

D6 Product Delivery

MedEOS – Coastal Water Monitoring

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1. Introduction

1.1. Purpose of this document

This document presents a synthetic description of MedEOS products delivery.

1.2. Scope of this document

This document shall present a summary of MedEOS project, the data package provided in the scope of its demonstrations and the means to access it, as long as practical details on the products main characteristics.

1.3. Acronyms and Abbreviations

Acronym / abbreviation	Description
MedEOS	Mediterranean Regional Initiative application - Land-based pollution assessment & monitoring in the Mediterranean coastal waters
UML	Unified Modeling Language
EO	Earth Observation
ESA	European Space Agency
S3-OLCI	Sentinel-3 Ocean and Land Color Instrument
S2-MSI	Sentinel-2 MultiSpectral Instrument
TSM	Total Suspended Matter
CDOM	Colored Dissolved Organic Matter
UNEP/MAP	Mediterranean Action Plan of the United Nations Environment Programme
URD	User Requirement Document
ICT	Information and communications technology
DREAL	French Regional Environment, Planning and Housing Department
OFB	Golfe du Lion Natural Marine Park
TGPAMA	Thermaikos Gulf Protected Areas Management Authority
AUTH-EPCL	Aristotle University of Thessaloniki-Environmental Pollution Control Laboratory
IMIDA	Institute of Agricultural Research & Development of Murcia
AWC	Arab Water Council
EgSA	Environmental Study Department from Egyptian Space Agency
NARSS	National Authority for Remote Sensing & Space Sciences
NIOF	Coastal Research Institute and National Institute for Oceanography and Fisheries
APAL	Tunisian Protection and Planning Agency of the Coastal Zone

2. Related Documents

2.1. Applicable Documents

Table 1 specifies the applicable documents supporting the generation of the current document.

Table 1. Applicable documents

Reference	Code	Title	Issue
AD.1	MERI-DMS-COM-PRS01-E	Full Proposal for ESA Mediterranean Regional Initiative - Applications - Land-based Pollution Assessment and Monitoring in the Mediterranean Coastal Waters	1.0
AD.2	EOP-SD-SOW-0149	Statement of Work - Mediterranean Regional Initiative - Applications - Land-based Pollution Assessment and Monitoring in the Mediterranean Coastal Waters	1.0
AD.3	MRI-DES-TEC-TNO01	D1 Requirements Baseline Document	2.0
AD.4	MRI-DES-TEC-TNO02	D3 Data Pool	1.0
AD.5	MEI-DES-TEC-TSP01-E	D4 Product Specification Document	1.0
AD.6	MEI-DES-TEC-TEC03-E	D5 Algorithm Theoretical Basis Document	3.2
AD.7	MEI-DES-TEC-TEC04-E	D7 Validation Report	2.2
AD.8	MEI-DES-TEC-TEC05-E	D8 Impact Assessment Report	2.0

2.2. Reference Documents

No reference documents support the generation of the current report.

3. The MedEOS project

While pollution remains a major threat of the Mediterranean Sea ecosystems, water quality assessment is primarily performed based on in situ measurements which are typically expensive, time-consuming and tedious. Nevertheless, satellite imagery must be considered as a potential solution to derive water quality parameters comparable to the standards defined by the regulatory actions, taking advantage of its enhanced temporal and spatial coverage.

Within this context and as part of the ESA Mediterranean Sea Regional Initiative, MEDEOS aims to develop and produce high-resolution, gap-free maps of experimental Earth observation water quality products. MedEOS employs data fusion techniques to combine the high temporal resolution of S3-OLCI and high spatial resolution of S2-MSI data, to capture the optimal spatio-temporal coverage over the Mediterranean Sea coastal waters with high-resolution, gap-free maps. Three different families of products shall be developed and validated taking advantage of this fused data:

- EO directly derived water quality products:
 - Total Suspended Matter (TSM)
 - Turbidity (TUR)
 - Chl-a Concentration (CHL)
 - Secchi Depth (ZSD)
 - CDOM - Coloured Dissolved Organic Matter (DOM)
- EO indirectly derived water quality products:
 - Faecal bacterial contamination indicators
 - Eutrophication indicators
 - Global environmental anomaly detection
 - River plume extension and characteristics

By the end of 2022, MedEOS has reached a major project milestone: a mid-term review with ESA has deemed the work valuable enough to proceed for its second year, which entails the full production and validation of the water quality monitoring products derived from satellite data for the whole Mediterranean coast.

