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Coastal pollution

Copernicus for Coastal Zone Management and Marine Environment Monitoring Service

Copernicus
Europe's eyes on Earth

Space

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INTRODUCTION

Main responses from a multinational sample of 10 countries (n=10,106) to a qualitative question that asked individuals to state the three main marine environment matters.
Frequency of responses is illustrated by the size of the text, with pollution noted most often
reproduced from Buckley and Pinnegar (2011)

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O U T L I N E

1. Oil spill in the Baltic area - Seatrack Web (STW) oil drift calculation system

2. Examples of oil spill/plastics modeling using CMEMS data in the Med Sea

- Operational forecast of oil spill drift (e.g. MEDESS)
- Hazard mapping for operational oil spills
- Plastic debris modeling

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CMEMS Baltic Sea data

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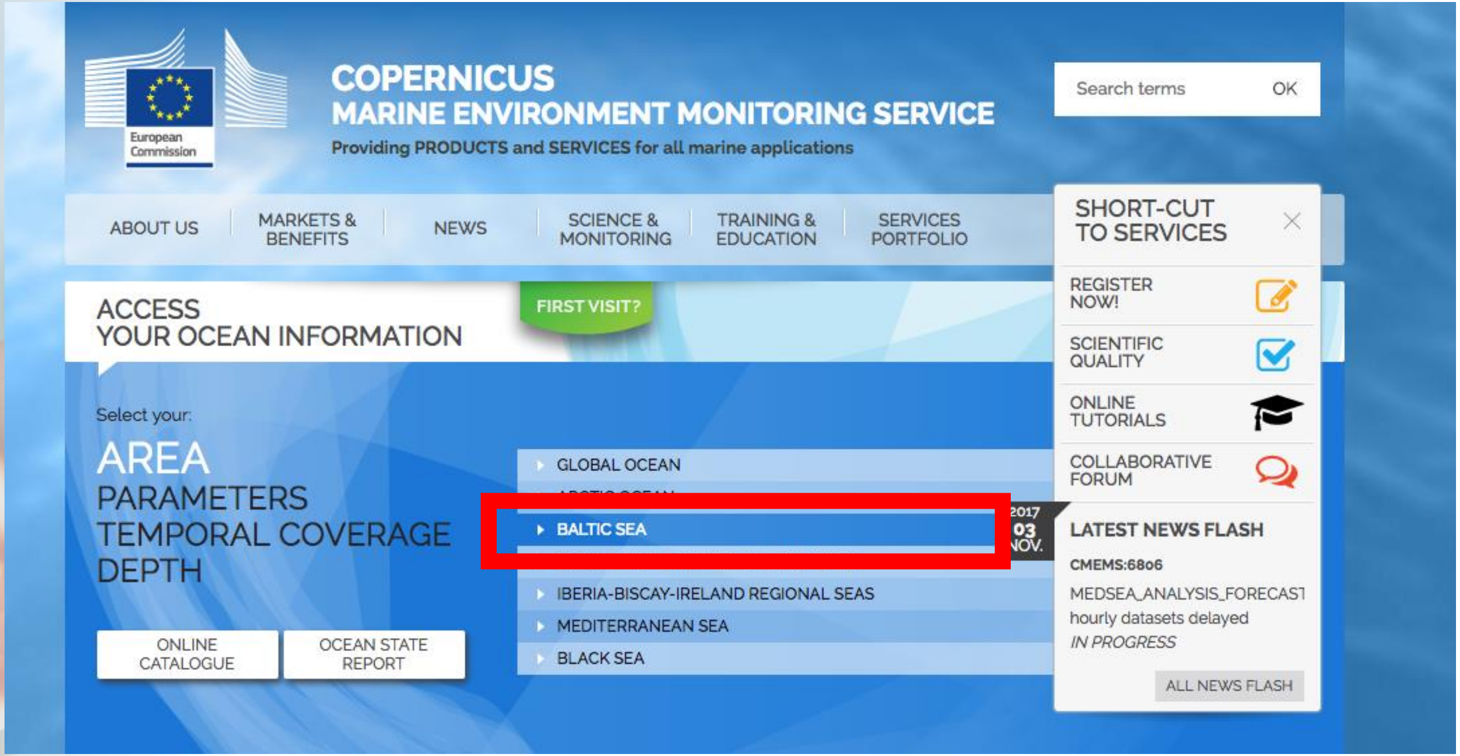

http://marine.copernicus.eu/

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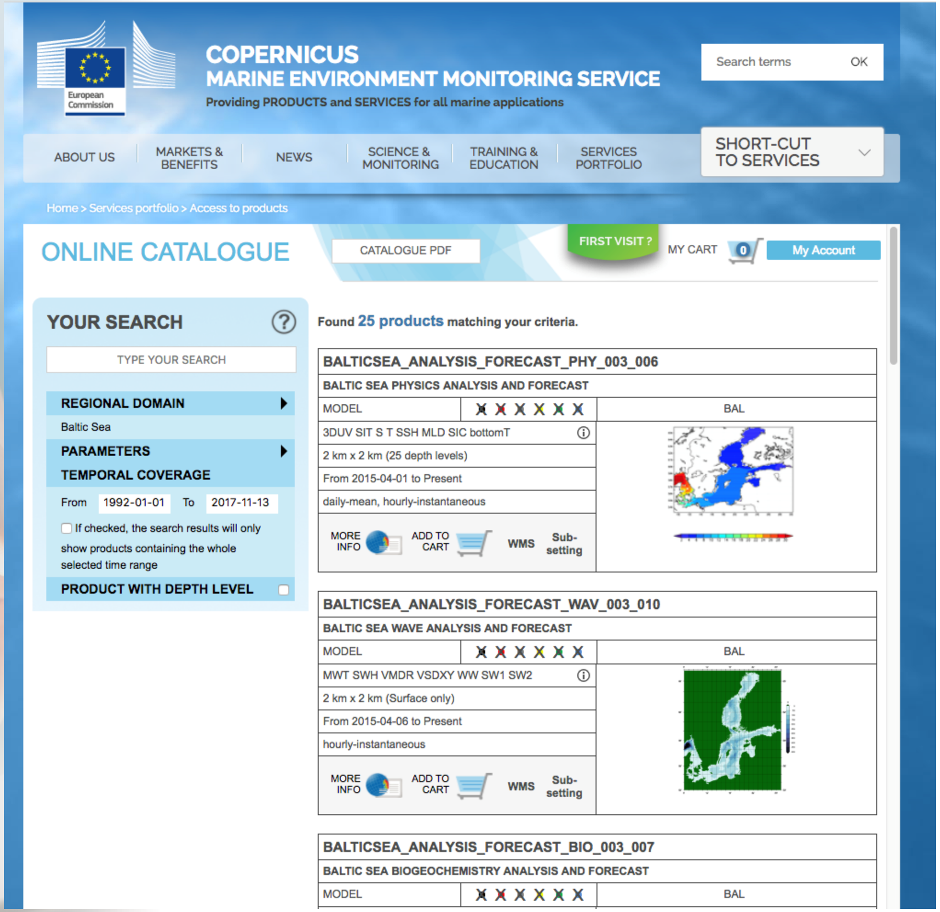
CMEMS Baltic Sea data



Some available products

- Physics and Waves Analysis and Forecast
- Biogeochemistry Analysis and Forecast
- Physics Reanalysis From SMHI (1989-2015)
- Ocean Colour Chlorophyll (Daily Observation)
- Ocean Colour Optics Product (Daily Observation)
- Sea Surface Temperature Analysis
- Sea Surface Temperature Reprocessed
- Sea Ice Concentration And Thickness
- In Situ Near Real Time Observations
- Observations Yearly Delivery In Delayed Mode (1990-2015)

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Seatrack Web oil drift calculation system

Seatrack Web (STW) oil drift calculation system is the official **HELCOM** drift model/forecasting and hindcasting system which is used for calculating the fate of oil spills

- hosted by Swedish Meteorological and Hydrological Institute (SMHI) and developed together by SMHI and a group of partner institutions around the Baltic Sea Denmark (FCOO), Germany (BSH) and Finland (FMI)
- a **three dimensional spill tracking model** and an easy to use web interface
- available online for **national authorities and certain research organisations**
- STW system is able to make forecasts of **how a cloud of particles (e.g. oil) will be moving and behaving on the sea surface**
- combines modeling run in a backtracking mode with the HELCOM AIS (Automatic Identification System) data in order to **identify which ships have passed the track of the oil spill**

