLLABORATIVE PROJECT *Call identifier: FP7-SPACE-2007-1*			
[RD-3]	**Observing The Mediterranean Sea from Space: 21 years of Pathfinder-AVHRR Sea Surface Temperatures (1985 to 2005). Re-analysis and validation.** Marullo S., B. Buongiorno Nardelli, M. Guarracino, and R. Santoleri	Ocean Sci., 3, 299-310, doi:10.5194/os-3-299-2007		2007
[RD-4]	**The Recommended GHRSST Data Specification (GDS) Revision 2.0.5** GDS 2.0.5 Technical Specifications https://www.ghrsst.org/files/download.php?m=documents&f=121009233443-GDS20r5.pdf	GHRSST Data Specification (GDS) GDS 2.0 revision 5		October 2012
[RD-5]	**Diurnal variations in AVHRR SST fields: a strategy for removing warm layer effects from daily image** Buongiorno Nardelli B., Marullo S. and R Santoleri	Rem. Sens. Env., 95, 47-56, doi:10.1016/j.rse.2004.12.005.		2005
[RD-6]	**A re-analysis of Black Sea Surface Temperature** Buongiorno Nardelli B., S. Colella, R. Santoleri, M. Guarracino, A. Kholod	J. Mar. Sys., 79, 1-2, 50-64, doi:10.1016/j.jmarsys.2009.07.001		2010

[RD-7]	**High and Ultra-High resolution processing of satellite Sea Surface Temperature data over Southern European Seas in the framework of MyOcean project** Buongiorno Nardelli B., C.Tronconi, A. Pisano, R.Santoleri,	Rem. Sens. Env.,129, 1–16, doi:10.1016/j.rse.2012.10.012.		2013
[RD-8]	**Evaluation of different covariance models for the operational interpolation of high resolution satellite Sea Surface Temperature data over the Mediterranean Sea** Buongiorno Nardelli, B.,A. Pisano, C. Tronconi, and R. Santoleri	Remote Sens. Environ., doi:10.1016/j.rse.2015.04.025.		2015
[RD-9]	**Gaussian Processes for Machine Learning, Chapter 4: Covariance functions**. Rasmussen C. E. & C. K. I. Williams	The MIT Press, ISBN 026218253X		2006
[RD-10]	**Three-Way Error Analysis between AATSR, AMSR-E, and In Situ Sea Surface Temperature Observations**. O'Carroll, A. G., J. R. Eyre, R. W. Saunders.	*J. Atmos. Oceanic Technol*., 25, 1197–1207, doi:10.1175/2007JTECHO542.1.		2008
[RD-11]	**"The Past, Present and Future of the AVHRR Pathfinder SST Program"** Casey, K.S., T.B. Brandon, P. Cornillon, and R. Evans.	*Oceanography from Space: Revisited, eds. V. Barale, J.F.R. Gower, and L. Alberotanza, Springer.* DOI: 10.1007/978-90-481-8681-5_16.		2010
[RD-12]	**CMEMS PRODUCT USER MANUAL For SST products over the Mediterranean and Black Seas** B.Buongiorno Nardelli, C. Tronconi, A. Pisano	CMEMS-OSI-PUM-010-004- -006-012-013 Issue: 4.2		September 2015

[RD-13]	**The new Mediterranean optimally interpolated pathfinder AVHRR SST Dataset (1982–2012).** Pisano, A., Buongiorno Nardelli, B., Tronconi, C. & Santoleri, R.	*Rem. Sens. Env*. 176, 107–116, doi:10.1016/j.rse.2016.01.019		2016