After the extensive experimentation and trade off analysis that informed the products main design choices, a first batch of results was made available in early November 2022, composed of a few months of selected parameters within MedEOS's five pilot areas. These samples of EO Direct, Indirect and Data Fusion products were the object of technical discussions between the project team and ESA project officers. During January 2023 these results were distributed to selected end-users for their own experimentation, allowing them to provide feedback about the product quality and usefulness, also indicating their preferences regarding technical aspects as the final spatial resolution.

By late 2023, and after several adjustments made in the algorithms (details in AD.6), the development team has performed additional validation of longer time series for selected parameters over areas where the respective in situ data is available, increasing the confidence on the product quality (more details available in AD.7). Early in 2024, a final round of impact assessment with engaged users was performed to understand how the final version of MedEOS products can improve their day-to-day activities related to water coastal water quality monitoring (details available in AD.8).

4. Product Delivery

Within MedEOS two capacity building-validation-feedback cycles were performed to allow for service development and delivery evolutions following feedback outputs (Table 2). For each of those demonstration cycles, a specific batch of products was delivered, as described in the following sections.

Stage	Period
1st Cycle	
Capacity building	January-February 2023
Demonstration exercise	February-March 2023
Feedback collection	March 2023
2nd Cycle	
Capacity building	January 2024
Demonstration exercise	January 2024
Feedback collection	February 2024

Table 2. Timeline of the two MedEOS demonstration cycles.

4.1. First demonstration cycle

Within the first cycle of service demonstration, a data package containing sample products covering all pilot areas was distribute through an FTP repository (described in section 5.2), The tables below present the detailed description of this dataset, which in some cases was also accompanied by illustrated samples produced by the pilot leaders to aid in product evaluation.

EO Direct Products								
	Sentinel 2				Sentinel 3			
	Start	End	n° days	n° images	Start	End	n° days	n° images
France	02/04/2021	30/08/2021	151	53	01/04/2021	31/08/2021	153	152
Greece	04/05/2019	26/09/2019	146	30	10/05/2019	30/09/2019	144	137
Spain	04/08/2019	27/12/2019	146	27	01/08/2019	31/12/2019	153	150
Egypt	02/04/2019	30/08/2019	151	30	02/04/2019	31/08/2019	152	144
Tunisia	01/04/2019	29/08/2019	151	31	01/04/2019	31/08/2019	153	141

Table 3. Sample dataset of EO Direct Products.

Data Fusion					
	Parameters	Start	End	n° days	n° images
France	TSM, TUR, CHL	01/05/2021	01/08/2021	93	93
Greece	TUR	01/06/2020	01/09/2020	93	93
Spain	ZSD	01/09/2019	01/12/2019	92	92
Egypt	DOM	01/05/2019	01/08/2019	93	93
Tunisia	TUR	01/05/2019	01/08/2019	93	93

Table 4. Sample dataset of Data Fusion Products.

