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Operational ECology

Ecosystem forecast products to enhance marine GMES applications

DG SPACE

Collaborative Project - small or medium-scale focused research project

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Author(s):	Z Wan, JI Allen, S Kay, K Tsiaras, J Beecham, G Cossarini, S Arkin, S Libralato, P Walker, A Christensen		
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OPEC Overview

“OPEC provides an enhanced capability to predict indicators of good environmental status in European regional Seas“

The OPEC project (Operational Ecology) will help develop and evaluate ecosystem forecast tools to help assess and manage the risks posed by human activities on the marine environment, thus improving the ability to predict the “health” of European marine ecosystems. The programme will focus on four European regional seas (North-East Atlantic, Baltic, Mediterranean and Black Seas) and plans to implement a prototype ecological Marine Forecast System, which will include hydrodynamics, lower and higher trophic levels (plankton to fish) and biological data assimilation.

Products and services generated by OPEC will provide tools and information for environmental managers, policymakers and other related industries, laying the foundations for the next generation of operational ecological products and identification of knowledge / data gaps.

OPEC will use the EU’s [Global Monitoring for Environment and Security Marine Service](#) as a framework and feed directly into the research and development of innovative global monitoring products or applications. This in turn will advise policies such as the European Marine Strategy Framework Directive and Common Fisheries Policy, as well as the continued monitoring of climate change and assessments of mitigation and adaptation strategies.

www.marineopec.eu

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Executive Summary

The purpose of this deliverable is to document the OPEC REA products publically available via the OPEC data portal <http://portal.marineopec.eu>. The aim is to deliver information on the state and dynamics of the European marine ecosystems to help protect and manage the marine environment and resources more effectively. The target audience includes marine managers, policy makers, industry and the research community. The data is provided following the Copernicus model, and is freely available for stakeholders to use and exploit as downstream services.

Relevance to Policy

A common set of descriptors with associated indicators for assessing the Good Environmental Status (GES) within the Marine Strategy Framework Directive (MSFD) and Essential Climate Variables (ECVs) has been defined across the four regions (Atlantic, Baltic Sea, Mediterranean Sea and Black Sea). These are the OPEC target variables. OPEC emphasizes the assessment of predictability of these key indicators. The OPEC data portal is dedicated to disseminating the products in a format that is easily accessible and downloadable by users and can be integrated into their systems.

1. Introduction

The primary goal of OPEC is to improve the quality of operational services for biogeochemical and ecological parameters and hence our ability to project the future status of European marine ecosystems by delivering a suite of error quantified indicators which describe changes in ecosystem function. WP2 of OPEC has established model systems for each region/sub region (Baltic, NE Atlantic, Mediterranean and Black Sea). Each model system comprises a hydrodynamic model code, coupled to a plankton model which includes carbonate chemistry, a data assimilation system and a HTL model. Earlier deliverables describe the model system (D2.4), forcing functions (D2.2), target indicators and metrics (D2.5) and validation data (D2.3). Each model system has performed a 20yr hindcast of their region for the targeted indicators and MSFD descriptors, and a 10yr reanalysis run with data assimilation.

The aim of Rapid Environmental Assessment (REA) in OPEC is to provide information which allows users to rapidly gain an overview of the current state of the ecosystem. This is a new service aimed at supporting policy, environmental management and other downstream services by providing error quantified hindcast estimates of the state of the environment in the recent past using the core model systems. WP3 for OPEC provides 3D ecosystem indicators covering a range of temporal and spatial scales. Emphasis has been placed on the GES descriptors for eutrophication, biodiversity and foodwebs and Essential Climate Variables. OPEC offers users open and free access to this simulated data. The primary tool for this dissemination is a suite of web-based tools that enable rapid integration and visualisation of multi-platform, and multi-parameter, data (T6.1). Following the principles of GEO common infrastructure, OPEC has developed a web based visualisation system, with data download and processing services. It can be viewed via the following link <http://portal.marineopec.eu>. The web portal hosts the results for each region on one site allowing easy integration and visualisation of data from multiple sources, with clear indications of quality and source. The focus is on delivering data in a form that allows for rapid interpretation in regional

contexts, and supports policy implementation, environmental management and relevant commercial uses.