Table 1: Reference documents

IV SST LEVEL 4 PROCESSING CHAIN AND ALGORITHMS

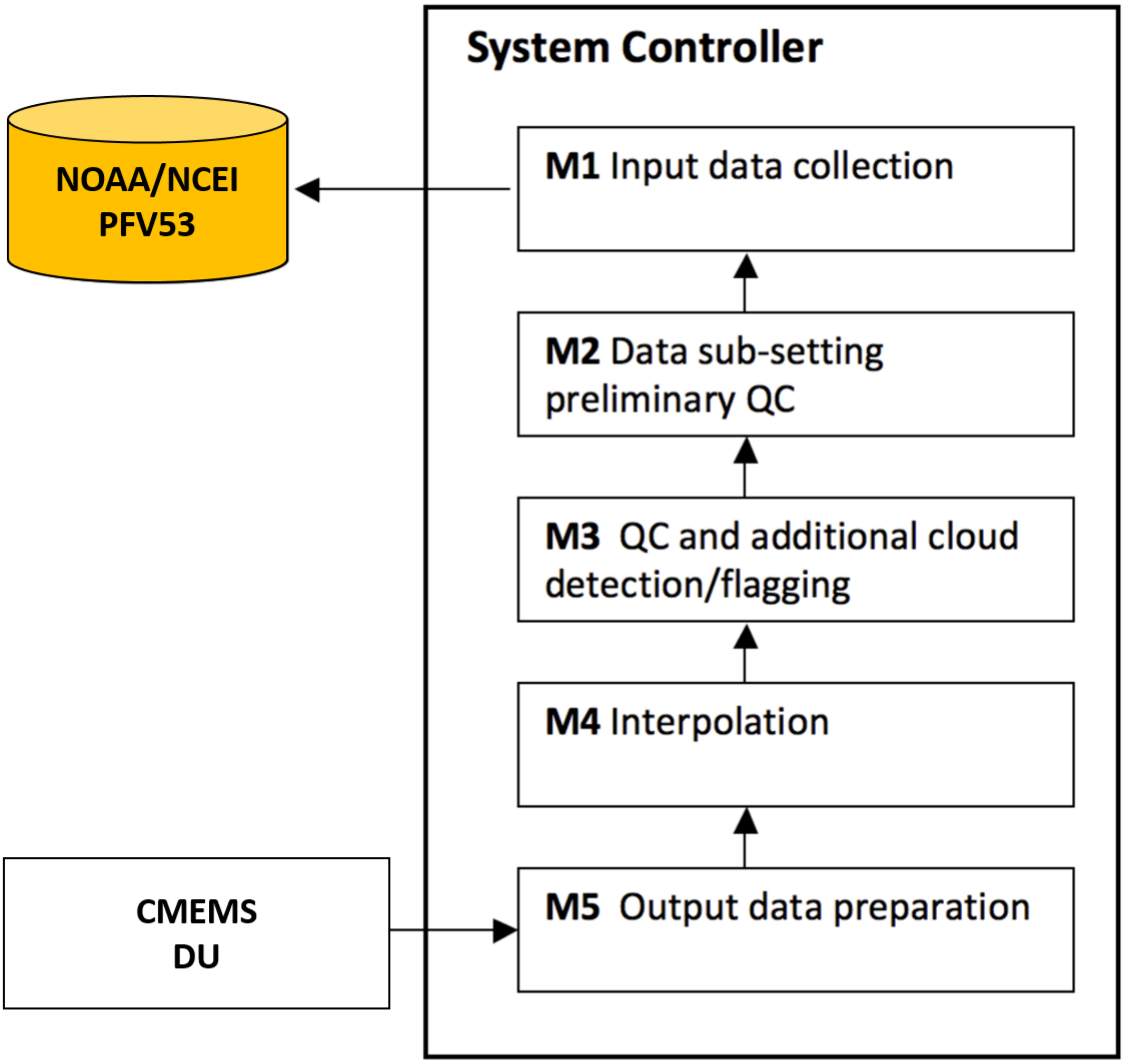

Figure 1. Schematic diagram of the processing chain used at GOS-ISAC-CNR for REP products.

The interpolation of PFV53 data (1981-2014) to L4 has been carried out by adapting CNR-ISAC-GOS near-real-time (NRT) SST processing chain **[RD-12]** to the PFV53 dataset (Fig. 1), and choosing the proper covariance models for each area, as fully described in **[RD-13]**. As Pathfinder has not yet released an update of its product, the standard REP data end in 2014. To provide an *Interim* REP product up to 2017, we thus followed this strategy:

1. Downsize the MED/BLK NRT UHR L4 (1 km) product to the MED/BLK REP L4 grid resolution (4 km);

2. Estimate the differences in terms of bias and root mean square difference (RMSD) between the two products for the overlap period (2008-2014);

3. Perform a local bias correction of the NRT products from 2015 to 2017;

4. Extend the REP L4 time series to 2017.

The NRT chain is organized in seven modules/packages (M1-7), which are managed through a specific System Controller. Here, only the first six modules have been used and the System Controller, generally governing the sequence of Near Real Time (NRT) operations, has been simplified to run as a 'one-shot' processing. All the main processing modules (M1-M4) are described hereafter as 'logical' steps (Fig. 1), even though some of them (M1-M2-M3) have been greatly simplified with respect to the NRT chain, considering that PFV53 data are already available as collated (merged) daily images, namely as GHRSST L3C (see **[RD-4]** for more details on L3C data), and (super) collation of data is thus not needed.

