OPerational ECology

Ecosystem forecast products to enhance marine GMES applications

DG SPACE

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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.

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Contents

Executive Summary

As a contribution for the next generation model setup and benchmarking planned to be done in the WP2 of the OPEC project, Task 2.5 provided validation data sets covering hydrography, nutrients, plankton and fish. The data requirements for each region varied according to the descriptors under consideration. Much of the required data has already been collated in open access data bases (e.g. ICES, PANGEA, SeaDataNet) and in previous and ongoing framework.

Relevance to Policy

Marine ecosystem models are becoming increasingly complex and sophisticated, and are being used to estimate the effects of future changes in marine systems with a view to informing important policy decisions. Despite their potential importance for this, far too little attention has been, and is generally, paid to model errors and the extent to which model outputs actually relate to real-world processes. To use our simulations either for science or policy applications we need to understand and be able to articulate their quality. This requires us to be able to provide information on model skill (i.e. how well it fits the observations), model uncertainty (i.e., model sensitivity to external forcing, structure and parameter choice), and predictability (i.e. articulating the time and space scales at which simulation outputs have 'skill').

First and foremost the credibility of future projections is dependent on the adequate simulation of the ocean biogeochemical features under current climate conditions. This requires an objective assessment of model skill against available data.

Meta data for validation data for regional systems

Skill assessment period will be 1990-2009 considering the ecological data scarcity in most regions and the fact that DMI downscaled forcing covers this period. Assessment will be made for the whole domain considering assessment boxes and during the period where data is available.

Each region has access to in-situ or remote sensing data for the following variables:

- Temperature
- Salinity
- DIN
- DIP
- Surface Chl-a
- Dissolved Oxygen

For comparisons against satellite, chlorophyll-a data should be transformed (k^2 or omega transformations), then correlation will be computed. Same metrics will be used in adequate assessment areas for each region.

Validation of Reanalysis Simulations

It is important to note that care needs to be taken in validating simulations which involve data assimilation. In OPEC we will use primarily use Ocean Colour data products (e.g.

chlorophyll, K_d) for assimilation into the biogeochemical models. Therefore these Earth Observation (EO) data products may not be used to validate the simulations, but can be used to verify the assimilation system is working correctly and to assess the forecast skill of the assimilated variable. The validation of a reanalysis simulation involves quantifying the model skill in reproducing non assimilated variables when compared with independent data.

Regional Status

Baltic Sea HBM-ERGOM

In-situ Data
In-situ observations for Temperature, Salinity, DIN, DIP, Chlorophyll a, DO are from ICES database from 1970-2010. There are 18 stations which have nearly monthly-series of observations.

Remote Sensing data
Remote sensing data include SST and Chlorophyll-a since 2006. The chlorophyll concentration have been derived from the MERIS Instrument onboard ENVISAT while the SST are derived from numerous satellite sensors (AVHRR, ATSR & AATSR) combined in a complex interpolation scheme.

Temperature [degrees C]

Salinity [psu]

Nitrate[mmol/m^3]

Phosphate [mmol/m^3]

Chlorophyll-a [mmol/m^3]

Oxygen [ppm]

North East Atlantic POLCOMS-ERSEM

The available data is mostly based on remote sensing products and nutrient, chlorophyll-a, oxygen, temperature and salinity data available through the ICES database:

Remote Sensing data:

Pathfinder: full period, SST [degrees C]

SeaWiFS: 1998-2004, Case 1, ocean colour (Chlorophyll-a [mg/m^3]).

MODIS: from 2003, Case 2, ocean colour (Chlorophyll-a [mg/m^3]).

Note that remote sensing products which have been used in the assimilation process cannot be used to validate reanalysis simulations only to verify the assimilation works.

In Situ data:

ICES Dataset on Ocean Hydrography forfull time period where available Data from low resolution CTD and bottle measurements. (In total each dataset contains >100 000 data points.)

Temperature [degrees C]
Salinity [psu]
Nitrate[mmol/m^3]
Phosphate [mmol/m^3]
Chlorophyll-a [mmol/m^3]
Oxygen [ppm]

North East Atlantic Ecosim / Ecospace Higher Trophic Level Model

Higher trophic level data is available for the following species which will be used in the model. Spatial data will generally be at the level of ICES rectangle which is approximately 55.6 km. The area under consideration will be the North Sea region between approximately 2 degrees West and 9 degrees East and between 52 and 62 degrees North.

Herring: IBTS Data for Herring and Herring larvae which can be used to estimate recruitment are available for all years from 1990. The spatial unit of data is the ICES statistical rectangle of approximately 55 km in length & width (varies with latitude). Data is annual.

Cod: IBTS data is available as above data is size / length sensitive so can separate measures of productivity and population.

