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 20/01/2020 to 20/04/2020.

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 and WP4 Satellite products validation and algorithm development.

WP1 – Management

The 5th 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 2nd payment (MS2) according to the Project payment plan.

WP4 Satellite products validation and algorithm development

Inventory of available in situ data sets of R_{rs}, Chl, CDOM, TSM for the Black Sea have been done.

The accuracy of OLCI Level-2 radiometric products have been assessed based on the data obtained from Galata AERONET OC site for the period April 2016 to August 2019.

The matchup analysis of OLCI Level 2 ocean color products with *in situ* data collected in the Black Sea within the period April 2016 – December 2019 has been performed.

The assessment of OLCI Level 2 radiometric products with radiometric measurements collected during two oceanographic campaigns is in 2016 and 2019 is in progress.

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
	1.3. 3rd progress report	Prof. S. Moncheva	Completed
	1.4. 4th progress report	Prof. S. Moncheva	Completed
	1.5. 5th progress report	Prof. S. Moncheva	Submitted
WP 2: Data collection	2.1. Bio-optical cruise work programme	V.Slabakova	Completed
	2.2. Field measurements	V. Slabakova	Completed
WP3:Data analysis and QA	3.1 AOP and IOP data	V.Slabakova	Completed
	3.2. Biological data	Prof.S. Moncheva	Completed
	3.3 GALATA AERONET-OC	V.Slabakova	Completed
WP4. Satellite products validation and algorithm development	4.1 Satellite products validation	V.Slabakova	On-going
	4.2 Algorithm development	V.Slabakova	On-going
WP 5.Web portal development	5.1 Web site preparation and portal database design	Prof. A. Palazov	Completed
	5.2 Operational web portal	Prof. A. Palazov	On-going

4 Problems, Issues and Risk Areas

Impact of the COVID-19 pandemic on the project activities

With work from home office the access to the IO-BAS computing and Internet facilities are not available. Hopefully the work restrictions in Bulgaria can be lifted on 13th of May. Otherwise there will be a slight delay in WP4 and WP 5 activities.

5 Meetings

Meeting Name	Description/ Purpose	Location	Planned Date	Actual Date	Attendees
PM 4 (KO+12)	4th progress meeting	Telecon	28.01.2020	28.01.2019	IO-BAS ESA

6 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	Accepted
TN6	4th progress report	18/12/2018	21/09/2019	MS2	Accepted
TN7	Description of the portal	18/12/2018	21/01/2020	MS2	Accepted
TN8	Analysis and QA of AOP and IOP data	18/12/2018	21/01/2020	MS2	Accepted
TN9	Analysis and QA of biological data	18/12/2018	21/01/2020	MS2	Accepted
TN10	Analysis and QA of AERONET-OC data	18/12/2018	21/03/2020	MS2	Accepted
TN11	5th progress report	18/12/2018	20/04/2020	MS3	Submitted

7 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
MS2	Progress (MS2): Upon successful completion of WP3 and acceptance of all related deliverables	40. 000	30/01/2020	30/02/2020	Received

8 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#

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

N/A

10 Any other Business

N/A