IV.1 M1 Collection of inputs

This module manages the external interface to the National Oceanographic Data Centre of NOAA (National Oceanic and Atmospheric Administration), providing access to the Pathfinder data and the internal input data archive. It was configured to collect only nighttime PFV53 L3C data, available from 25 August 1981 to 31 December 2014.

All L3C data are provided with additional information, including quality level flags and cloud flags (see **[RD-4]**).

IV.2 Algorithms

IV.2.1 L3C data extraction, preliminary data selection and reformat to internal L3 (M2)

The second module deals with the data pre-processing. SST data are first extracted based on the geographical coverage and local time of the observations, on pixel basis. To avoid diurnal warming contamination **[RD-5]**, the ISAC-GOS system only selects the nighttime L3C PFV53 data. L3C data preliminary selection is then performed, starting from the quality flags and confidence values associated to each pixel. Only high quality flag (namely, the fourth and fifth value of the flag) data are retained. Selected valid data are then saved in an internal format over the original Pathfinder grid.

IV.2.2 L3C additional cloud screening (M3)

In this module, an additional check on cloud contamination is performed by flagging the pixels that result to be colder (by a fixed threshold) than the previous day value, as measured in the corresponding L3C.

IV.2.3 Creation of the L4 analysis and error estimate (M4)

Two different space-time optimal interpolation (OI) schemes have been adopted for the Mediterranean and Black Sea CMEMS SST data reprocessing.

OI gives an estimate of an anomaly field with respect to a first guess, assuming the statistical characteristics of the variability are known (background error covariance and observation error covariance). The SST L4 analysis is then obtained as a linear combination of the observations, weighted directly with their correlation to the interpolation point and inversely with their cross-correlation and measurement error. OI also provides an estimate of the interpolation error, basically providing information on the observations impact on each grid point (see also **[RD-3]**, **[RD-6]** and **[RD-7]**).

Actually, in 'truly optimal' space-time interpolation, one should consider a temporal sequence of the images as the state vector, and several realizations of these space-time data should be used to estimate the covariance. This would clearly lead to a huge (computationally unfeasible) matrix inversion in the OI. Conversely, approximated OI approaches using analytical (parametric) covariance functions are easily extended to higher-dimensional state vectors allowing including also temporal decorrelations. These functions clearly decay at increasing generalized distances, and allow excluding from the analysis the observations that are found far from the interpolation point, which makes the algorithms theoretically sub-optimal, but computationally efficient. On the other hand, these more complex models, even if solved in a sub-optimal way, generally describe the system evolution better than models based on spatial covariance alone.

The REP BLK OI scheme uses exactly the same covariance function defined in **[RD-6]**, except for the fact that the background field has been replaced here with a daily (decadal) climatology computed from the entire PFV53 series (namely, from 1982 to 2014 since 1981 begins from August). This choice was driven by the extremely high cloud coverage over the Black Sea, which makes particularly difficult to estimate complex covariance models directly from the observations.

Conversely, for the REP MED, different analytical space-time covariance models (based on different first guess fields) have been tested before reprocessing the entire PFV53 dataset: simple spatially uniform covariance function and climatological first guess as in **[RD-3]**, spatially varying covariance function parameters based on a climatological first guess or on previous day analysis, as for the NRT processing **[RD-12]**.

The scheme chosen uses a daily decadal climatology as first guess (built from the entire PFV53 dataset), and a covariance model that assumes spatially varying parameters. This is different from what is presently used in the NRT chain, i.e. a covariance model considering previous day analysis as the background field **[RD-12]**. In fact, both models gave comparable results in terms of error statistics computed with insitu matchup data (evaluated on a subset of data, i.e. year 2010-2011) when using several satellite SST sources in input (the NRT chain ingests all available infrared measurements, not just AVHRR), and, in this case, the previous day analysis only provided a slightly better ability to reconstruct small scale structure evolution, as demonstrated by running tests with simulated clouds of different sizes. Further tests have shown that when only AVHRR data are used, using previous day analysis as first guess (and corresponding covariance model), often creates artefacts in the interpolated field. Therefore, the most conservative choice has been made here: to adopt the spatially varying covariance model based on the daily climatology.