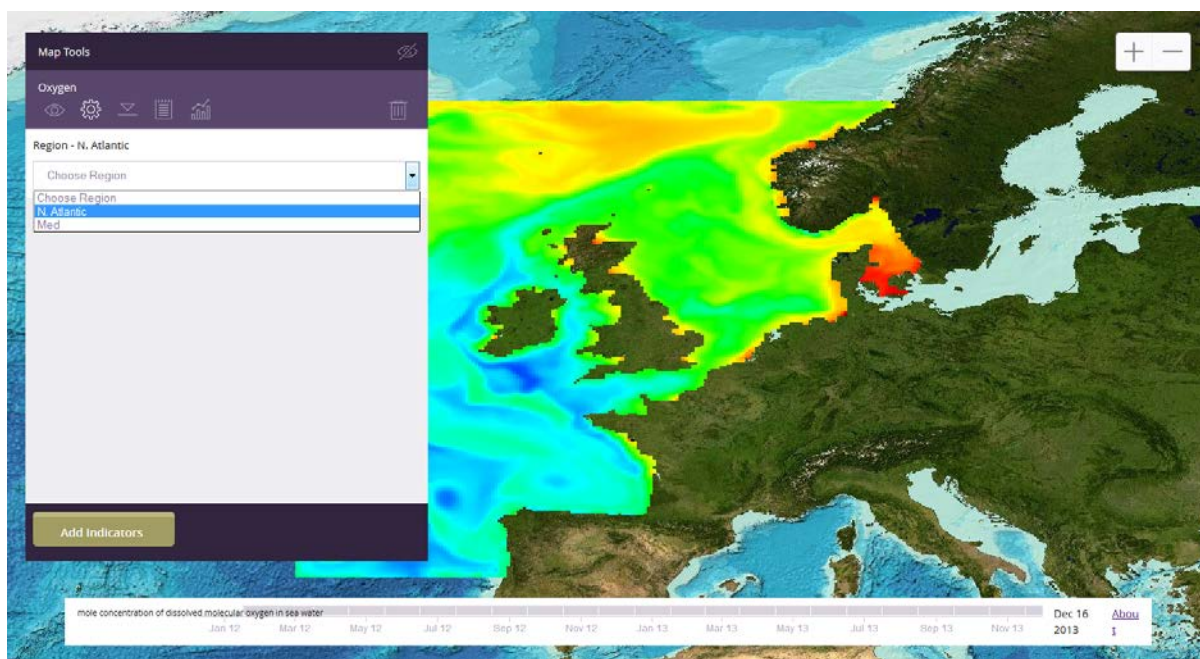


Figure 1. Example screenshot from the OPEC data portal showing simulated oxygen in the North Atlantic on Dec 16 2013.

OPEC target indicators

At an earlier stage of the project key indicators were agreed (D2.3). These indicators were considered to be fairly robust with a stronger level of model skill and uncertainty. The target indicators provide information about the state of the marine environment in each regional sea and are considered to be of interest and relevance to decision makers and environmental managers.

Each partner has provided model outputs for these agreed indicators where their model allowed and there was confidence in the output. Additional indicators are also included in the portal as appropriate for the various models.

The tables that follow provide a region by region summary of the data available in the portal. The tables describe for each region, the common name for each indicator, an indicator description, units, maximum and minimum values, and a time interval. In addition to help provide guidance for data users, the data creators have provided an expert judgement to estimate of their confidence (High, Medium or Low) in model data product. Where a key indicator has not been provided an explanation is given.

For each variable model data is provided for the period 1990 to the present day. To do this we have combined three simulations (figure 2), the hindcast (1990 – 2009), a transition simulation (2010 – June 2012) and the REA (rolling three month hindcast to June 2014). The hindcast simulations are described in D2.6 and D2.8. The regional hindcast in the Baltic, NE Atlantic and Black Seas are forced with regional climate hindcast performed by Danish Climate Centre at DMI using a regional

climate model HIRHAM5 for the period 1989-2009. The exception is in the Mediterranean region, where 2 models were run, HCMR (Greece) using the DMI forcing and OGS (Italy) driving their model with the operational ocean physics forecast provided by MyOcean. The transition and REA simulations were forced with archived meteorological forecast products (Baltic: DMI), NE Atlantic (UKMO), Black Sea (Turkish MO) and Mediterranean (HCMR: POSIDEN). The OGS simulations continued to use the MYOcean operational ocean physics.

