Ocean predictions for supporting the marine safety in the Mediterranean

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and MEDESS-4MS partners

COSS-TT workshop,
February 4-7, 2013
Lecce, Italy

Outline

- GMES (Copernicus) Global Monitoring for Environment and Security
- Motivation for Oil Spills predictions in the Mediterranean
- MEDESS-4MS project
  - Objectives
  - Role in operational oil spill response
  - MEDESS-4MS service solution
- MEDSLIK
  - About it
  - Characteristics
  - Features and applications using MyOcean products
- Epilogue

GMES Marine Core Services

One of the EU Space programs is the GMES-Copernicus (Global Monitoring for Environment and Security).

GMES = Observing our planet for a safer world

- Aims to setup operational services related to land, ocean, atmosphere, emergency, security and climate changes, providing access to monitoring and forecasting information at regional and global levels,
- For Policy-makers and public authorities to assist in the preparation of environmental legislation and policies, for example on Climate Change.
- For citizens's protection: **emergency and search-and-rescue services, civil protection authorities, response in pollution**, etc

GMES services:

- are based on Earth monitoring data, collected from space (satellites), air (airborne instruments, ocean (floats, shipboard instruments, etc.), land (measuring stations, etc.)
- produce output information in the form of maps, datasets, reports, targeted alerts, etc.

6 thematic areas are developed by GMES: land, atmosphere, emergency, security, climate change and …Marine.

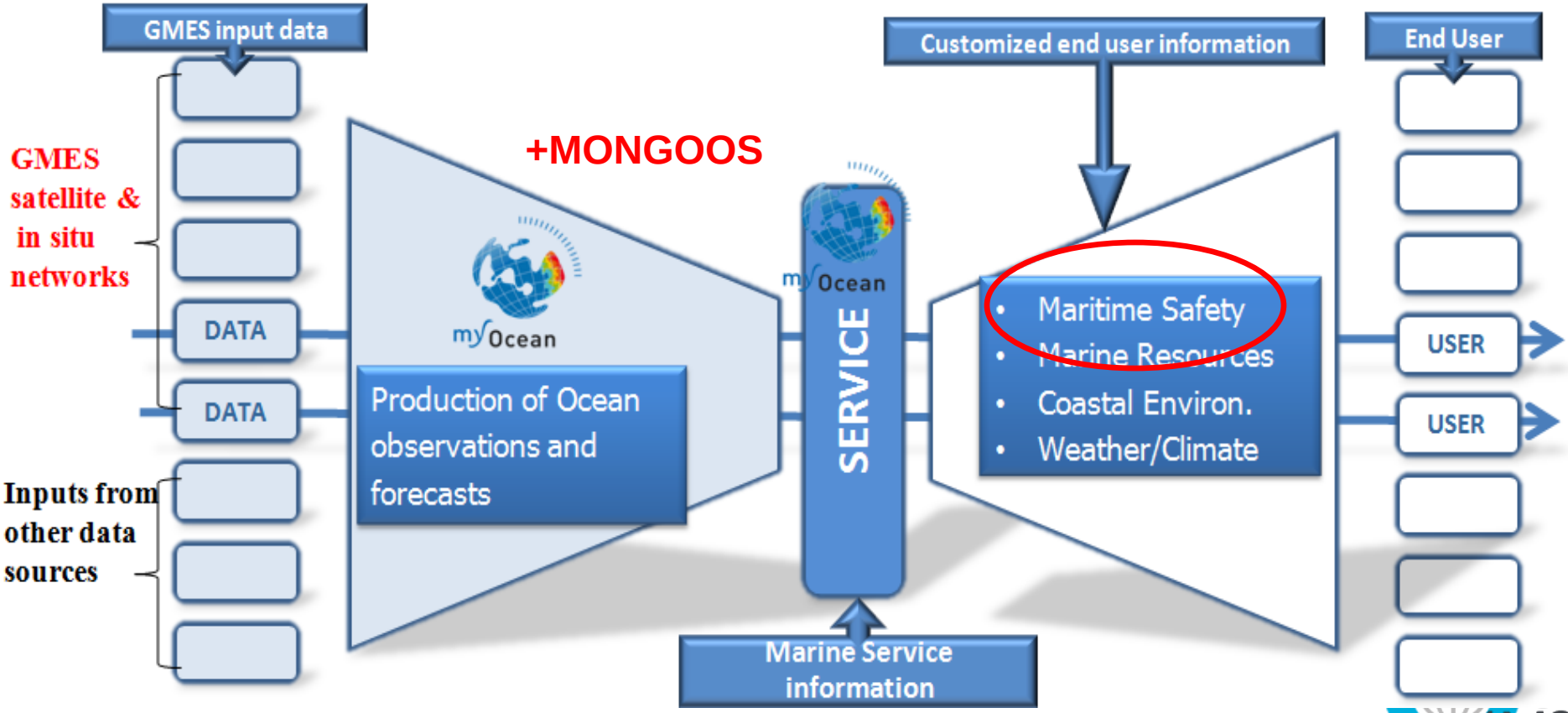
MyOcean followed by MyOcean II is the major component of the future "**GMES Marine Service**" (2014).