More details on the covariance parameters are given in Annex 2, while a complete description of the development and validation of the various algorithms will be given in [**RD-8]**.

The data sub-sampling strategy, inversion technique and numerical implementation of the OI scheme are the same used in the NRT processing chain **[RD-12]**. In practice, the input data are selected only within a limited sub-domain (within a space-time influential radius), namely within a temporal window of ten days and a spatial influential radius ranging between 300 and 900 km. Before entering the influential data selection within each analysis, L3C images are checked for residual cloudy pixels at both resolutions. In practice, cloud margins are first eroded, flagging all values within a distance of two pixels to a pixel already flagged as cloudy. A second check is then performed through the comparison to the closer (in time) L4 analysis available, which is used as a reference only if the analysis error is lower than a fixed value.

To avoid data propagation across land, the REP scheme uses a single land mask. In particular, given the interpolation point and the input point selected within the sub-domain, the latter is taken into account for the interpolation only if there is no a land pixel between the straight line connecting the two points.

V SST REP LEVEL 4 PRODUCTS DESCRIPTION

V.1 Common characteristics

All CNR-ISAC-GOS REP L4 products are delivered on a regular grid, in netCDF format.

For product SST_MED_SST_L4_REP_OBSERVATIONS_010_021, the following dataset can be found:

Dataset name	Name	Description	Standard name	Unit	Dimensions
SST_MED_SST_L4_REP_OBSERVATIONS_010_021_a	**analysis_error**	estimated error standard deviation of analysed_sst	-	kelvin	(time, lat, lon)
	analysed_sst	analysed sea surface temperature	sea_surface_temperature	kelvin	(time, lat, lon)

For product SST_BS_SST_L4_REP_OBSERVATIONS_010_022, the following dataset can be found:

Dataset name	Name	Description	Standard name	Unit	Dimensions
SST_BS_SST_L4_REP_OBSERVATIONS_010_022_a	**analysis_error**	estimated error standard deviation of analysed_sst	-	kelvin	(time, lat, lon)
	analysed_sst	analysed sea surface temperature	sea_surface_temperature	kelvin	(time, lat, lon)

V.2 REP MED and BLK L4 products

The REP L4 product format specifications are described in detail in **[RD-4].** Annex 1 provides an example of the netCDF file headers.

V.3 Temporal Coverage

The CNR-ISAC-GOS REP MED and BLK L4 SST products (detailed in the present document) cover the entire PFV53 dataset, i.e. 25 August 1981 – 31 December 2014. This time series has been extended with the *Interim* REP MED and BLK data up to 2017.

VI NOMENCLATURE OF FILES

CMEMS REP L4 SST products over the Mediterranean Sea and Black Sea are referenced as follows in the CMEMS catalogue, accessible through the CMEMS web site (http://marine.copernicus.eu/web/69-interactive-catalogue.php):

Product: **SST-MED-SST-L4-REP-OBSERVATIONS-010-021**

Datasets: **SST-MED-SST-L4-REP-OBSERVATIONS-010-021_a**

Product: **SST-BS-SST-L4-REP-OBSERVATIONS-010-022**

Datasets: **SST-BS-SST-L4-REP-OBSERVATIONS-010-022_a**

VI.1 Nomenclature of files when downloaded through the CMEMS Web Portal Subsetter Service

Files nomenclature when downloaded through the CMEMS Web Portal Subsetter is based on product dataset name and a numerical reference related to the request date on the MIS.

The scheme is: **datasetname-nnnnnnnnnnnnn.nc**

where :

datasetname is a character string within one of the following :

SST_MED_SST_L4_REP_OBSERVATIONS_010_021_a

SST_BS_SST_L4_REP_OBSERVATIONS_010_022_a

nnnnnnnnnnnnn: 13 digit integer corresponding to the current time (download time) in milliseconds

since January 1, 1970 midnight UTC.