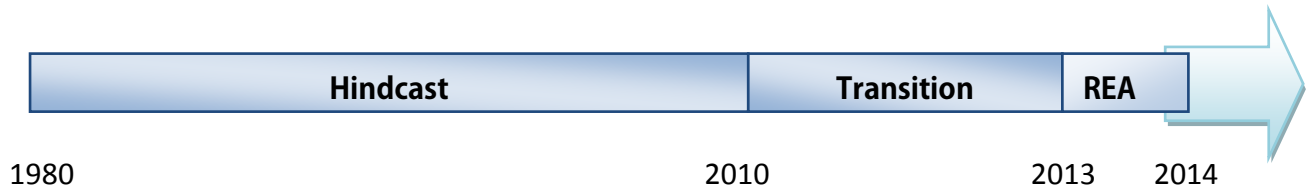


Figure 2: Schematic of the timelines of the OPEC simulations.

Please note: At the time of update (November 2014) this document provides details of data currently available on the portal. New data is regularly added to reflect the continually expanding data set.

2. OPEC data portal data holdings by region

2.1 Baltic

Region: **Baltic (DMI)**
 Model: HBM-ERGOM
 Met forcing: DMI regional hindcast
 Time period: 2012 06 01 – 2013 12 31
 Contact: Zhenwen Wan zw@dmj.dk
[Target indicators](#) | [Additional Indicators](#)

Common name	Description	Portal	Units	Min	Max	Interval	Expert Judgement
Temperature	Temperature of sea water	Yes	degrees Celsius	-3	30	Monthly	High
Salinity	Salinity of sea water	Yes	PSU	0	36	Monthly	High
Nitrate (DIN)	Dissolved inorganic nitrogen (nitrate + ammonia)	Yes	mmol m ⁻³	0	100	Monthly	Medium
Phosphate (DIP)	Dissolved inorganic phosphate	Yes	mmol m ⁻³	0.01	4.67	Monthly	Medium
Silicate	Silicate is not a limiting nutrient in the Baltic and so not included						
Mixed layer depth	Thickness of mixing layer	Yes	m	4	300	Monthly	Medium
Oxygen	Dissolved oxygen	Yes	mmol m ⁻³	15	424	Monthly	Medium
Net Primary Production	Not explicitly included in the model						
Chlorophyll a	Chlorophyll a	Yes	mg C m ⁻³	0	100	Monthly	Medium
pH	Ph value of acidity of sea water	Yes	N.A.	0	14	Monthly	Low
Phytoplankton	Chlorophyll a can be considered as a proxy for phytoplankton						
Zooplankton	Zooplankton in nitrogen content	Yes	mmol N m ⁻³	0	1.4	Monthly	Low

Region: **Baltic (DTU)**
 Model: SMS
 Met forcing: fisheries and survey data and HBM-ERGOM
 Time period: 1990-2013
 Contact: Asbjorn Christensen asc@aqua.dtu.dk
[Additional Indicators](#)

Common name	Description	Portal	Units	Min	Max	Interval	Expert Judgement
Cod (age2)	Age class of cod	Yes	Tonnes/km ²	0.05	0.17	Quarterly	Medium

2.2 NE Atlantic

Region: **NE Atlantic**
 Model: POLCOMS-ERSEM
 Met forcing: DMI regional hindcast
 Time period: 2012 06 01 - 2013 12 31
 Contact: Stefano Ciavatta, s.ciavatta@pml.ac.uk / Susan Kay suka@pml.ac.uk / Momme Butenschon momm@pml.ac.uk / Icarus Allen jia@pml.ac.uk
[Target indicators](#) | [Additional Indicators](#)

Common name	Description	Portal	Units	Min	Max	Interval	Expert Judgement
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Temperature	Temperature	Yes	degrees Celsius	-2	20	Monthly	High	
Salinity	Salinity	Yes	psu	10	36.5	Monthly	High	
Nitrate	Nitrate	Yes	mmol m ⁻³	0	100	Monthly	Medium	
Phosphate	Phosphate	Yes	mmol m ⁻³	0	2	Monthly	Medium	
Silicate	Silicate	Yes	mmol m ⁻³	0	40	Monthly	Medium	
Mixed layer depth	Mixed layer depth	Yes	m	5	750	Monthly	Medium	
Oxygen	Dissolved oxygen	Yes	mmol m ⁻³	150	350	Monthly	Medium	
Net Primary Production	Net primary production	Yes	metric_ton C d ⁻¹	-4	110	Monthly	Medium	
Chlorophyll a	Chlorophyll a	Yes	mg m ⁻³	0	15*	Monthly	Medium	
Phytoplankton	Total phytoplankton carbon	Yes	mg C m ⁻³	0	700*	Monthly	Medium	
Zooplankton	Total zooplankton carbon	Yes	mg C m ⁻³	0	200*	Monthly	Low	
Euphotic depth	Euphotic depth	Yes	m	0	250	Monthly	Medium	
nitrate/phosphate ratio	Nitrate/phosphate monthly mean of daily ratio	Yes		1	0	43	Monthly	Medium
nitrate/silicate ratio	Nitrate/silicate monthly mean of daily ratio	Yes		1	0	300	Monthly	Medium
pCO2	Partial pressure of co2 in water (PML)	Yes	µatm	100	500	Monthly	Medium	
Potential energy anomaly	Potential energy anomaly for top 400 m of water	Yes	J m ⁻³	0	520	Monthly	Medium	