GMES Marine Core Services

General aims of the OCEAN component of GMES:

a) Produce regular and systematic information on the state of the oceans (analyses & forecasts), global and European Seas.

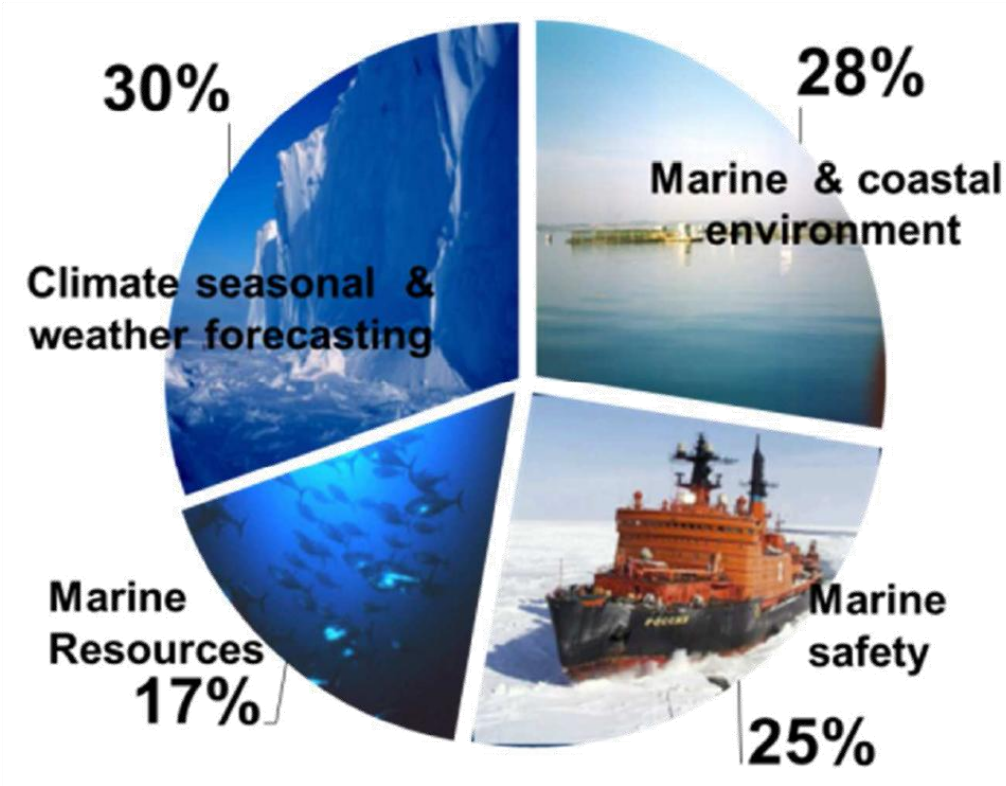
b) The products should be observational and model data, in RT.



as from MyOcean Areas of benefits

MyOcean designed : ……..