Sand Eel: This is a regional species with important populations on the Dogger Bank, banks on the Eastern North Sea and East of the Scottish Isles. Spawning stock biomass data exist for all years and larval numbers for recent years. Analysis will focus on annual time series data.

Plaice: Annual IBTS data available by ICES rectangle for the time period in question.

Sea Birds: Data from JNCC on seabird numbers and recruitment (surviving chicks) available by species (model lists seabirds as an aggregate functional group) for 1990 to 2012. Because data is on nesting rather than feeding birds and birds can be wide ranging, data will be examined non-spatially.

Mediterranean Sea POM-ERSEM

Avaialble data are mostly based on remote sensing products and in situ data for dissolved inorganic nutrients (nitrate, phosphate, silicate), chlorophyll-a and pH available through Medatlas 2002 and SeaDatanet databases.

Remote Sensing data:
AVHRR: 1990-2009, SST [degrees C]
SeaWiFS: 1998-2004, ocean colour (Chlorophyll-a [mg/m^3]).
MODIS: 2003-2009, ocean colour (Chlorophyll-a [mg/m^3]).

Note that remote sensing products which have been used in the assimilation process cannot be used to validate reanalysis simulations only to verify the assimilation works.

In Situ data:

1990-2000: Extracted from Medatlas 2002 database (202 cruises containing >10 000 stations.)

Temperature [degrees C]

Salinity [psu]

Nitrate[mmol/m^3]

Phosphate [mmol/m^3]

Chlorophyll-a [mmol/m^3]

Oxygen [ppm]

Aegean Sea Anchovy

Validation data (HCMR database, Somarakis et al., 2007; Giannoulaki et al., 2007) for anchovy cover the N. Aegean area (22E-27E, 38N-41N).

Growth (weight):
Larvae multi-year estimates, adult year-to-year growth (age0, age1, age2)

Abundance:
Egg and larvae spatial distribution (June: 2003-2006)

Biomass:

Adult spatial distribution (June: 2003-2006)

Total biomass Time series (June: 2003-2006)

Catch:

Annual values 2002-2008

Length distribution of anchovy population (June: 2003-2006)

Mediterranean Sea OPATM-BFM-EwE

Low trophic level data:

The available data is mostly based on remote sensing products available through the MyOcean catalogue and in situ data for dissolved inorganic nutrients (nitrate, phosphate, silicate), oxygen and chlorophyll-a through EU/MEDAR/MEDATLAS II and EU/MTP II/MATER databases (Manca et al. 2004) and possibly other data retrieved from National Oceanographic Data Centre (NODC) at OGS.

Remote Sensing data:

SeaWiFS: 1998-2010, ocean colour (Chlorophyll-a [mg/m^3]).

MODIS: 2007-2009, ocean colour (Chlorophyll-a [mg/m^3]).

Note that remote sensing products which have been used in the assimilation process cannot be used to validate reanalysis simulations only to verify the assimilation works.

In Situ data:

Extracted from EU/MEDAR/MEDATLAS II and EU/MTP II/MATER databases (~50000 profiles, mostly from 1980 to 1999), and possibly from NODC-OGS databases (for the extension to the last decade).

Nitrate[mmol/m^3]

Phosphate [mmol/m^3]

Silicate [mmol/m^3]

Chlorophyll-a [mmol/m^3]

Oxygen [ppm]

High trophic level data:

Higher trophic level data is available for the following species which will be used in the model. The area under consideration will be the Adriatic Sea (GFCM GSA 17) from Trieste to Vieste latitude.

Data regard midyear biomass in metric tonnes (t) for the whole basin as estimated by tuned Virtual Population Analysis. Biomass data for sardine (*Sardina pilchardus*) span from 1975 to 2006, and for anchovy (*Engraulis encrasicolus*) from 1976 to 2006 (Santojanni et al., 2003, 2005, 2006a, 2006b, 2006c).

Catch data (t) per each year from 1975 to 2006 for sardine and from 1976 to 2006 for anchovy are also available

Black Sea POM-BIMS

Validation data are mostly based on remote sensing products and some in situ data as explained below:

Time frame 1980-1996 (Source: Black Sea Data Base)

DIN, DIP, Chlorophyll a:

Data available from cruises etc. across the entire Black Sea. (ca. > 2000 stations per parameter).

DO: data from one cruise in open Black Sea 1993 available (19 stations) .

Time frame after 1996 (Source: SeaDataNet)

DIN, DIP: after 1996 total of 217 stations in coastal areas off Georgia available (1999, 2000, 2006,2008-2010).

DO: 98 stations available (2007-2010)

Note that remote sensing products which have been used in the assimilation process cannot be used to validate reanalysis simulations only to verify the assimilation works.

HTL validation

Catch statistics: TUIK (Turkish Statistics Agency), FAO time series and Marine Science Institute database on anchovy catch.

Biomass and F estimations: after Prodanov et al., 1997

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