.nc: standard NetCDF filename extension.

Example:

SST_BS_SSTA_L4_NRT_OBSERVATIONS_010_006_d_1303461772348.nc

VI.2 Nomenclature of files when downloaded through the CMEMS FTP Service

Files nomenclature when downloaded through the CMEMS FTP is this of the original files, and is described in detail in **[RD-4].** Annex 1 provides an example of the netCDF file name.

Example:

20141231000000-GOS-L4_GHRSST-SSTfnd-OISST_HR_REP-MED-v02.0-fv01.0.nc

VII ANNEX 1: DESCRIPTION OF FILE FORMATS

VII.1 Example header of a high resolution L4 file

An example header of a high resolution L4 netCDF file (SST_MED_SST_L4_REP_OBSERVATIONS_010_021_a) following GDS2.0.5 specification (generated using ncdump) is given below.

elaborating :
20141231000000-GOS-L4_GHRSST-SSTfnd-OISST_HR_REP-MED-v02.0-fv01.0.nc file

```
dimensions:
	time = 1 ;
	lat = 378 ;
	lon = 1305 ;
variables:
	int time(time) ;
		time:long_name = "reference time of sst field" ;
		time:standard_name = "time" ;
		time:axis = "T" ;
		time:calendar = "Gregorian" ;
		time:units = "seconds since 1981-01-01 00:00:00" ;
		time:comment = "Nominal time of Level 4 analysis" ;
	float lon(lon) ;
		lon:long_name = "longitude" ;
		lon:standard_name = "longitude" ;
		lon:axis = "X" ;
		lon:units = "degrees_east" ;
		lon:comment = "geographical coordinates, WGS84 projection" ;
		lon:valid_min = -20.f ;
		lon:valid_max = 40.f ;
	float lat(lat) ;
		lat:long_name = "latitude" ;
		lat:standard_name = "latitude" ;
		lat:axis = "Y" ;
		lat:units = "degrees_north" ;
		lat:comment = "geographical coordinates, WGS84 projection" ;
		lat:valid_min = 29.f ;
		lat:valid_max = 47.f ;
	short analysed_sst(time, lat, lon) ;
		analysed_sst:long_name = "analysed sea surface temperature" ;
```

```
        analysed_sst:standard_name = "sea_surface_temperature" ;
        analysed_sst:type = "foundation" ;
        analysed_sst:units = "kelvin" ;
        analysed_sst:_FillValue = -32768s ;
        analysed_sst:add_offset = 273.15f ;
        analysed_sst:scale_factor = 0.01f ;
        analysed_sst:valid_min = -300s ;
        analysed_sst:valid_max = 4500s ;
        analysed_sst:source =  "[1981-2012] NODC-L3C_GHRSST-SSTskin-AVHRR_Pathfinder-PFV5.2;
[2013-2015] SST_MED_SST_L4_NRT_OBSERVATIONS_010_004_c_V2"
        analysed_sst:comment = "[1981-2012] Optimal interpolation (OI) sst measurements from
        daily Pathfinder L3S,0.0417 deg; [2013-2015] Interim product based on locally bias-adjusted
        SST_MED_SST_L4_NRT_OBSERVATIONS_010_004_c_V2"
    short analysis_error(time, lat, lon) ;
        analysis_error:long_name = "estimated error standard deviation of analysed_sst" ;
        analysis_error:units = "kelvin" ;
        analysis_error:_FillValue = -32768s ;
        analysis_error:add_offset = 0.f ;
        analysis_error:scale_factor = 0.01f ;
        analysis_error:valid_min = 0s ;
        analysis_error:valid_max = 10000s ;
        analysis_error:source = "[1981-2012] NODC-L3C_GHRSST-SSTskin-AVHRR_Pathfinder-
        PFV5.2; [2013-2015] SST_MED_SST_L4_NRT_OBSERVATIONS_010_004_c_V2"
        analysis_error:comment = "Error obtained by Optimal interpolation (OI)" ;
    byte sea_ice_fraction(time, lat, lon) ;
        sea_ice_fraction:standard_name = "sea_ice_area_fraction" ;
        sea_ice_fraction:long_name = "sea ice area fraction" ;
        sea_ice_fraction:units = "1" ;
        sea_ice_fraction:_FillValue = -128b ;
        sea_ice_fraction:add_offset = 0.f ;
        sea_ice_fraction:scale_factor = 0.01f ;
        sea_ice_fraction:valid_min = 0b ;
        sea_ice_fraction:valid_max = 100b ;
        sea_ice_fraction:source_ice = "Not applicabile for Mediterranean sea" ;
        sea_ice_fraction:comment_ice = "Not applicabile for Mediterranean sea" ;
        sea_ice_fraction:comment = "Not applicabile for Mediterranean sea" ;
        sea_ice_fraction:source = "Not applicabile for Mediterranean sea" ;
    byte mask(time, lat, lon) ;
        mask:long_name = "sea/land/lake/ice field composite mask" ;
        mask:_FillValue = -128b ;
        mask:units = "1" ;
        mask:flag_values = 1b, 2b, 3b, 4b ;
        mask:flag_meanings = "sea land lake ice" ;
```