EO Indirect Products - Faecal Bacteria Vulnerability Index				
Sentinel 2				
	Start	End	n ^o days	n ^o images
France	02/04/2021	30/08/2021	151	53
Greece	04/05/2019	26/09/2019	146	30
Spain	04/08/2019	27/12/2019	146	27
Egypt	02/04/2019	30/08/2019	151	30
Tunisia	01/04/2019	29/08/2019	151	31
Sentinel 3				
	Start	End	n ^o days	n ^o images
France	01/04/2021	31/08/2021	153	152
Greece	10/05/2019	30/09/2019	144	120
Spain	01/08/2019	31/12/2019	153	147
Egypt	02/04/2019	31/08/2019	152	144
Tunisia	01/04/2019	31/08/2019	153	141
EO Indirect Products - Eutrophication Index				
Sentinel 2				
	Start	End	n ^o days	n ^o images
France	02/04/2021	30/08/2021	151	53
Greece	09/05/2019	21/09/2019	136	29
Spain	04/08/2019	27/12/2019	146	27
Egypt	02/04/2019	30/08/2019	151	30
Tunisia	01/04/2019	29/08/2019	151	31
Sentinel 3				
France	01/04/2021	31/08/2021	153	152
Greece	10/05/2019	30/09/2019	144	120
Spain	01/08/2019	31/12/2019	153	148
Egypt	02/04/2019	31/08/2019	152	144
Tunisia	01/04/2019	31/08/2019	153	141
EO Indirect Products - River Plume Monitoring				
Sentinel 2				
	Start	End	n ^o days	n ^o images
France	02/04/2021	17/08/2021	138	20
Egypt	07/04/2019	30/08/2019	146	14
	Start	End	n ^o days	n ^o images
France	03/04/2021	20/08/2021	140	70
Egypt	05/04/2019	31/08/2019	149	107
Sentinel 3				
	Start	End	n ^o days	n ^o images
France	02/04/2021	17/08/2021	138	20
Egypt	07/04/2019	30/08/2019	146	14

Table 5. Sample dataset of EO Indirect Products.

4.2. Second demonstration cycle

For the second cycle of service demonstration, much longer time series of results were produced, although only for pilot areas from the Northern Mediterranean (France, Greece, Spain), for all the MedEOS products described in section 6 (except for Data Fusion, which was only made available for pilot area 1). While the data package containing all results were made available to users through an FTP repository, a web-based geoportal was employed as second method for data delivery, following request from users received during the first cycle of demonstration. The geoportal allows for visualising the resulting maps of water quality parameters and indicators, offering a much simpler and easier way of accessing the information.

Table 6 describes the time of interest covered by the dataset used for the second service demonstration cycle. While all the results of Direct Products and Data Fusion were made available both in the FTP and the geoportal, for Indirect Products only selected samples are presented in the geoportal, with the full time series provided only in the FTP.

Table 6. Sample dataset employed in the second service demonstration cycle.

Pilot Area	Start	End	n° Sentinel 2 results (days)	n° Sentinel 3 results (days)	n° Data Fusion results (days)
France	01/01/2019	30/06/2023	406	1583	286
Greece	02/11/2017	30/06/2023	476	1550	-
Spain	02/11/2017	29/06/2021	194	636	-

The following sections presents the details on the delivery methods and main characteristics of MedEOS' products.

5. Delivery methods

During the demonstration exercise foreseen in MedEOS, its results should be made available for users by means of a dedicated geoportal and the FTP repository, for which the detailed access information was provided.

Once the project is concluded, MedEOS products and datasets are still to be provided per request, which should be directed to Deimos, the hosting platform administrator: spatialops@deimos-space.com.

5.1. MedEOS geoportal

All the MedEOS services are currently integrated within [services4EO](#), an EO exploitation platform hosted on cloud infrastructure sponsored by ESA. Results for the specific areas of interest to be explored in the demonstration exercises are delivered through a web-based [geoportal](#). This web-based tool, presented in Figure 1, allows users to discover environmental timeseries from the MedEOS services and visualize its outputs, which are also made available for download.