* These values are estimates and need to be checked against what is used on the web server in practice

The following variables could also be provided if required:

Daily: any of the variables provided at monthly frequency

Seasonal temperature and salinity anomalies

Annual oxygen minimum, chlorophyll maximum, bloom maximum and duration, winter minimum N, P and Si.

pH, as daily or monthly average

Region: NE Atlantic (Cefas)

Model: POLCOMS-ERSEM-Ecospace – Cefas North Sea Model

Met forcing: DMI regional hindcast

Time period: 2012 06 01 – 2013 12 31

Contact: Jonathan Beecham Jonathan.Beecham@cefas.co.uk

Area: Latitude 51. to 60.8899 by 1/9 degrees

Longitude -6 to 10 by 1/6 degrees

Common name	Description	Portal	Units	Min	Max	Interval	Expert Judgement
Adult Cod	Adult cod wet biomass	Yes	g/m ²	0	0.451	Daily	Low
Adult herring	Adult herring wet biomass	Yes	g/m ²	0	7.54	Daily	Medium
Juvenile cod	Juvenile cod wet biomass	Yes	g/m ²	0	0.429	Daily	Low
Juvenile herring	Juvenile herring wet biomass	Yes	g/m ²	0	0.162	Daily	Low
Phytoplankton biomass	Phytoplankton biomass	Yes	g/m ²	0	100	Daily	Medium

Plaice	Plaice wet biomass	Yes	g/m ²	0	4.811	Daily	Low
Sandeels	Sandeel wet biomass	Yes	g/m ²	0	112.2	Daily	Low
Seabirds	Seabird wet biomass	Yes	g/m ²	0	0.0333	Daily	Low
Zooplankton	Herbivorous_and_Omnivorous_zooplankton_copepods_	Yes	g/m ²	0	35	Daily	Medium

2.3 Mediterranean

<i>Region: Mediterranean (HCMR)</i>							
<i>Model: POM-ERSEM</i>							
<i>Met forcing: POSEIDON regional hindcast</i>							
<i>Time period: 2012 06 01 – 2013 12 31</i>							
<i>Contact person: Kostas Tsiaras (ktsiaras@hcmr.gr), George Triantafyllou (gt@hcmr.gr)</i>							
Target indicators Additional Indicators							
Common name	Description	Portal	Units	Min	Max	Interval	Expert Judgement
Temperature	Sea water temperature	Yes	degrees Celsius	10	30	Monthly	High
Salinity	sea water salinity	Yes	psu	32	40	Monthly	High
Nitrate	mole concentration of nitrate in sea water	Yes	mmol m ⁻³	0.1	5	Monthly	Medium
Phosphate	mole concentration of phosphate in sea water	Yes	mmol m ⁻³	0.005	0.15	Monthly	Medium
Silicate	mole concentration of silicate in sea water	Yes	mmol m ⁻³	0.1	5	Monthly	Medium
Mixed layer depth	Ocean mixed layer thickness	Yes	m	10	500	Monthly	High
Oxygen	mole concentration of dissolved oxygen in sea water (HCMR)	Yes	mmol m ⁻³	180	280	Monthly	Low
Net Primary Production	net primary prod in sea water (PML)	Yes	mg C m ⁻³ d ⁻¹	0.1	20	Monthly	Medium
Chlorophyll a	mass concentration of Chl in sea water	Yes	mg m ⁻³	0.02	3	Monthly	Medium
Phytoplankton	Mass concentration of phytoplankton in sea water	Yes	mgrC m ⁻³	0.5	40	Monthly	Medium
Zooplankton	Mass concentration of mesozooplankton in sea water	Yes	mgrC m ⁻³	0.5	10	Monthly	Medium
pCO2	partial pressure of carbon dioxide in sea water	Yes	µatm	100	500	Monthly	Medium
pH	pH of sea water	Yes	N.A.	7.5	8.5	Monthly	Low