HELCOM

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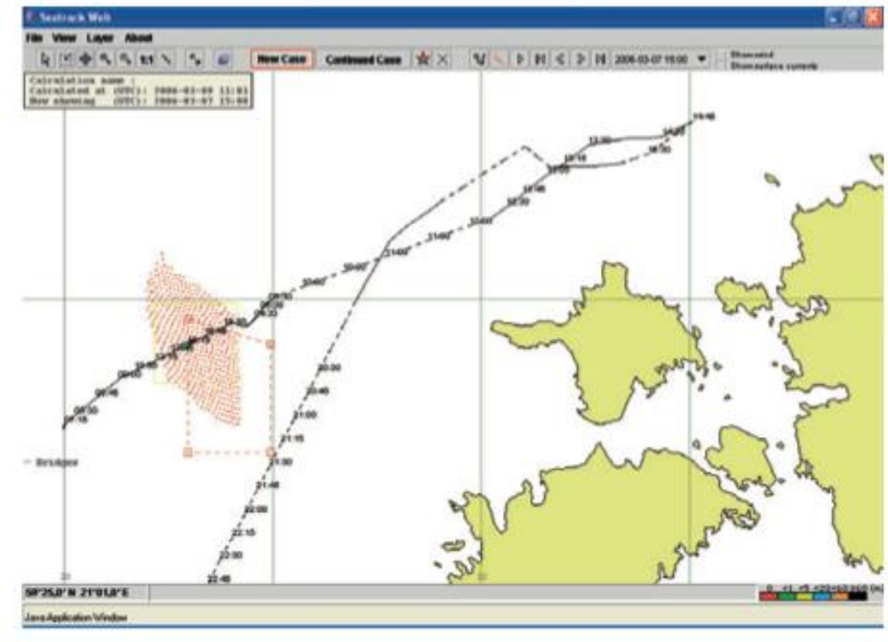
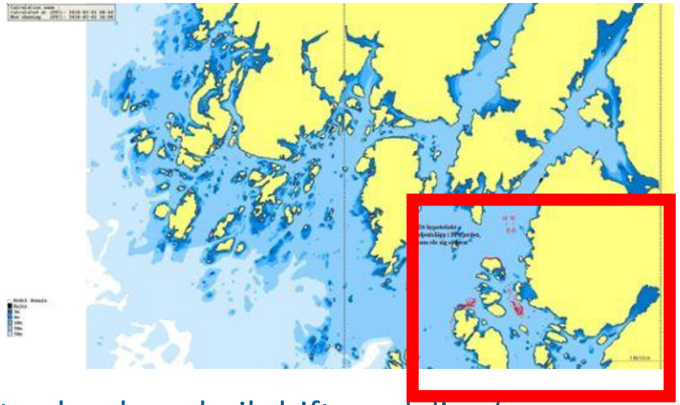
Seatrack Web oil drift calculation system



HELCOM Seatrack Web showing an oil slick and its backtracking trajectory (in red) together with the route of a suspected ship



http://www.helcom.fi/action-areas/response-to-spills/helcom-seatrackweb-and-oil-drift-modeling/
http://www.smhi.se/en/services/professional-services/environment/high-resolution-oil-drift-forecasts-1.7625

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OUTLINE

1. **Oil spill in the Baltic area** - Seatrack Web (STW) oil drift calculation system

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CMEMS Med-MFC data

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- Ocean currents (hourly forecasts, daily analyses) for calculation of the **oil spill** and **plastic transport**
- Sea surface temperature (hourly forecasts, daily analyses) for calculation of the oil weathering
- Mediterranean Sea physics as boundary conditions for nesting a high-resolution model
(Adriatic Forecasting System AFS)

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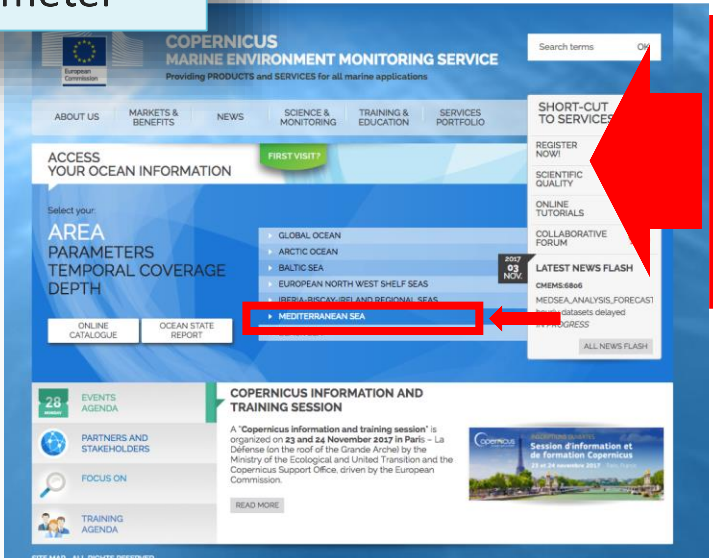
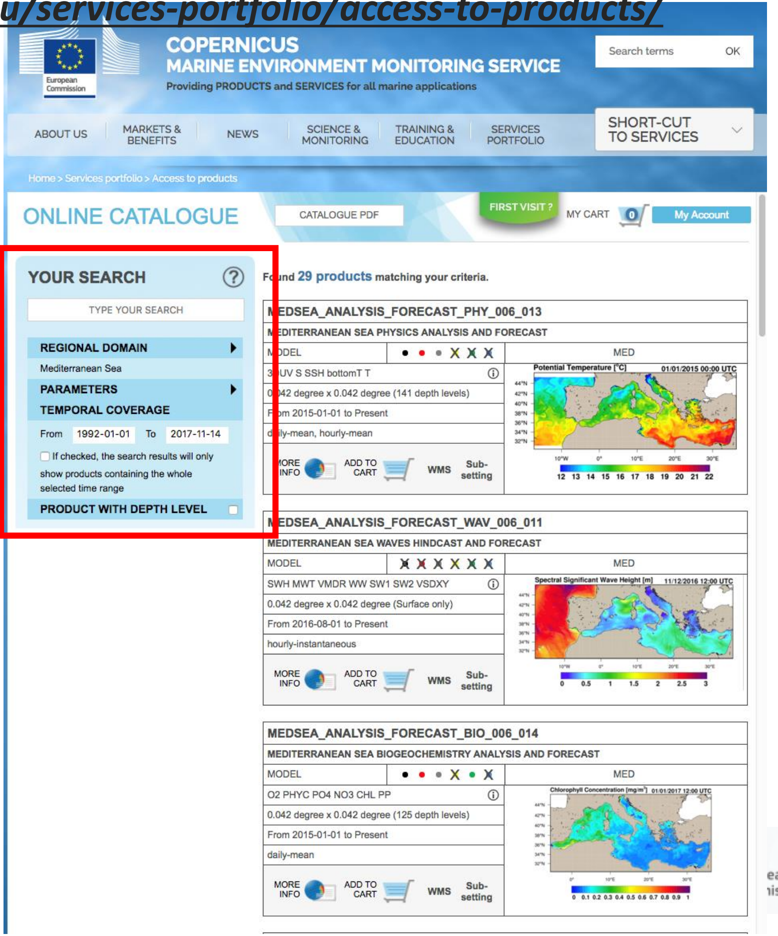
Data: how to download the product

Online catalogue on ***http://marine.copernicus.eu/services-portfolio/access-to-products/***

Select the area of interest and the parameter





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Data: how to download the product


ONLINE CATALOGUE

CATALOGUE PDF | FIRST VISIT ? | MY CART 0 | My Account

MEDITERRANEAN SEA PHYSICS ANALYSIS AND FORECAST

Metadata provided by CMEMS
Credits: E.U. Copernicus Marine Service Information

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DOWNLOAD PRODUCT

INFORMATION | DOCUMENTATION | SERVICES | NEWS FLASH

PRODUCT IDENTIFIER MEDSEA_ANALYSIS_FORECAST_PHY_006_013

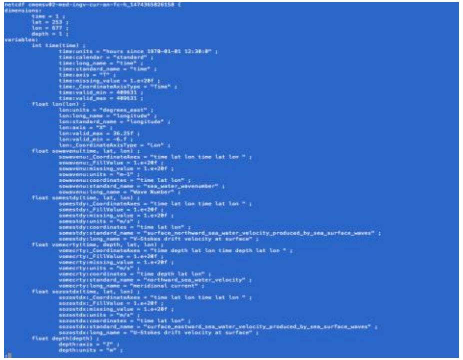
OVERVIEW

Short description:
The physical component of the Mediterranean Forecasting System (Med-currents) is a hydrodynamic model implemented over the whole Mediterranean Basin. The model horizontal grid resolution is 1/24˚ (ca. 4 km) and has 141 unevenly spaced vertical levels.The hydrodynamics are supplied by the Nucleous for European Modelling of the Ocean (NEMO v3.6) and the model solutions are corrected by a variational data assimilation scheme (3DVAR) of temperature and salinity vertical profiles and along track satellite Sea Level Anomaly observations.