- to support the MS decision makers in the Marine Environment and Security fields
- to foster applications related to →



- **safety at sea (offshore operations, search & rescue, combating oil spills…)**
- monitoring sea water quality,
- assessing environmental impact,
- delivering data for Climate Change scenarios,
- protecting living marine resources,
- Renewable energy (thermal, wave)
- predicting coastal erosion, etc

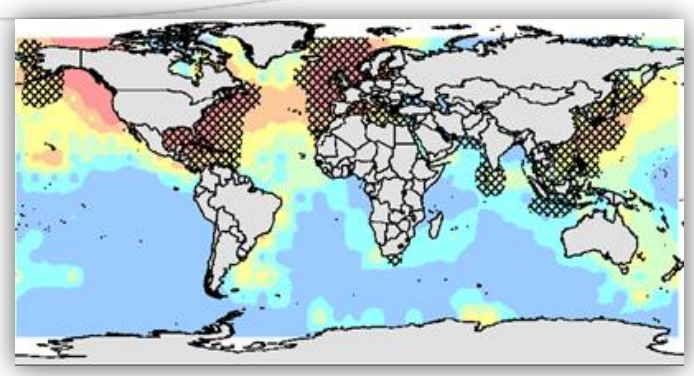
MED ESS 4MS

Motivation for Oil Spill Predictions

One of the permanent risk from an incident in the sea is associated with the heavy traffic of maritime transport and with the coastal and offshore installations related to oil industry.

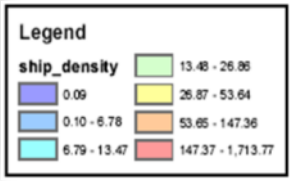
Such a dense activity, imposes on the coastal countries the need for preparing an operational response in cases of major incident.

EU request the implementation of the Directive 2005/35, in order to identify the polluter.



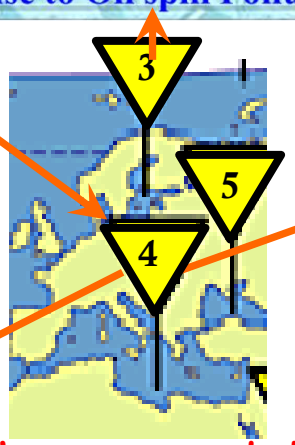
Map with ship accidents: more than 4 ships per

Ship density:



