ESA STUDY – PROGRESS REPORT

ESA Contract No: №4000123951/18/NL/SC	SUBJECT: Black Sea Color	INSTITUTE: INSTITUTE OF OCEANOLOGY
ESA Proposal No: AO/1-8785/16/NL/SC	Revision No.: 1	INSTITUTE'S REFERENCE: www.io-bas.bg

ABSTRACT (Summary of the Project):

Optical remote sensing (satellite ocean color) has demonstrated the capability to provide synoptic information of the optical and biogeochemical properties of the oceans. This is based on the determination of the spectrum of the water leaving radiance (i.e., the radiance emerging from below the sea surface obtained from the top-of-atmosphere signal corrected for the atmospheric perturbation). The amplitude and spectral shape of this primary geophysical ocean color product (i.e., the remote sensing reflectance), is then interpreted in terms of derived products such as concentrations of optically significant constituents or inherent optical properties for bio-geo-chemical and environmental applications at global or regional scales. Specifically, satellite ocean color has given another dimension to marine biogeochemistry and ecosystem studies, offering new opportunities for direct monitoring of biodiversity and shelf - sea fronts providing key information for instance on the timing and spatial distribution of plankton blooms, the magnitude of primary production and provision of environmental data layers crucial for building predictive models of species (fish and other pelagic animals) and habitat distributions, relevant for the implementation of important EU environmental policies (Water Framework Directive, Marine Strategy Framework Directive) and climate change projections. The main limitation in the operational use of satellite ocean colour data in the Black Sea and in other marginal seas is the lack of regional bio-optical algorithms linking the satellite signal to the specific bio-optical indicators. In fact operational satellite products generally rely on algorithms developed for global applications which are the source of large uncertainties (on the order of hundred percent for chlorophyll a) in the Black Sea coastal areas due to their optical complexity. This urges reinforcing efforts on the development of specific regional bio-optical algorithms by relying on in situ reference data sets of statistically representative and comprehensive bio-optical measurements. The reference bio-optical data, in addition to support algorithms development, will also be essential for the assessment of standard Sentinel-3 ocean colour data products delivered by Copernicus Marine and Climate Change services.

The project aims at the implementation of a program to support remote sensing applications for operational environmental monitoring and climate studies in the Black Sea. This objective will be achieved through the assessment of current Sentinel-3 ocean color data products and additionally the implementation of new bio-optical algorithms for the quantification of the concentration of seawater optically significant constituents. The previous activity will benefit from the collection, analysis and application of comprehensive reference bio-optical measurements of optical properties (inherent and apparent) and concentration of seawater optically significant constituents from a major oceanographic campaign.

The work described in this report was done under ESA PECS Contract. Responsibility for the

contents resides in the author or organisation that prepared it.
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BIO-OPTICS FOR OCEAN COLOR REMOTE SENSING OF THE BLACK SEA (Black Sea Color)

(№4000123951/18/NL/SC)

Progress Report

1. Introduction

The Black Sea receives drainage from almost one-third of the continental Europe which includes significant portions of 17 countries, 13 capital cities and some 160 million people. While the physical processes of this highly important socio-economic marine region are relatively well assessed, its trophic and geochemical status is still not fully understood. Within such a framework, optical remote sensing of the sea (satellite ocean color) can provide synoptic information of seawater biogeochemical properties through maps of optically significant seawater constituents (i.e., Nezlin et al., 1999; Barale et al., 2002, ; Slabakova et al., 2014; Churilova et al., 2017). However, satellite derived products (e.g., chlorophyll a concentration commonly used as a proxy for phytoplankton biomass) exhibit large uncertainties in most of the marginal seas as demonstrated by local studies supported by truth data (Kopelevich et al., 2004, 2013; Sancak et al., 2005). Specifically Sancak et al. (2005) showed that the standard ocean color algorithms developed for global applications can be the source of large overestimates (up to hundreds of percent) of chlorophyll a concentration for both the Black Sea and the Eastern Mediterranean Sea. Sancak et al. (2005) recommend the collection of additional in situ data to understand the living and nonliving content of the water column affecting the signal received by satellite ocean color sensors. The works of Kopelevich et al. (2004, 2013) and Suslin et al. (2016) showed the possibility of minimizing the uncertainties in satellite derived products by developing regional algorithms for the Black Sea. This urged the creation of comprehensive data sets of statistically representative in situ measurements suitable for the development of specific regional bio-optical algorithms and which is more important to validate these algorithms. This urges reinforcing efforts on the development of specific regional bio-optical algorithms by relying on *in situ* reference data sets of statistically representative and comprehensive bio-optical measurements. The reference bio-optical data, in addition to support algorithms development, will also be essential for the assessment of standard Sentinel-3 ocean colour data products delivered by Copernicus Marine and Climate Change services.

The objective of the progress report is to provide all actors with actual information concerning the status of the project, which was kicked off on 18/12/2018. This report covers the time period from 18/06/2019 to 20/09/2019.