Detailed description:
The Mediterranean Forecasting System, MFS, (Pinardi et al., 2003, Pinardi and Coppini 2010, Tonani et al 2014) is providing, since year 2000, analysis and short term forecast of the main physical parameters in the the Mediterranean Sea and it is the component of the Med-currents system.
The oceanic equations of motion of Med-currents system are solved by an Ocean General Circulation Model (OGCM), based on the latest available NEMO model version 3.6, with non-linear free surface formulation and time-varying vertical z-star coordinates.
NEMO has been implemented in the Mediterranean at 1/24° x 1/24° horizontal resolution and 141 unevenly spaced vertical levels, covering the whole Mediterranean Sea and also extend into the Atlantic in order to better resolve the exchanges with the Atlantic Ocean at the Strait of Gibraltar.The topography is created starting from the GEBCO 30arc-second grid (http://www.gebco.net/data_and_products/gridded_bathymetry_data/gebco_30_second_grid/), filtered and manually modified in critical areas such as: islands along the Eastern Adriatic coasts, Gibraltar and Messina straits, Atlantic box edge. The model has a non-linear explicit free surface and it is forced by surface pressure, interactive heat, momentum and water fluxes at the air-sea interface. The vertical background viscosity and diffusivity values are set to 1.2e-6 [1] and 1.0e-7 [2] respectively, while the horizontal bilaplacian eddy diffusivity and viscosity are set respectively equal to -1.2e8 [3] and -2.e8 [4]. Moreover at the bottom, a quadratic bottom drag coefficient with a logarithmic formulation has been used according to Maraldi et al. (2013). The model uses vertical partial cells to fit the bottom depth shape.
The hydrodynamic model is nested, in the Atlantic, within the daily analysis and forecast CMEMS GLO-MFC product at 1/12° horizontal resolution, GLOBAL_ANALYSIS_FORECAST_PHYS_001_024, by using a BDY (Unstructured Open Boundary Conditions) tool, since it allows to specify easier the location of the open boundaries. The model is forced by momentum, water and heat fluxes interactively computed by bulk formulae using the 6-hours (for the first 3 days of forecast a 3-hours temporal resolution is used), 0.125° horizontal-resolution operational analysis and forecast fields from the European Centre for Medium-Range Weather Forecasts (ECMWF) and the model predicted surface temperatures (details of the air-sea physics are in Tonani et al., 2008). The water balance is computed as Evaporation minus Precipitation and Runoff. The evaporation is derived from the latent heat flux, precipitation is provided by ECMWF as daily averages, while the runoff of the 39 rivers implemented is provided by monthly mean datasets: the Global Runoff Data Centre dataset (Fekete et al., 1999) for the Po, Ebro, Nile and Rhone rivers; the dataset from Raicich (1996) for: Vjosë, Seman rivers; the UNEP-MAP dataset (Implications of Climate Change for the Albanian Coast, Mediterranean Action Plan, MAP Technical Reports Series No.98., 1996) for the Buna/Bojana river; the PERSEUS dataset for the following 32 rivers: Piave, Tagliamento, Soca/Isonzo, Livenza, Brenta-Bacchiglione, Adige, Lika, Reno, Krka, Arno, Nerveta, Aude, Trebisjnica, Tevere/Tiber, Mati, Volturno, Shkumbini, Struma/Strymonas, Meric/Evros/Maritsa, Axios/Vadar, Arachtos, Pinios, Acheloos, Gediz, Buyuk Menderes, Kopru, Manavgat, Seyhan, Ceyhan, Gosku, Medjerda, Asi/OrontesThe Dardanelles Starit is closed but considered as volume input (Kourafalou and Barbopoulos ,2003) through a river-like parametrization.
The data assimilation system is the 3DVAR scheme developed by Dobricic and Pinardi (2008) and modified by Storto at al (2015). Background error correlation matrices vary monthly for each grid point in the discretized domain of the Mediterranean Sea. Observational error covariance matrix are evaluated with Desroziers's relationship (Desroziers et al, 2005)The assimilated data include: Sea Level Anomaly (a satellite product accounting for atmospheric pressure effect is used) from CLS SL-TAC, and vertical temperature and salinity profiles from Argo. Objective Analyses-Sea Surface Temperature (OA-SST) fields from CNR-ISA OSI-TAC are used for the correction of surface heat fluxes with the relaxation constant of 40 W m-2 K-1.
Processing information:
The analysis is done weekly, on Tuesday, for the previous 15 days. The assimilation cycle is daily (24hr) and is done in filter mode. 10-day forecast is produced every day. The forecast is initialized by a hindcast every day except Tuesday, when the analysis is used instead of the hindcast.
Quality / Accuracy / Calibration information:
http://calval.bo.ingv.ithttp://medforecast.bo.ingv.it/mfs-lr-evaluation/http://marine.copernicus.eu/services-portfolio/scientific-quality/#mfcs|medsea|medsea-analysis-forecast-phys-006-001
References:

- Desroziers, G., Berre, L., Chapnik, B. and Poli, P. (2005). Diagnosis of observation, background and analysis-error statistics in observation space. Quarterly Journal of the Royal Meteorological Society, 131, 3385–3396.

Download the product with the user interface



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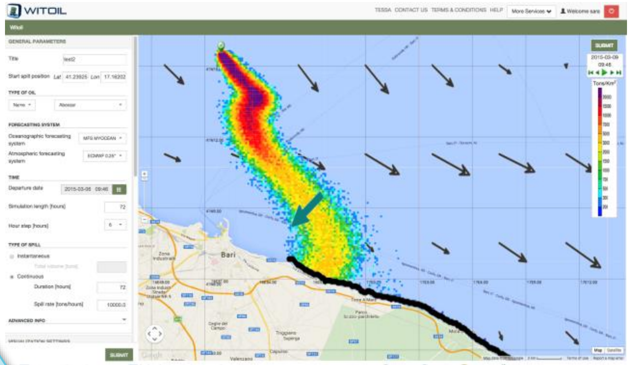
Operational forecast of oil spill: methodology

C
Cu s
hourly
forecasts,
daily analyses
1/16° x 1/16°
horizontal
res n

heric
wind
6 hrs -
12,5 km

MEDSLIK-II

Oil Spill forecast



MEDESS4MS

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Operational forecast of oil spill drift: demonstration