Regional Emergency Centres for Response to Oil spill Pollution

An incident like this may occur



Response to oil incident: booms deployment

Response to an oil incident: oil combating vessel

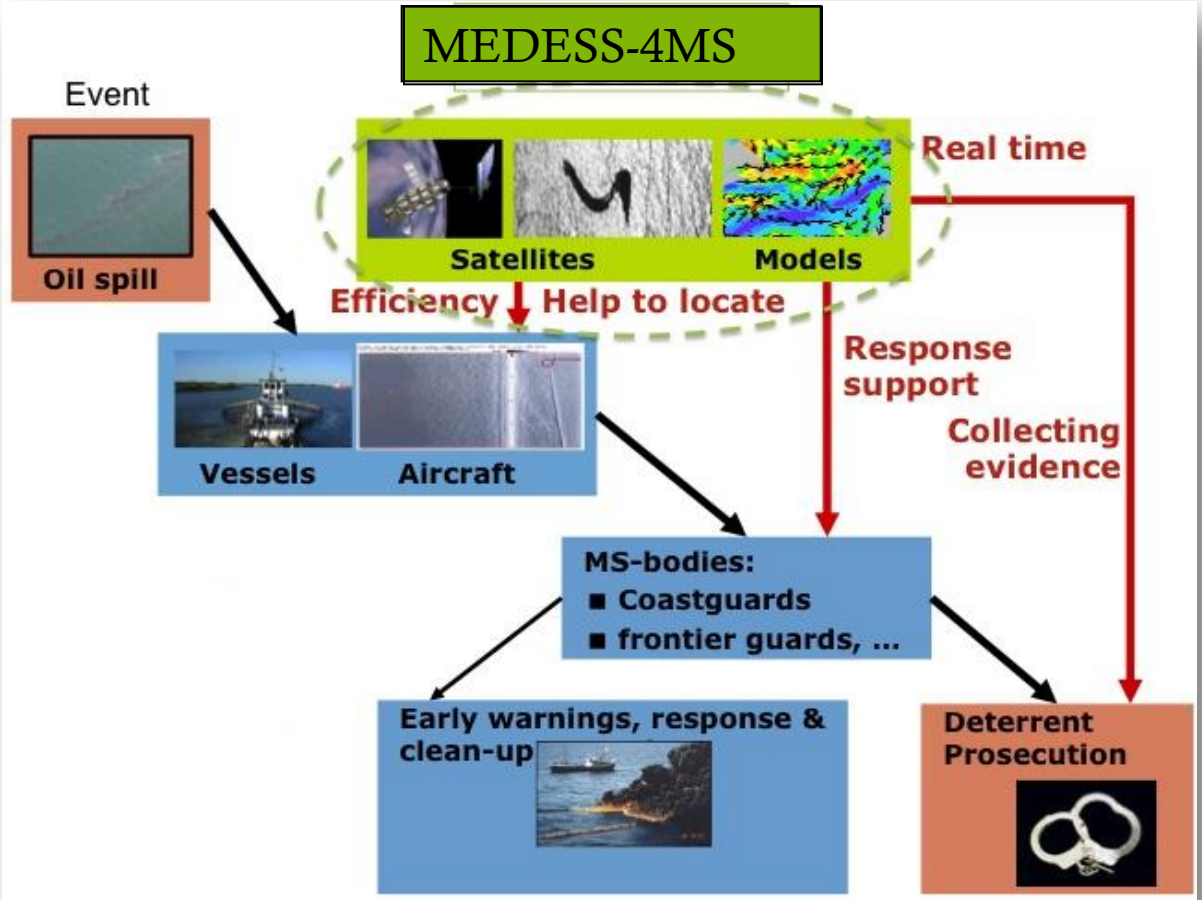
The recommended procedure for responding to oil spill incidents includes the application of oil spill models.

The catastrophe

Motivation for Oil Spill Predictions

- The success of response to oil spill incidents depends on the prediction of the movement and weathering of the oil spill or moving of the floating object. Such predictions may be obtained through the application of oil spill and floating objects models to predict:
  - Where the oil spill will move
  - How soon it will get there
  - Which resources are threatened
  - What will it look like when it arrives
- **The predictions need to be operational and using the best available meteo-ocean forecast**

As from REMPEC, the agencies need an integrated service…



Modified from Cristina Farchi

…to strength the national/regional response chain for accidental spills and deliberate discharges from ships.