mask:valid_min = 0b ;
mask:valid_max = -1b ;
mask:source = " " ;
mask:comment = "b0:1 = grid cell is open sea water; b1:1 = land is present in his grid cell; b2:1 = lake surface is present in this grid cell; b3:1 = sea ice is present in this grid cell; b4-7: reserved for future grid mask data" ;

// global attributes:
:Conventions = "CF-1.4 " ;
:title = "Mediterranean SST Analysis L4, Reprocessed using Pathfinder L3S, 0.0417 deg daily (SST_MED_SST_L4_REP_OBSERVATIONS_010_021_a)"
:summary = "[1981-2012] Daily gap-free maps (L4) at 0.0417deg. x 0.0417deg. horizontal resolution over the Mediterranean Sea.The maps are obtained using night-time data extracted from Pathfinder Version 5.2,whenever available, and regridded data from Version 5.0 for the period 1994257 to 1995018; [2013-2015] Daily gap-free maps (L4) at 0.0417deg. 0.0417deg. horizontal resolution over the Mediterranean Sea.The maps are obtained using bias-adjusted UHR NRT L4 dat"
:references = "A. Pisano, B. Buongiorno Nardelli, C. Tronconi, R. Santoleri: The new Mediterranean optimally interpolated pathfinder AVHRR SST Dataset (1982-2012). /Remote Sensing of Environment./ 176 (2016) 107-116, doi: 10.1016/j.rse.2016.01.019; http://pathfinder.nodc.noaa.gov and Casey, K.S., T.B. Brandon, P. Cornillon, and R. Evans: The Past, Present and Future of the AVHRR Pathfinder SST Program, in Oceanography from Space: Revisite, eds. V. Barale, J.F.R. Gower, and L. Alberotanza, Springer, 2010. DOI: 10.1007/978-90-481-8681-5_16."
:institution = "GOS" ;
:history = "GOS-MYO processor V3: new version" ;
:comment = "WARNING: some applications are unable to properly handle byte values. If Values >127 are encounterd, please subtract 256" ;
:license = "free registration at Copernicus Marine Service (http://marine.copernicus.eu/web/56-user-registration-form.php)" ;
:id = " " ;
:DSD_entry_id = "-GOS-L4HRfnd-MED" ;
:naming_authority = "org.ghrsst" ;
:product_version = "1.0" ;
:uuid = " " ;
:gds_version_id = "v2.0.5" ;
:netcdf_version_id = "3.6.0-p1 of Oct 16 2005 13:23:24" ;
:date_created = "20160727T154734Z" ;
:file_quality_level = 3 ;
:spatial_resolution = "0.0417 degree" ;
:start_time = "20141230T190000Z" ;
:time_coverage_start = "20141230T190000Z" ;
:stop_time = "20141231T070000Z" ;