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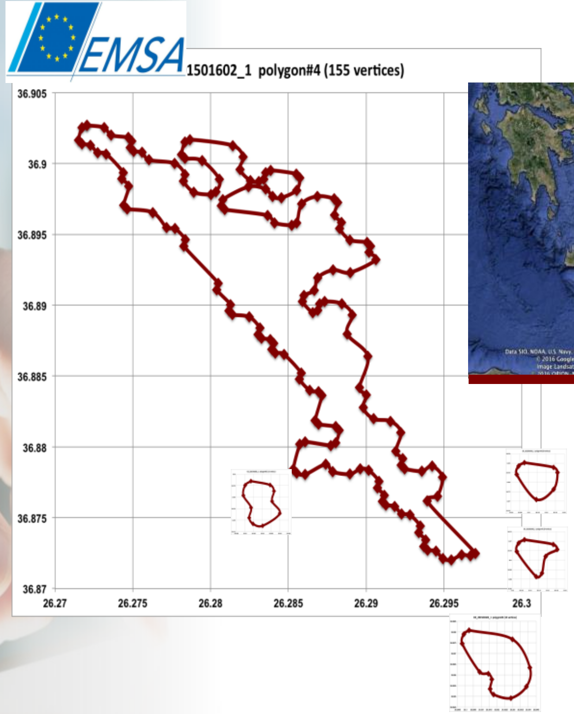
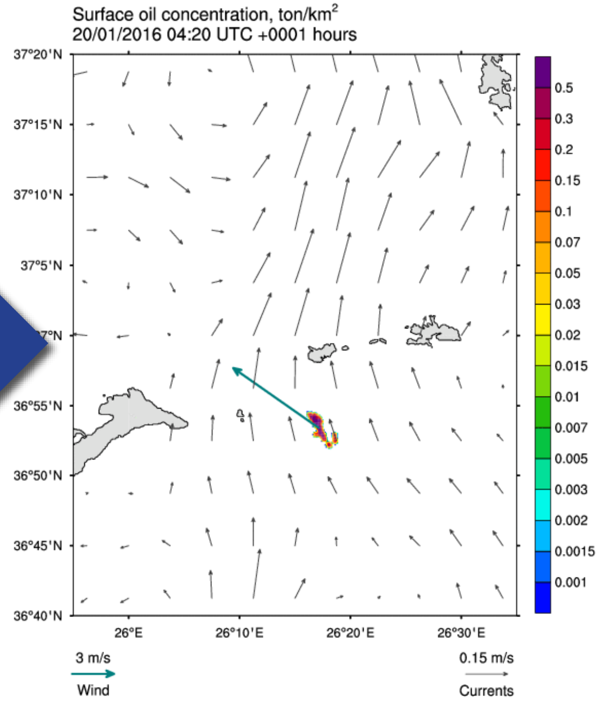


5-Polygon Oil Spill in the Aegean Sea 20-01-2016 04:20

Northward transport led to the oil contamination of Kinaros Island coastline (Greece)



Hazard mapping for operational oil spills: methodology

The oil hazard mapping methodology uses the following assumptions:

1. the traffic density distribution and the amount of oil operationally spilled

1. the oil spill simulations, performed using the past daily weather and oceanographic conditions from 2009 to 2013

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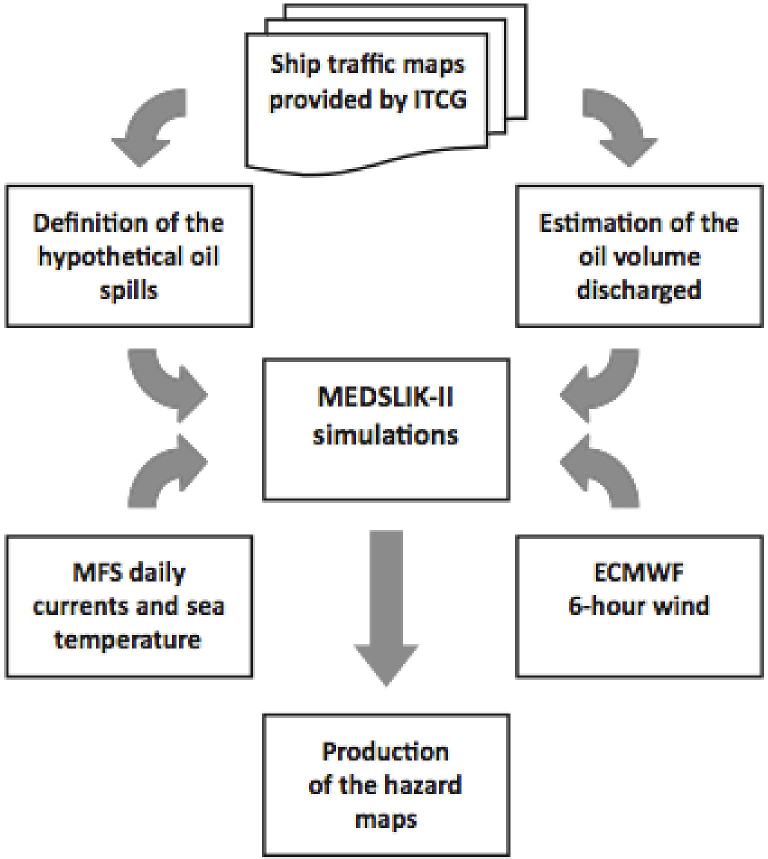
Hazard mapping for operational oil spills: methodology



3 steps:

1. definition of the hypothetical oil spills (positions, starting dates, and number of oil spills) starting from the ship traffic maps; estimation of the oil quantity discharged along the selected shipping lanes
2. oil spill model simulations
3. production of hazard maps

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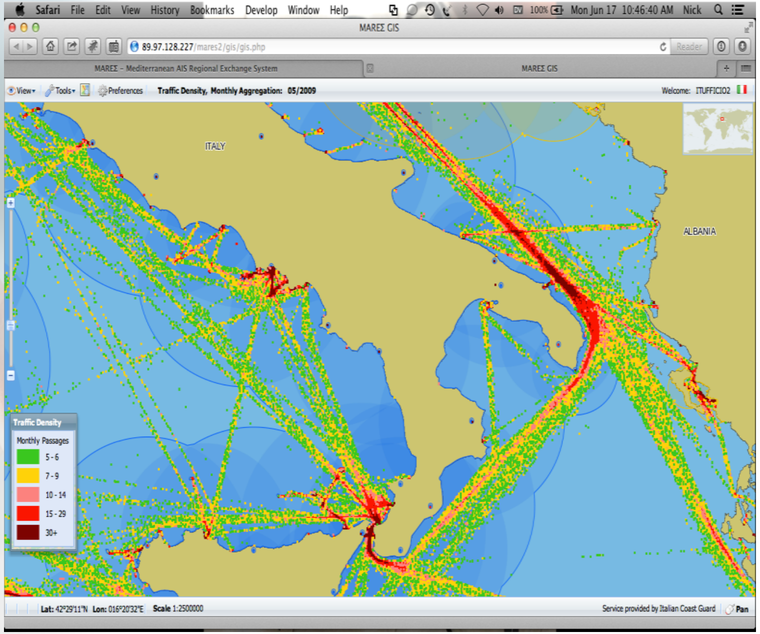
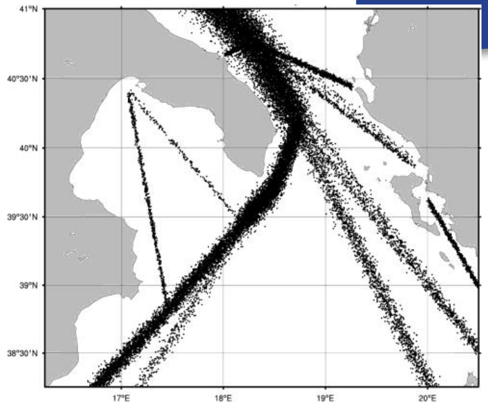
Hazard mapping for operational oil spills: methodology - the traffic density distribution

Digitizing the ship traffic maps provided by the Italian Coast Guard



Monthly Ship Traffic Maps provided by ITCG

Spill list
1.000.000 spills/month



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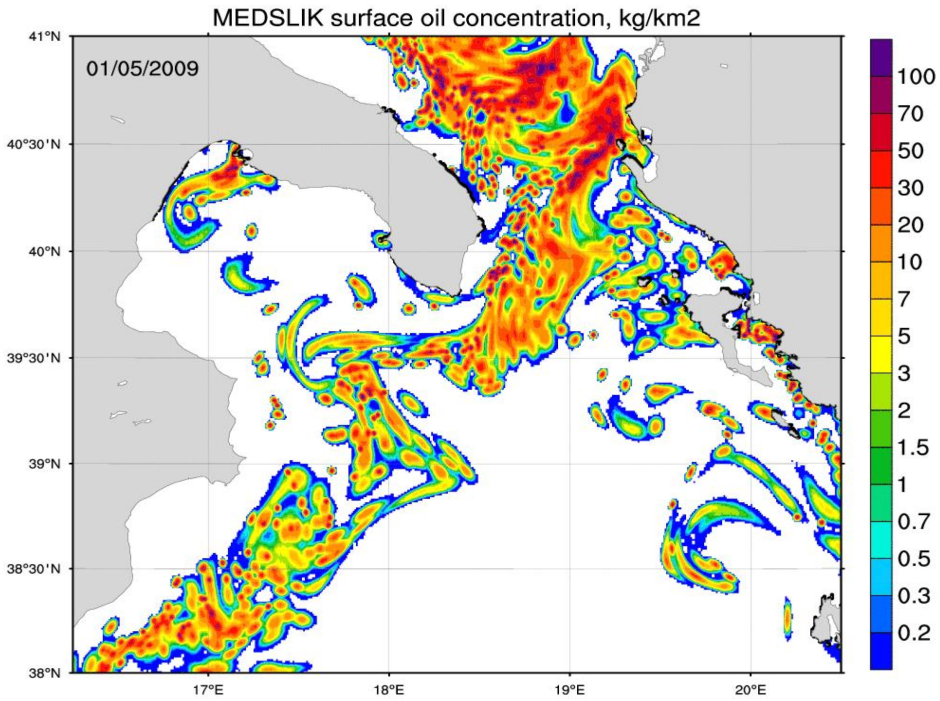
Hazard mapping for operational oil spills: methodology - the oil spill simulations