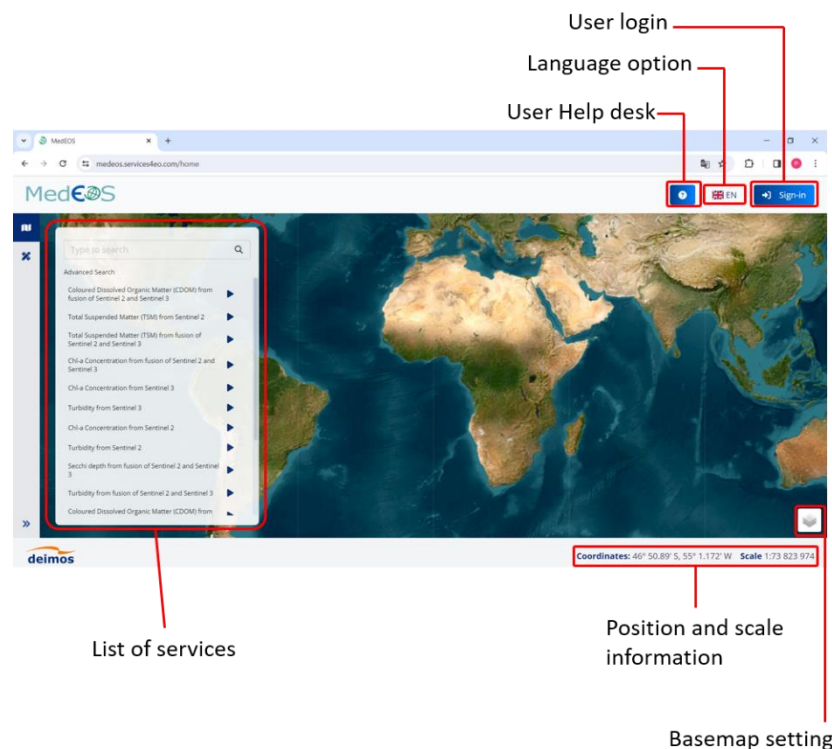


Figure 1. General layout of MedEOS geoportal.

Following the format of a web-based map, the MedEOS geoportal provides an option to customize the *basemap* used as background based in a wide range of options (Google, Esri, Wikipedia and OpenStreetMap). The solution is currently provided in several different languages and a specific button is included for the users to request support from the *services help desk* (currently still under implementation). The map allows for zooming in and out and for easy navigation over different locations, presenting the related geographical information in the lower right corner. The *log in* option facilitates the control of the user activity by service providers, but also allows direct access to user/specific results from previous interactions with the portal.

The main feature in the MedEOS geoportal, however, is the *list of services*, on the left side of the geoportal screen, which presents all services. The tool follows a data-by-order logic: the user is required to place an order for each specific results he intends to visualize, considering time and area of interest (and input parameters in the case of downstream services). Once the order is successfully placed (using the ► button),

users can visualize the results by opening the respective order using a drop-down menu (clicking in the > symbol).

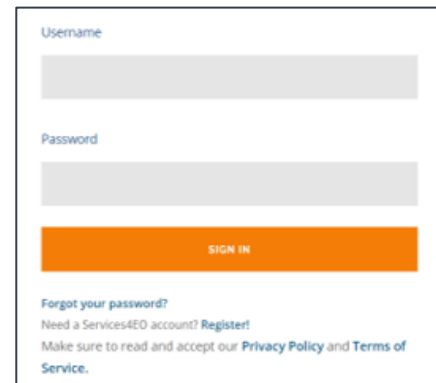
5.1.1. Signing in

The first step to use the MedEOS geoportal is to sign in a user account. Once the user clicks on the indicated button, the login form on the right is showed.

During the demonstration exercises, specific credentials were used within each pilot area. For the remaining trial period before MedEOS Final Review, the following credentials for testing should be used:

- Username: *MedEOS_testing*
- Password: *MedEOS_testing*

Once the trial period is finished, data access requests should be directed to Deimos, the hosting platform administrator: spatialops@deimos-space.com.



5.1.2. Triggering services

Once a user clicks on the ▶ button of a particular service, a 3-page form is presented. The first page presents a brief description of the service, while the second includes instructions for triggering it and the third present the input options for triggering the order. The area for which the service can be triggered is also indicated by the green shading (Figure 2).