:time_coverage_end = "20141231T070000Z" ;
:software_version = "Copernicus Marine Service HR L4 Processor V.1" ;
:northernmost_latitude = 45.9792f ;
:southernmost_latitude = 30.2708f ;
:easternmost_longitude = 36.2292f ;
:westernmost_longitude = -18.1042f ;
:Scaling_Equation = "(scale_factor*data) + add_offset" ;
:source = "[1981-2012] NODC-L3C_GHRSST-SSTskin-AVHRR_Pathfinder-PFV5.2; [2013-2015] EUR-L2P-ATS_NR_2P, UPA-L2P-ATS_NR_2P, JPL-L2P-MODIS_A, JPL-L2P-MODIS_T, EUR-L2P-NAR17_SST, EUR-L2P-NAR18_SST, EUR-L2P-SEVIRI_SST, EUR-L2P-AVHRR_METOP_A, EUR-L2P-AVHRR_METOP_B";
:platform = "[1981-2012] NOAA07,NOAA09,NOAA11,NOAA14,NOAA16, NOAA17,NOAA18,NOAA19; [2013-2015] Envisat, NOAA-18, MetOpA, Aqua, Terra, MSG1" ;
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:creator_email = "gsdk@isac.cnr.it" ;
:creator_url = "http://gosweb.artov.isac.cnr.it/" ;
:project = "Copernicus Marine Service" ;
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:publisher_url = "http://marine.copernicus.eu/" ;
:publisher_email = "servicedesk.cmems@mercator-ocean.eu, gsdk@isac.cnr.it" ;
:processing_level = "L4" ;
:cdm_data_type = "grid"

VIII ANNEX 2. COVARIANCE MODEL FOR REP MED L4

VIII.1 Background correlation function model

The background correlation function is assumed to depend separately from time and space lag:

$$C = C(Dr, Dt) = C(Dr) \cdot C(Dt).$$

For the REP MED, similarly to the NRT processing **[RD-12]**, a new functional model has been chosen for the spatial dependence with respect to the one adopted in **[RD-3]** and **[RD-7]**, optimizing the fit to the correlation estimated from the observations. A negative exponential correlation function provides the best fit for the temporal dependence.

The new function is a rational quadratic correlation and can be interpreted as an infinite sum (integral) of squared exponential correlation functions, each with a different characteristic length-scale **[RD-9]**:

$$C(Dr) = \left(1 + \frac{(Dr)^2}{2aL^2}\right)^{-a}$$

$$C(\Delta t) = e^{-\frac{\Delta t}{\tau}}$$

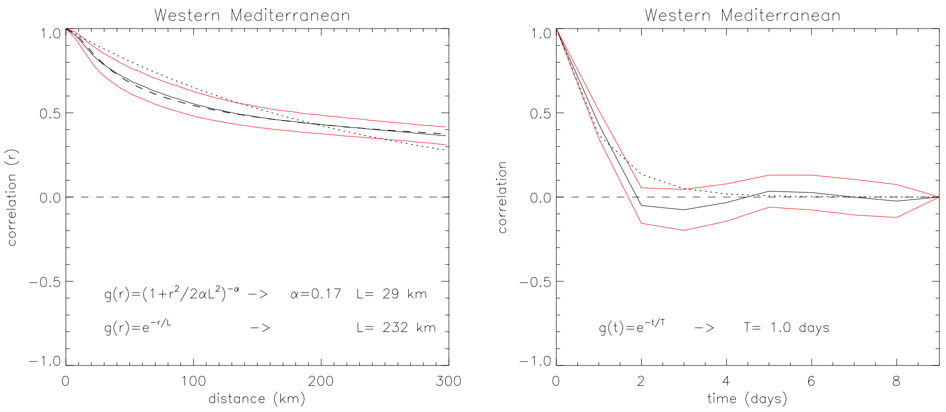
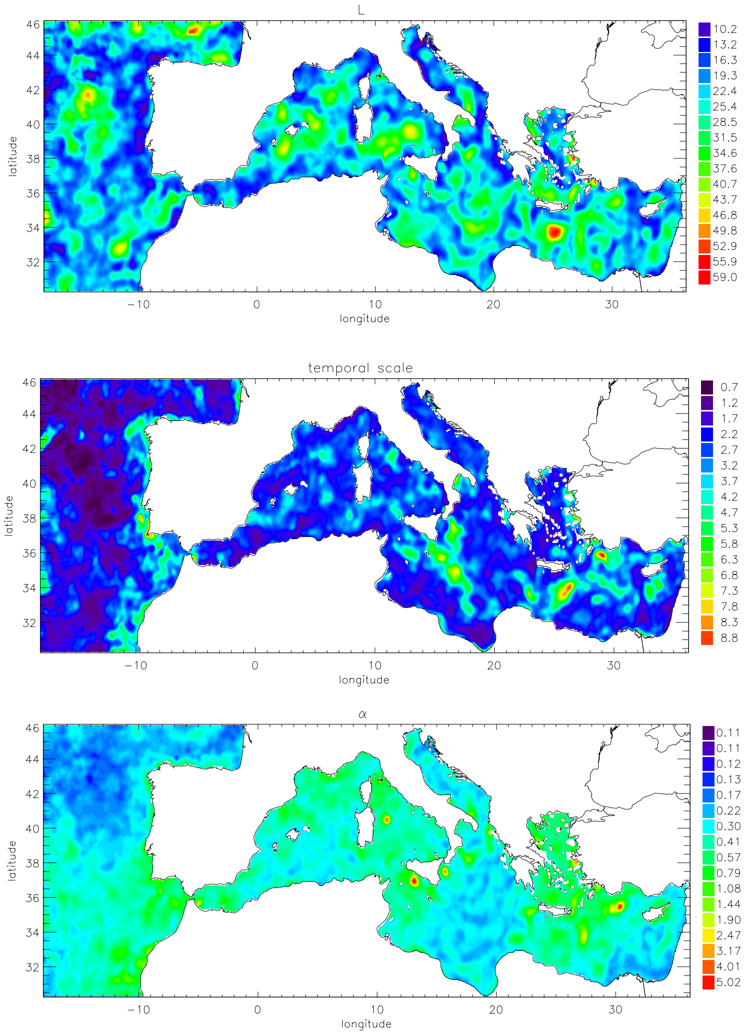