Hourly Surface Oil Concentration $C_{HOUR}(x,y)$ Maps

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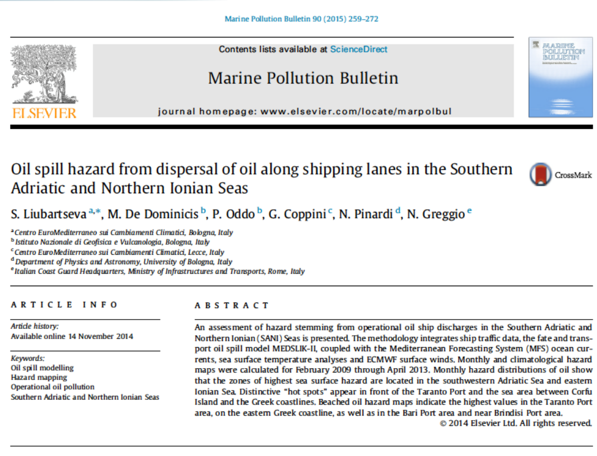
Hazard maps for operational oil spills: demonstration



Marine Pollution Bulletin 90 (2015) 259–272

Contents lists available at ScienceDirect

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

Oil spill hazard from dispersal of oil along shipping lanes in the Southern Adriatic and Northern Ionian Seas

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[b] Istituto Nazionale di Geofisica e Vulcanologia, Bologna, Italy
[c] Centro EuroMediterraneo sui Cambiamenti Climatici, Lecce, Italy
[d] Department of Physics and Astronomy, University of Bologna, Italy
[e] Italian Coast Guard Headquarters, Ministry of Infrastructures and Transports, Rome, Italy

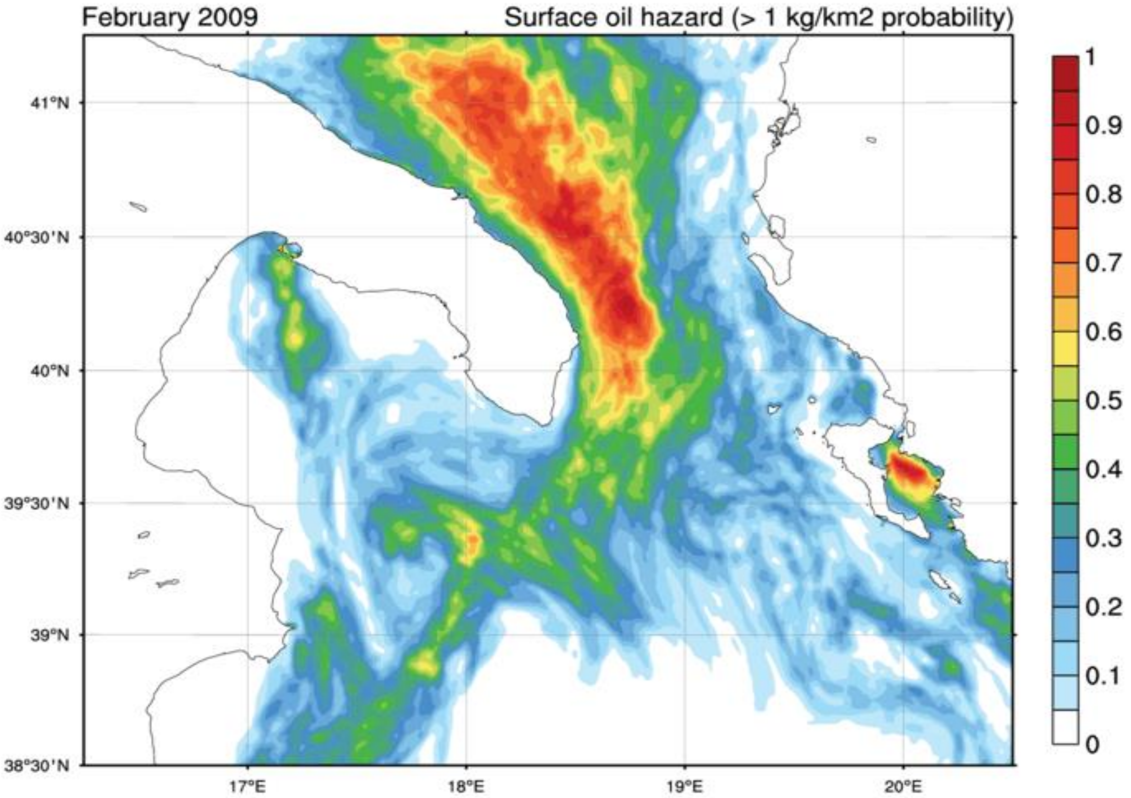
A R T I C L E I N F O

Article history:
Available online 14 November 2014

Keywords:
Oil spill modelling
Hazard mapping
Operational oil pollution
Southern Adriatic and Northern Ionian Seas

A B S T R A C T

An assessment of hazard stemming from operational oil ship discharges in the Southern Adriatic and Northern Ionian (SANI) Seas is presented. The methodology integrates ship traffic data, the fate and transport oil spill model MEDSLIK-II, coupled with the Mediterranean Forecasting System (MFS) ocean currents, sea surface temperature analyses and ECMWF surface winds. Monthly and climatological hazard maps were calculated for February 2009 through April 2013. Monthly hazard distributions of oil show that the zones of highest sea surface hazard are located in the southwestern Adriatic Sea and eastern Ionian Sea. Distinctive "hot spots" appear in front of the Taranto Port and the sea area between Corfu Island and the Greek coastlines. Beached oil hazard maps indicate the highest values in the Taranto Port area, on the eastern Greek coastline, as well as in the Bari Port area and near Brindisi Port area.



Hazard maps for operational oil spills: demonstration

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At risk of chronic oil pollution: Marine Protected Areas