MEDESS-4MS Project

Mediterranean Decision Support System 4 Marine Safety

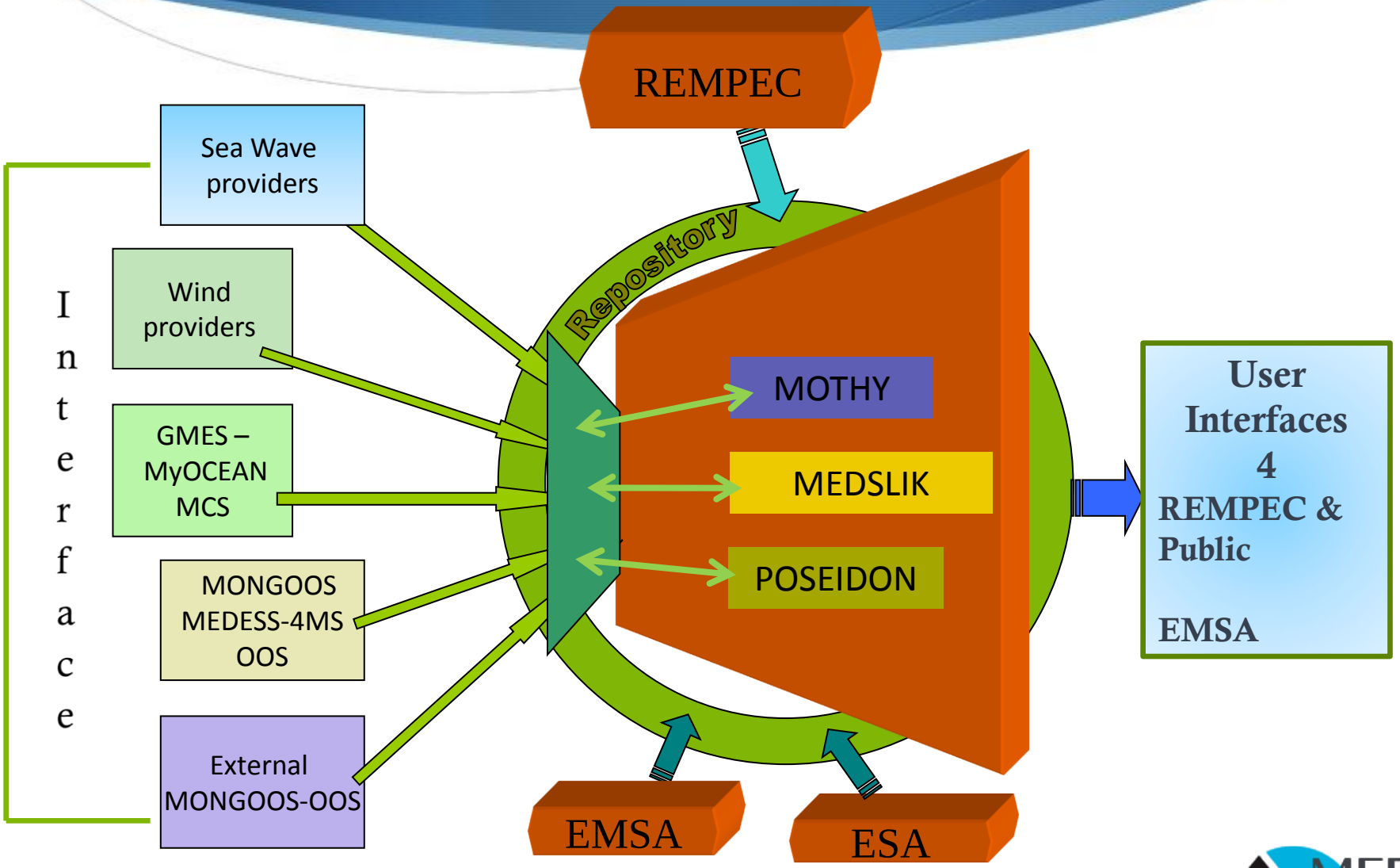
- Dedicated to maritime risks prevention and strengthening of maritime safety related to oil spill pollution in the Mediterranean.
- General objective: Delivery of an integrated, operational, multi-model oil spill prediction service in the Mediterranean
  - connected to existing monitoring platforms (REMPEC, EMSA-CSN, AIS)
  - using the well established oil spill modeling systems
  - using data from the GMES Marine Core Service –MyOcean & the national ocean forecasting systems -MONGOOS.