Figure A1. Sub-basin averaged Covariance function fit examples

VIII.2 Background covariance assumptions

The covariance model used for the REP MED are assumed to be locally stationary, i.e. different characteristic space and time scales are considered at each location, but the correlation function used at each interpolation point is not changed within a pre-defined (space-time) influential radius during the optimal interpolation. This a priori assumption relaxes the previous one of a unique (basin-wide) space and time decorrelation scale (**[RD-3]**, **[RD-7]**), though it still leads to an approximation of the true background covariance matrix, which would be unfeasible to estimate directly from the whole set of observations available, due to computational limitations.



a)

b)

c)

Figure A2. Background covariance parameters: L (a), T (b) α (c).

VIII.3 Signal variance and noise-to-signal ratio

Coherently with the definition of a new background correlation function, a new spatially varying noise-to-signal ratio has been estimated. As for the NRT processing **[RD-12]**, this computation was based on the three-way error analysis proposed in **[RD-10]** and on the matchup dataset between satellite (L3S and climatological data) and in situ (drifter) observations set up in **[RD-7]**. More specifically, assuming the errors from three data sources to be uncorrelated, it is possible to estimate the L3S observation variance σ^2_{L3S} from the variances of the difference between the three observation types (see **[RD-10]**):

$$\sigma^2_{L3S} = 1/2(\sigma^2_{L3S\text{-}drifter} + \sigma^2_{L3S\text{-}clim} - \sigma^2_{drifter\text{-}clim})$$

$$\sigma^2_{L3S\text{-}drifter} = 0.48\ K$$

$$\sigma^2_{clim\text{-}drifter} = 0.89\ K$$

$$\sigma^2_{L3S\text{-}clim} = 0.90\ \mathrm{K}$$

$$\sigma^2_{L3S} = 0.33\ K$$

(Number of matchup data: 3536)

L3S variance is used here to set the noise level, assumed spatially uniform.

Similarly, it is then possible to estimate the (spatially varying) true signal variance as the difference between the variance of the difference between L3S and background data ($\sigma^2_{L3S\text{-}background}$, which is estimated from all available observation and background fields) and the noise variance (σ^2_{L3S}):

$$\sigma^2_{background} = \sigma^2_{background\text{-}L3S} - \sigma^2_{L3S}\ (+2r_{background,L3S}\ \sigma_{L3S}\sigma_{background}),$$

provided the correlation between L3S and background errors ($2r_{background,L3S}$) can be assumed zero. This condition is essentially met when using climatology as background field, but it could fail when considering the previous day analysis as first guess. In fact, L3S errors are often related to specific atmospheric conditions, possibly persisting for more than one day in specific areas. In that case, the background error could be underestimated, being correlated to the observation error. This might lead to inaccurate noise-to-signal estimates, affecting the weighting of the new observations that enter the interpolation with respect to the background field.