(1) **Capo Rizzuto MPA (Italy)**

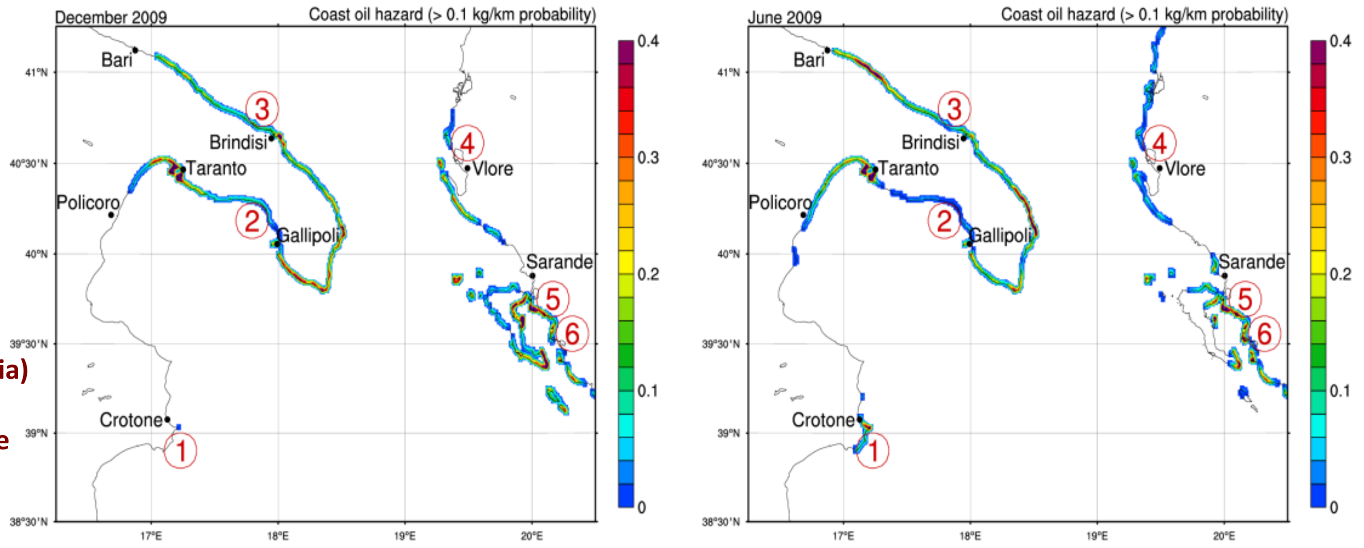
(2) **Porto Cesareo MPA (Italy)**

(3) **Torre Guaceto MPA (Italy)**

(4) **Vjose-Narte Landscape Protected Site (Albania)**

(5) **Butrinti National Park (Albania)**

(6) **Kalama Delta Natural Reserve (Greece)**



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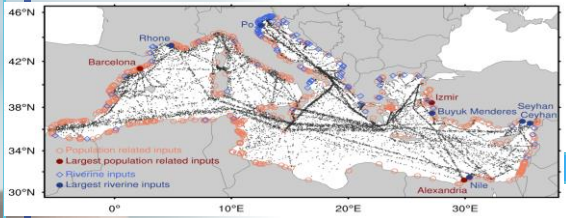
Plastic debris modeling in the Med Sea

Sources

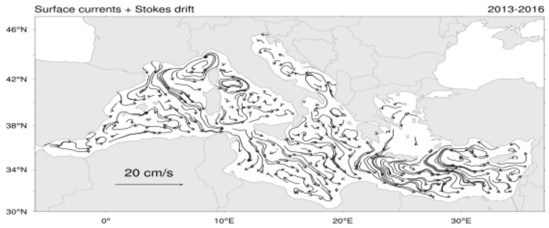


- Cities
- Rivers
- Shipping lanes

Transport and interaction with the boundaries

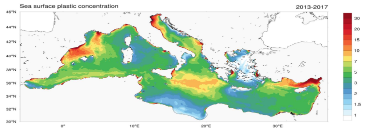
Sea surface drivers:

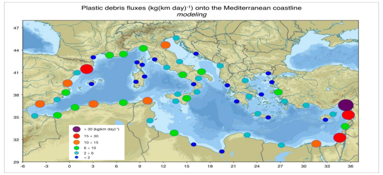
- Currents
- Waves (the Stokes drift)

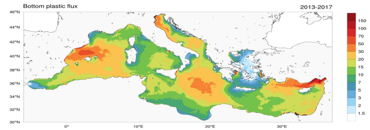


Stochastic beaching and sedimentation

Destination







- Sea surface
- Coastlines
- Bottom

Ensemble simulations

2D Stochastic Lagrangian module

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Plastic debris modeling in the Med Sea

Inputs of plastics into the Mediterranean

Operational oceanography datasets

Ensemble simulations

2D Stochastic Lagrangian module

Sea surface plastics

Coastal plastics

Benthic plastics

Coastal human population:

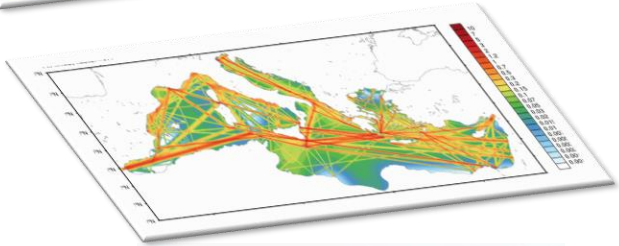
by Brinkhoff http://www.citypopulation.de

River discharges:

by Verri et al. (2017), PERSEUS Atlas (2015), Ludwig et al., (2010, 2009), Tockner et al. (2009)

PDFs of ship locations:

by an original methodology of AIS traffic map digitizing (Liubartseva et al., 2015)



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Plastic debris modeling in the Med Sea

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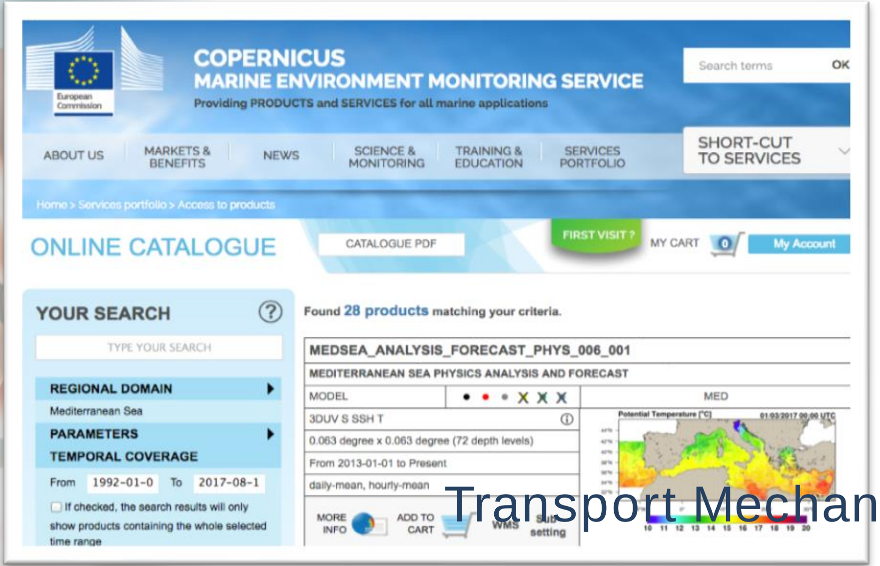
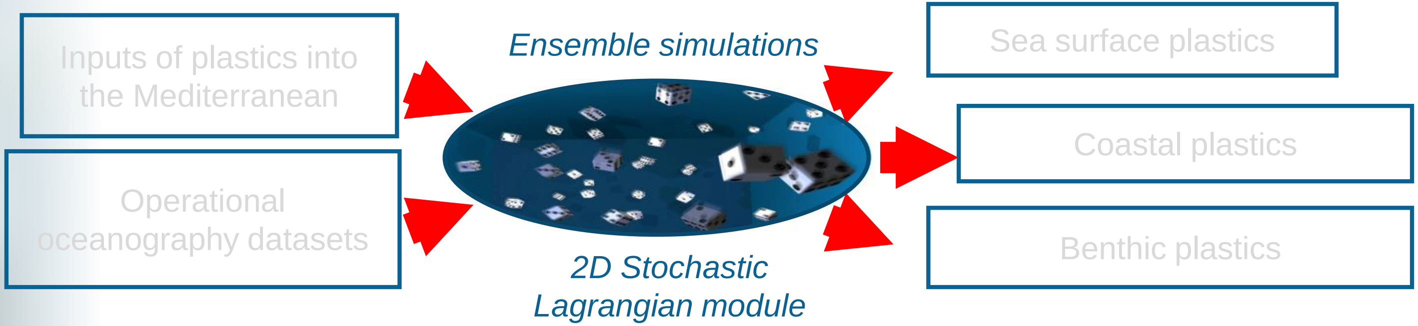
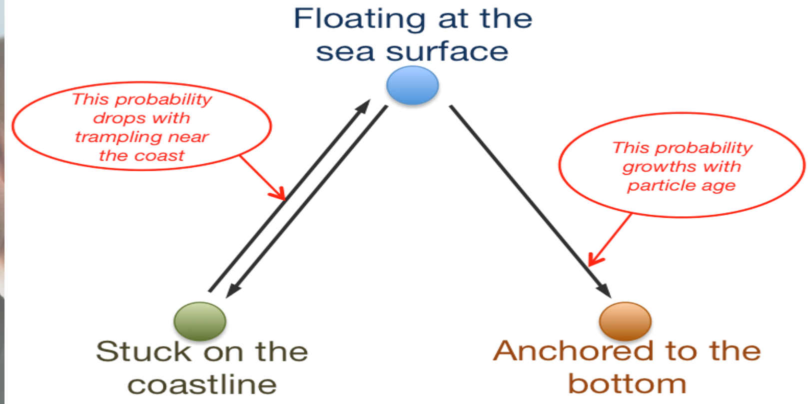