Particular Objectives

MEDESS-4MS will establish a downstream service including:

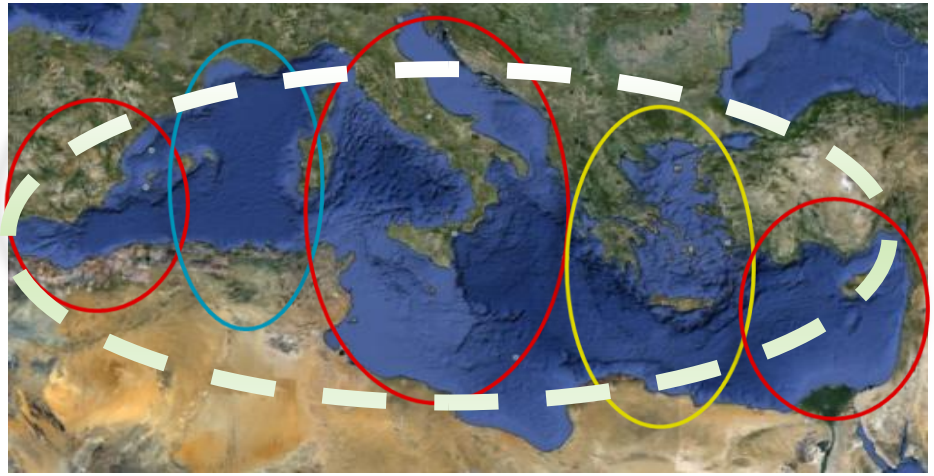
- Exploitation of the GMES MCS products and of the national ocean forecasting systems-MONGOOS
- Design and implementation of a unique Web portal access point for end-users with different UI (for REMPEC, EMSA and generic users)
- Training on the MEDESS-4MS service
  - key end-users and the generic users
  - non-EU countries responsible agencies, as defined by REMPEC for the Mediterranean and the MS responsible agencies, as defined by EMSA
- Development of concepts and plans for its implementation to other EU regions, such as the Black Sea.

MEDESS-4MS Service Solution



MEDESS-4MS solution

MEDESS-4MS will build upon the demo implementations carried out in the frame of EC projects (MFSTEP, MERSEA, ECOOP, MARCOAST, MyOcean), by maturing the pre-cursor services provided to individual MS response agencies, to an integrated structured service delivery for all the countries in the Mediterranean, and to major key end-users, such as REMPEC and EMSA.



The geographical area of the service will cover the Mediterranean, based on the sound expertise of the MEDESS-4MS MONGOOS and response agencies partners in their areas of responsibility.

Geographical deployment of the MEDESS-4MS subsystems:

MEDSLIK

MOTHY

POSEIDON

MEDESS-4MS solution

MEDESS-4MS provides solution to all 11 of EMSA's requirements and to the new CSN portal I/O needs.

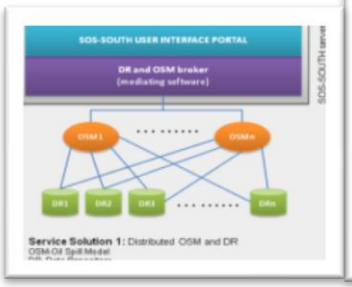
MEDESS-4MS will provide 3 services scenarios:

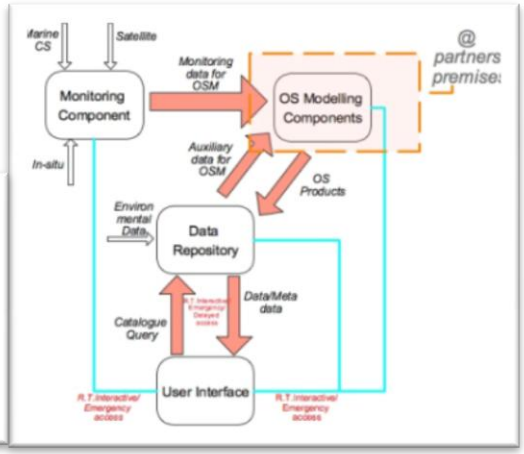
1) RT oil spill forecasting by authorized users;