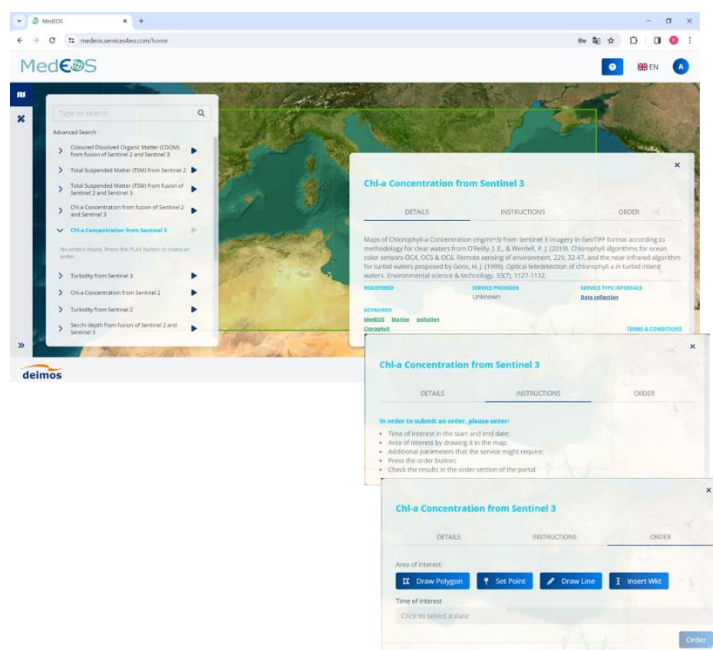


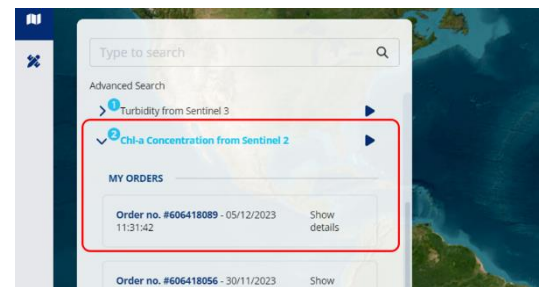
Figure 2. Tabs for triggering services in MedEOS geoportal.

All MedEOS services have just two parameters that have to be set by the user as input for the orders: area of interest (AOI) and time of interest (TOI). While the AOI can be defined by drawing polygons, lines and/or points directly in the map, the information can be inserted with better accuracy by using a string in the WKT format.

5.1.3. Visualize and retrieve data

Once a user has placed an order, results are immediately made available. To visualize results, the user should click on the “>” sign next to the name of the server and choose the desired order from the list (see image on the right).

By clicking in “Show details”, the results layer is opened, and once this is activated, a time series is presented in the upper right corner of the screen. The user should click on the desired date so that the results are presented in the geoportail – the circle for the select date becomes white.



Finally, to download the ordered data, the user should click on the indicated by the red box in Figure 3.

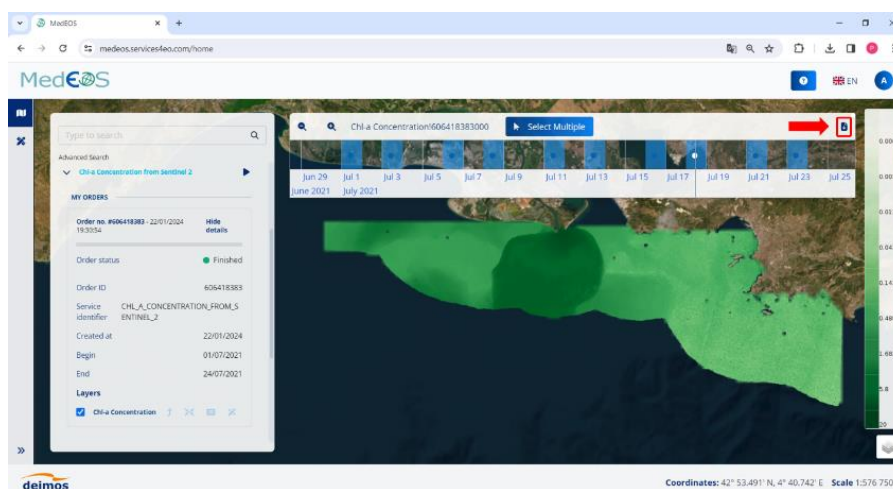


Figure 3. Result visualisation and button to download products from MedEOS geoportail.