The aim of this project is to implement of a program to support remote sensing applications for operational environmental monitoring and climate studies in the Black Sea. This objective will be achieved through the assessment of current Sentinel-3 ocean color data products and additionally the implementation of new bio-optical algorithms for the quantification of the concentration of seawater optically significant constituents. The previous activity will benefit from the collection, analysis and application of comprehensive reference bio-optical measurements of optical properties (inherent and apparent) and concentration of seawater optically significant constituents from a major oceanographic campaign and automated AERONET- OC system installed on earthgas exploration platform – GALATA.

The main technical objectives are:

1. Execution of the oceanographic cruise in the Black Sea and creation of reference data set of optical properties (inherent and apparent) and concentration of seawater optically significant constituents;

2. Analysis and quality assurance of the bio-optical data from the field campaign and AERONET-OC system;

3. Assessment of standard Copernicus Sentinel-3 ocean color products using novel bio-optical measurements from the Black Sea oceanographic cruise;

4. Development of bio-optical algorithms for the determination of optically significant seawater constituents for OLCI (Ocean and Land Colour Instruments) data in the Black Sea;

5. Generation of ocean color test products freely accessible through web interface.

2. Highlight Summary

The main efforts during the reporting period were dedicated to the WP1 Project Management and Reporting, WP3 Data analysis and QA and WP5 Web portal development.

1. Detailed Progress of Work

Work package	Activities	Responsible Person	Status
WP1: Project Management and Reporting	1.1. 1st progress report	Prof. S. Moncheva,	Completed
	1.2. 2nd progress report	Prof. S. Moncheva	Completed
WP 2: Data collection	2.1. Bio-optical cruise work programme	Violeta Slabakova	Completed
	2.2. Field measurements	Violeta Slabakova	Completed
WP3:Data analysis and QA	3.1 AOP data 3.2. Biological data 3.3 GALATA AERONET-OC	Prof. S Moncheva, Violeta Slabakova	On-going
WP 5.Web portal development	5.1. Web site preparation and portal database design	Prof. A. Palazov	On-going

WP1 – Management

The 3rd progress report was generated and submitted to ESA during the reporting period . The required financial documents were prepared and submitted to ESA-P system by the Project coordinator in order to apply for the 1st payment (MS1) according to the Project payment plan.

WP3– Data analysis and QA

Task 3.1 AOP data analysis and QA

Data products from the free-fall optical profiler collected during the Black Sea Bio-Opt 2019 cruise include spectral values of: irradiance reflectance, remote sensing reflectance, normalized water–leaving radiance, diffuse attenuation coefficient. The processing and quality assurance of the radiometric data products followed the steps presented in [1] and carried out using the Optical Processor System [2] applying the multi-cast method (i.e., by combining multiple profiles in a single one to increase depth resolution in the subsurface layer applied to extrapolate subsurface values).

Task 3.2 Biological data

The quality control and quality assurance in collection and analysis of the bio-optical data set from the field campaign to serve as a reference statistically representative *in situ* measurements is instrumental for minimizing the uncertainties in satellite derived products

and validation of the specific Black Sea algorithm. For the in situ chlorophyll data set (analysis is completed) the QC/QA procedure followed ISO 10260 [3] and [4] for fluorometry. For phytoplankton QC/QA procedure followed the Black Sea Manuals [5 and 6].

Task 3.3 GALATA AERONET –OC data

The marine AERONET-OC data (i.e., L_{WN}) have been obtained from the Aerosol Robotic Network (AERONET-OC) of autonomous radiometer operated at a GALATA Platform (https://aeronet.gsfc.nasa.gov/new_web/ocean_color.html) for the period June 2016-|December 2018 . The data are restricted to the Level-2 products exhibiting the highest level of quality assurance (pre and post field calibration, automatically cloud clear and manually inspection [7]).