Region: Mediterranean (OGS)							
Model: OPATM-BFM- ECOPATH with ECOSIM							
Met and physical forcing: MyOcean Mediterranean Forecast System (MFC)							
Time period: 2012 06 01 - 2013 12 31							
Contact persons: Gianpiero Cossarini gcossarini@ogs.trieste.it / Simone Libralato slibralato@ogs.trieste.it / Cosimo Solidoro csolidoro@ogs.trieste.it							
Target indicators		Additional Indicators					
Common name	Description	Portal	Units	Min	Max	Interval	Expert Judgement
Temperature	Temperature	Yes	°C	5	27	Monthly	High
Salinity	Salinity	Yes		28	39.5	Monthly	High
Nitrate	Winter min nitrate	Yes	mmol m ⁻³	0.2	8	Monthly	High
Phosphate	Winter mini phosphate	Yes	mmol m ⁻³	0	0.3	Monthly	High
Silicate	Mole concentration of silicate in sea water	Yes	mmol m ⁻³	0	10	Monthly	High
Mixed layer depth	Not explicitly computed by the model						
Oxygen	Oxygen	Yes	mmol m ⁻³	150	250	Monthly	Medium
Net Primary Production	Net primary production	Yes	mg C m ⁻³ d ⁻¹	-5	25	Monthly	Medium
Chlorophyll a	Total chl	Yes	mg m ⁻³	0	0.4	Monthly	High
pH	Not included since confidence is low						
Phytoplankton	Total phytoplankton biomass in carbon	Yes	mg C m ⁻³	0	30	Monthly	High
Zooplankton	Total zooplankton biomass in carbon	Yes	mg C m ⁻³	0	20	Monthly	Medium
Ammonia	Ammonia	Yes	mmol m ⁻³	0	2	Weekly	High
Nitrate/Phosphate ratio	Ratio of (Nitrate + Ammonia) to Phosphate	Yes	1	1	225	Monthly	Medium
Nitrate/Silicate ratio	Ratio of Nitrate and Silicate	Yes	1	0	2	Monthly	Medium
pCO ₂	partial pressure of CO ₂ in water	Yes	µatm	200	480	Monthly	Medium
Anchovy	Total biomass in wet weight of anchovy	Yes	Tons/k m ²	0.4	1.6	Monthly	Medium
Sardine	Total biomass in wet weight of sardine	Yes	Tons/k m ²	0.3	3.3	Monthly	Medium

2.4 Black Sea

Region: Black Sea (IMS-METU)							
Model: POM-BIMS_ECO							
Met forcing: DMI regional hindcast							
Time period: 1990-2009							
Contact persons: Sinan Arkin sinan.arkin@ims.metu.edu.tr / Baris Salihoglu baris@ims.metu.edu.tr							
Target indicators		Additional Indicators					
Common name	Description	Portal	Units	Min	Max	Interval	Expert Judgement
Temperature	Temperature	Yes	degrees Celsius	5	25	Monthly	High

Salinity	Salinity	Yes	psu	14	22	Monthly	high
Nitrate	Mole concentration of nitrate in sea water	Yes	mmol m ⁻³	0	6	Monthly	medium
Phosphate	Mole concentration of phosphate in sea water	Yes	mmol m ⁻³	0	1.5	Monthly	medium
Silicate	The Black Sea model does not include silicate						
Mixed layer depth	Ocean mixed layer thickness	Yes	m	0	60	Monthly	medium
Oxygen	Mole concentration of dissolved oxygen in sea water	Yes	mmol m ⁻³	10	350	Monthly	medium
Net Primary Production	Net primary production in sea water	Yes	mg C m ⁻³ d ⁻¹	10	80	Monthly	medium
Chlorophyll a	Mass concentration of chlorophyll in sea water	Yes	mg m ⁻³	0.5	2	Monthly	medium
pH	In terms of carbonate system properties, the model has better skill in predicting pCO ₂ in seawater than pH						
Phytoplankton	Chlorophyll is a good proxy for phytoplankton in the Black Sea model						
Zooplankton	Mass concentration of total zooplankton expressed as carbon in sea water	Yes	mg C m ⁻³	0	100	Monthly	low
pCO ₂ w	Partial pressure of carbon dioxide in sea water	Yes	µatm	300	1000	Monthly	medium