5.2. FTP server

MedEOS results are also provided through an FTP server hosted by Deimos, which can be accessed using the following credentials:

- Host name: *sftp.elecnor-deimos.com*
- Username: *deimos387*
- Password: *01,kVau.81*
- Port: 22 (please note some clients set port 21 as default)
- HTTPS access: <https://sftp.elecnor-deimos.com/deimos387>

Once logged in, a link to the archive can be found (*deimos387*) and within it the folders containing the results for each of the pilot areas:

- [France](#) (Sentinel 2 tile T31TFH)
- [Greece](#) (Sentinel 2 tile T34TFK)
- [Spain](#) (Sentinel 2 tile T30SXG)

Results in each pilot area folder are organized in terms of the product families, sensors and parameters described above:

```
/1_EO_Direct_Products
/Sentinel_2
/Sentinel_3
```

/2_Data_Fusion¹

/3_EO_Indirect_Products

/X_parameter (EVI, FBVI, GEAD, RPM_Primary, RPM_Secondary)

/Sentinel_2

/Sentinel_3

¹ only available for the pilot area in France.

6. Products Characteristics

Table 7 describes the main characteristics of MedEOS’ sample (file formats, spatial and temporal resolution):

Table 7. MedEOS products main characteristics.

Product		Format	Spatial Resolution (m)	Temporal Resolution (days)	
EO Direct Products	Sentinel 2	GeoTIFF, NetCDF	20	5	
	Sentinel 3		300	1	
Data Fusion images	Sentinel 2 + Sentinel 3	GeoTIFF	60	1	
EO Indirect Products	Faecal Bacteria Vulnerability Index	NetCDF	Sentinel 2	20	5
			Sentinel 3	300	1
	Eutrophication Index		Sentinel 2	20	5
			Sentinel 3	300	1
	River Plume monitoring	shapefile	Sentinel 2	20	5
			Sentinel 3	300	1
	Global environmental anomaly detection	csv	Sentinel 2	-	-
			Sentinel 3	-	-

6.1. Naming convention

The files with MedEOS EO Direct Products and Data Fusion results follow a naming convention defined as:

SSS_DDDDDDDD_TTTTTT_UUUUUUUU_YYYYYYYY__FFF_PPP_XXXXXX where:

- SSS is the satellite code (S3_, S2A or S2B)
- DDDDDDDD is the acquisition date (year, month, day)
- TTTTTT is the UTC acquisition time (hour, minutes, seconds)
- UUUUUUUU is an 8 characters unique identifier
- YYYYYYYY is the file type specific to the MedEOS project (DWQ_TPZ or ISEAAPP__)
- FFF is the data format (TIF, or NC_)
- PPP is the parameter (CHL, DOM, KDB, TSM, TUR or ZSD)
- XXXXXX is the Sentinel-2 tile identifier

For the EO Indirect Products result files, a different naming convention is followed:

PPP_SSS_DDDDDD _XXXXXX where:

- PPP is the parameter (Faecal Bacteria Vulnerability Index (T90), Eutrophication Index (EI) or River Plume Monitoring(Rhone_plume))
- SSS is the satellite code (S3_, S2A or S2B)
- DDDDDDDD is the acquisition date (year, month, day)
- XXXXXX is the Sentinel-2 tile identifier

6.2. Postprocessing

During the production of MedEOS results, an “integer” format was used to archive some of the data, as it more efficient than storing it in the original floating-point format. Therefore, independent of being retrieved from the geoportal or from the FTP server, the MedEOS EO Direct Products requires a conversion to obtain the actual floating-point values:

float_value = (integer_value – offset) / gain where gains and offsets are indicated in Table 8.

Table 8. Gains and offsets for Direct Products postprocessing.

Parameter	Scale	Unit	Gain	Offset
CHL	log	mg/m3	6553	19659
DOM	log	m-1	6553	26212
TSM	log	g/m3	5461	16383
TUR	lin	FNU	65	0
ZSD	lin	m	327	0

CHL, DOM, and TSM are given in log scale: the values can be converted to linear scale by applying **linear_value = 10**log_value**. All the results from Data Fusion are given in log scale and therefore subject to similar conversion.