Daily analyses of ocean currents and waves (Clementi et al., 2017) provided by CMEMS at a 1/16°×1/16° (~ 6.5 km) horizontal resolution

Transport Mechanism = Sea surface currents + Waves

Plastic debris modeling in the Med Sea





3 states of particles and allowed transitions between the states

Stochastic Lagrangian modeling

1 200 000 virtual particles per day are seeded into the Mediterranean and tracked 2013 − 2017

(1) Advection by the surface currents and Stokes drift
(2) Random walk technique for subgrid turbulence
(3) Stochastic algorithms for beaching and sedimentation

Plastic debris modeling in the Med Sea

User

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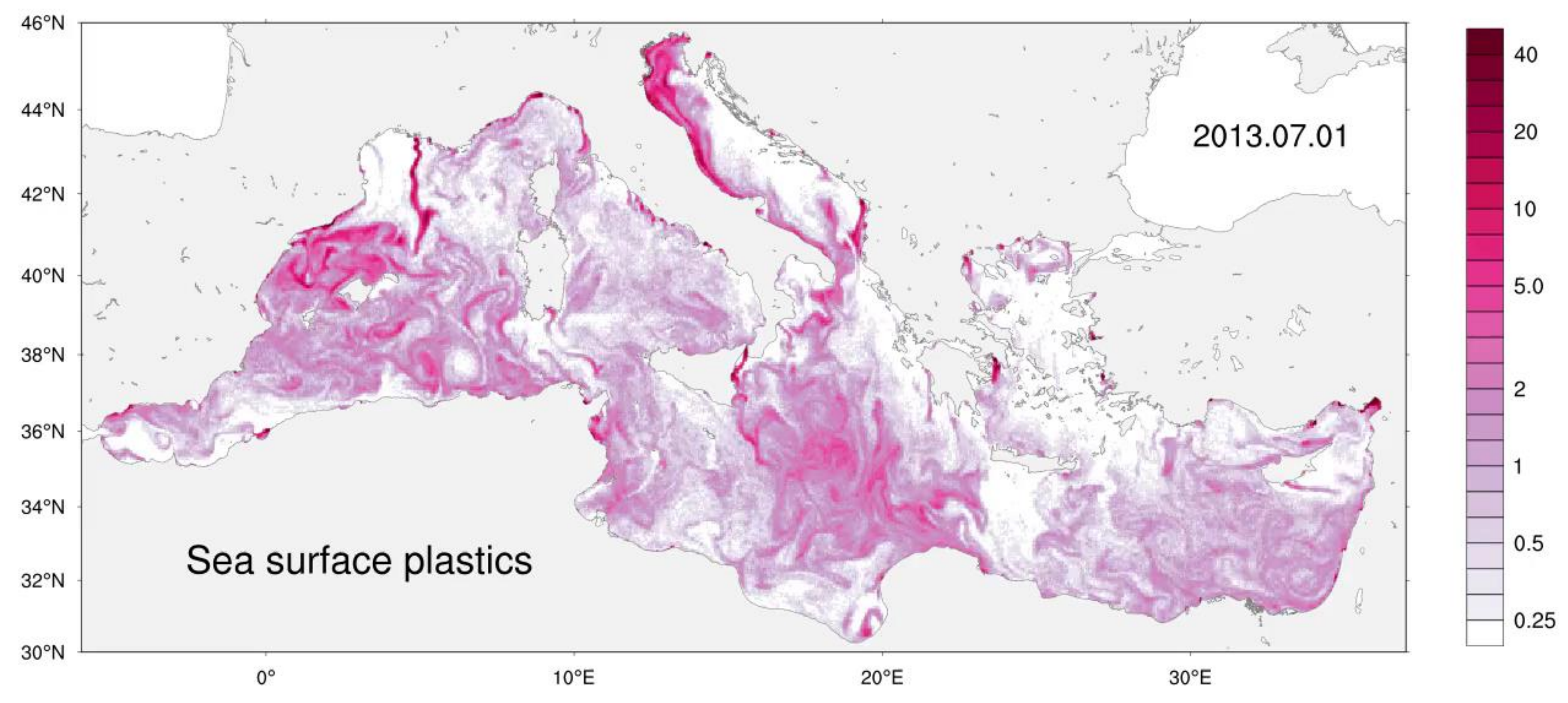

Plastic debris modeling in the Med Sea

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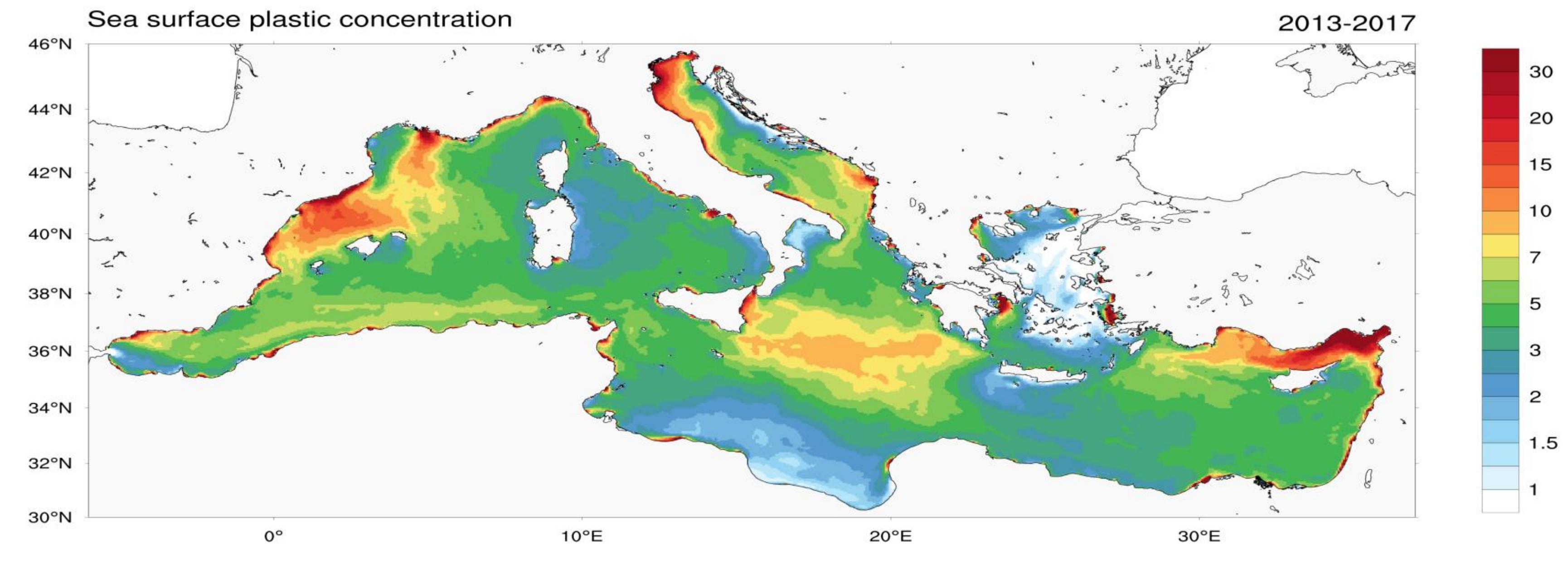

Plastic debris modeling in the Med Sea

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Inputs of plastics into the Mediterranean