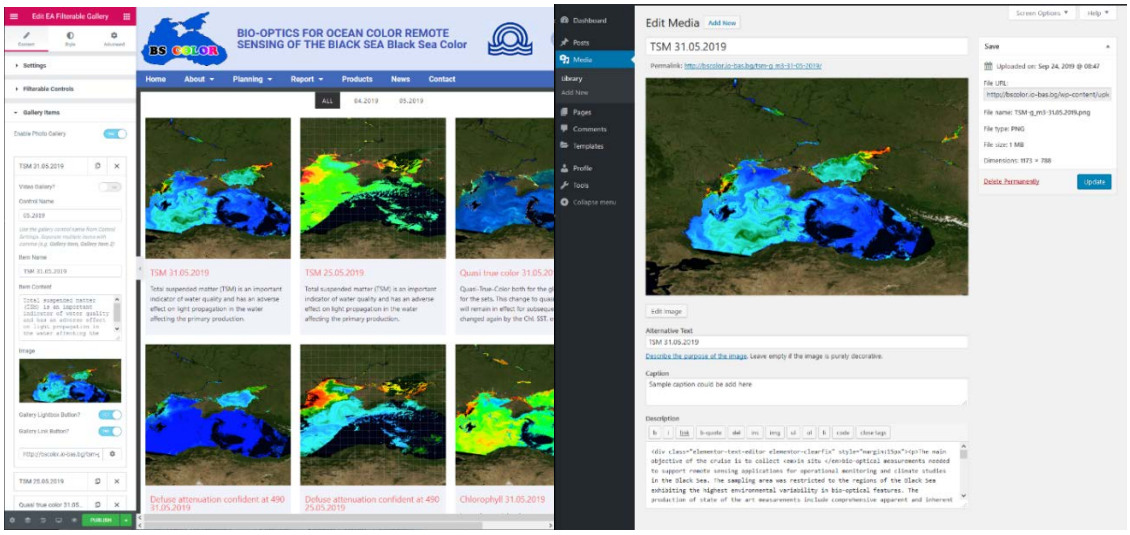
WP5– Web portal development

The first version (V1) of the Black Sea Color web site containing preliminary information about the project activities has been released. The website has been deployed and ran on IO-BAS server. The address of the website is http://bscolor.io-bas.bg/.

The web portal is built to support static and dynamic scientific content with the ability to be easy manageable and maintained. It is based on the WordProess.org Content Management System (CMS) with simple design and fine tuned between features and performance. The portal is easily extensible and virtually could host and serve almost all kinds of content types in a different form and easy to be supported.

Products page is a specially customized gallery that is designed to provide sets of graphical data along with their metadata. Several different layers of information details are provided in a categorizable manner.

The built in abilities for managing the images, data and there are attributes makes the work of adding, updating, extending information effortless.



2. Problems, Issues and Risk Areas

N/A

3. Meetings

Meeting Name	Description/ Purpose	Location	Planned Date	Actual Date	Attendees
PM 2 (KO+6)	Presentation of progress and discussion of planning and problems	Telecon	17.06.219	17.06.2019	IO-BAS ESA

4. Deliverables Status (overview of all contractual deliverables)

Deliverable Identifier	Title/ Description	Baseline Delivery Date @ KO	Planned or Actual Delivery Date	Associated Payment Milestone	Status (Planned / Delivered /Accepted)
TN1	Cruise plan	18/12/2018	12/03/2019	MS1	Accepted
TN2	1st progress report	18/12/2018	12/03/2019	MS1	Accepted
TN3	Bio-optical cruise report	18/12/2018	12/06/2019	MS1	Accepted
TN4	2nd progress report	18/12/2018	12/06/2019	MS1	Accepted
TN5	3rd progress report	18/12/2018	20/09/2019	MS2	Delivered

5. Milestone Payment Plan: Status

ID	Description	Amount (€)	Contractual date	Actual/ Expected Date	Status
MS1	Progress (MS1): Upon successful completion of WP 2 and acceptance by the Agency of all related deliverables: TN1, TN2, TN3 and TN4	60.000	18/06/2019	18/07/2019	Received

6. Planning

WP	Task Name	Year 1											Year 2											
		T0+1	T0+2	T0+3	T0+4	T0+5	T0+6	T0+7	T0+8	T0+9	T0+10	T0+11	T0+12	T0+13	T0+14	T0+15	T0+16	T0+17	T0+18	T0+19	T0+20	T0+21	T0+22	T0+23	T0+24
1	**Project Management and Reporting**			TN2			TN4			TN5			TN6			TN11			TN13			TN16			TN19,20,21,22,23,24
2	**Data collection**																								
	T 2.1 Organization bio-optical campaign			TN1																					
	T 2.2 Field measurements						TN3																		
3	**Data analysis and quality assurance**																								
	T3.1 Analysis and QA of AOP and IOP data													TN8											
	T 3.2. Analysis and QA of biological data													TN9											
	T3.3 Analysis and QA of AERONET –OC data													TN10											
4	**Satellite products validation and algorithm development**																								
	T 4.1 Satellite products validation.																	TN12							
	T 4.2 Algorithm development																				TN14				
	T 4.3 Cross-comparison of regional and global algorithms																					TN15			
	T 4.4 Assessment of new products																						TN17		
5	**Web portal development**																								
	T 5.2 Web site preparation and portal database design													TN7											
	T 5.2 Operational web portal																							TN18	

Legend

Work pakage duration

Task duration

Meetings

Deliverables TN#

7. Action Item – Status List (overview of all project actions)

N/A

8. Any other Business

N/A

References:

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3. ISO 10260: Water quality. Measurements of biochemical determinants. Spectrophotometric measurement of chlorophyll-a concentration.ISO 10260 (1992E).

4.Parsons T.R., Maita Y., Lalli C.M. A manual of chemical and biological methods for seawater analysis. Pergamon Press; Oxford: 1984. p. 173

5.Moncheva, Parr, 2015.Manual for Phytoplankton Sampling and Analysis in the Black Sea. Black Sea Commission.

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7.G. Zibordi, J. F. Berthon, F. Mélin, D. D'Alimonte, and S. Kaitala, "Validation of satellite ocean color primary products at optically complex coastal sites: Northern Adriatic Sea, Northern Baltic Proper and Gulf of Finland," Remote Sens. Environ., vol. 113, no. 12, pp. 2574–2591, 2009.