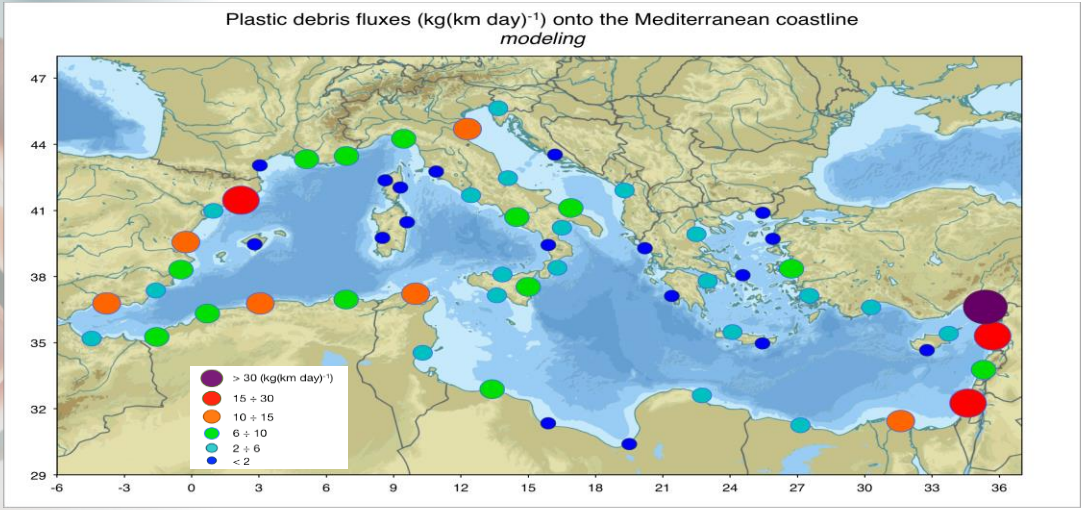
Operational oceanography datasets

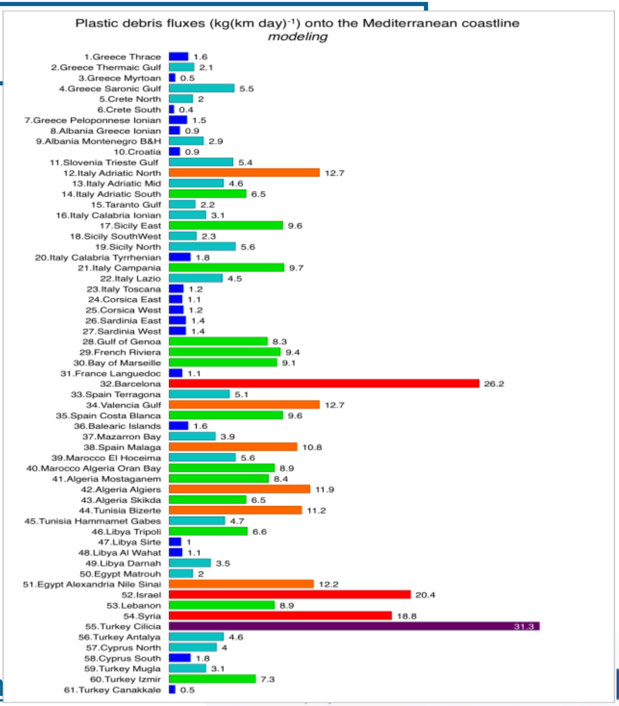
Ensemble simulations

2D Stochastic Lagrangian module

Sea surface plastics

Coastal plastics





Relief Map of the Mediterranean Sea by Nzeemin, https://commons.wikimedia.org/wiki/File:Relief_Map_of_Mediterranean_Sea.pn

Plastic debris modeling in the Med Sea

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Inputs of plastics into the Mediterranean

Operational oceanography datasets

Ensemble simulations

2D Stochastic Lagrangian module

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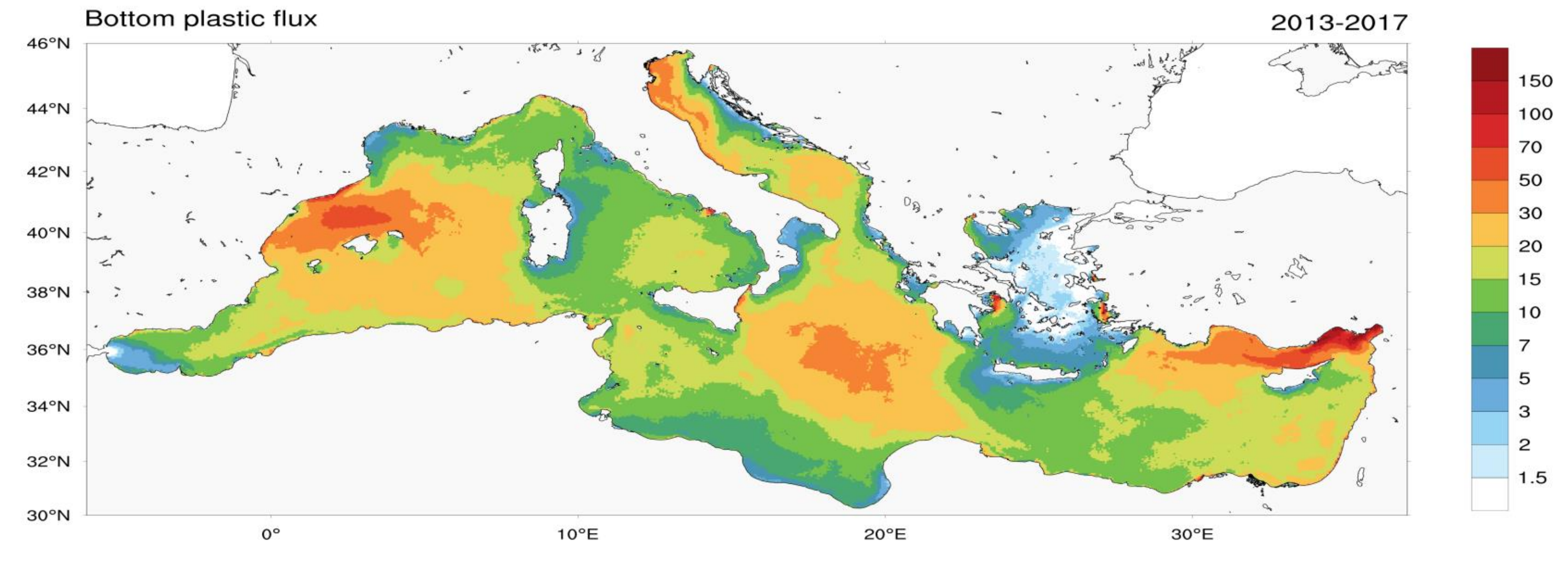
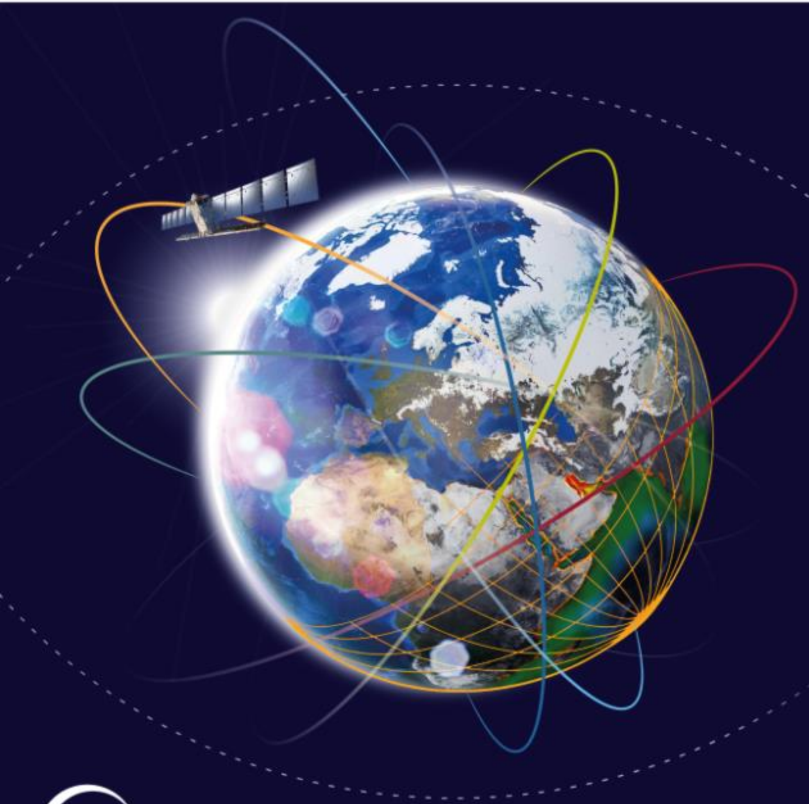
Benthic plastics



European Commission



Thank you!

For further information:

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svitlana.liubartseva@cmcc.it

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