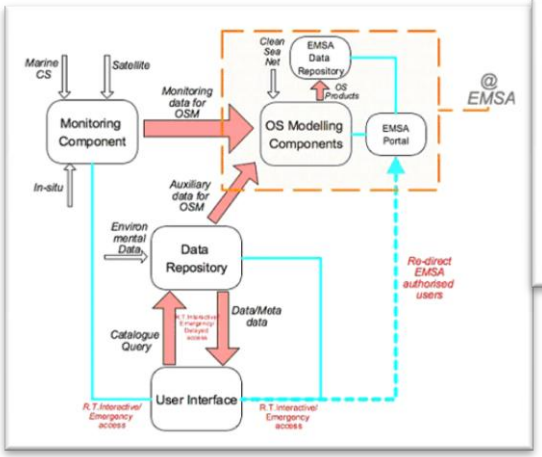
2) Delayed mode by authorized users;

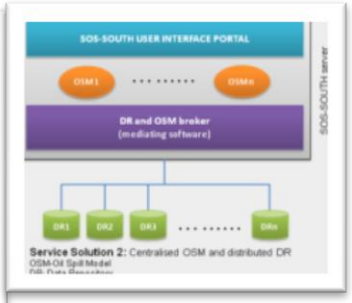
3) Oil Spill Decision Support System, for selection of management strategies.

MEDESS-4MS service scenario 1 examines two different User Interfaces, one better suited to the EMSA requirements (including automatic mode) and another to REMPEC and generic users.







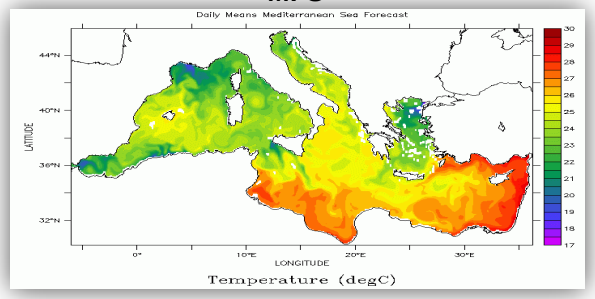


Downscaled ocean forecasts

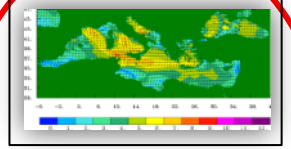
Oil spill dispersion forecast

ECOOP/LEV-DESS Decision Support System: Pre-Cursor to the MEDESS-4MS

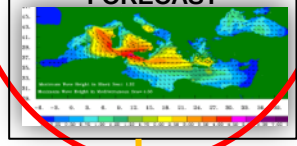
MFS



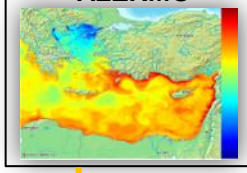
SKIRON



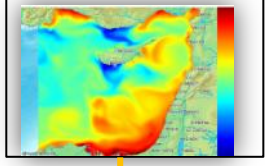
CYCOFOS – WAVE FORECAST



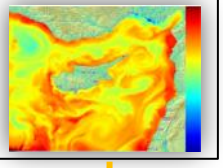
ALERMO



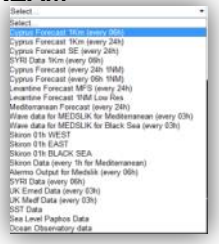
CYCOFOS - LEV



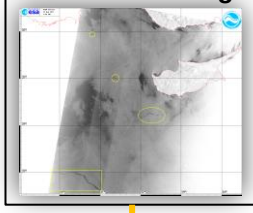
CYCOFOS



DOWNSTREAM FORCING



ESA ASAR image



ONLINE OUTPUTS

Sat	Sun	Mon	Tue	Wed	Thu	Fri
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3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

MEDSLIK

Request from response agencies, REMPEC, EMSA.

MED ESS 4MS

MEDSLIK

- MEDSLIK 3D model is successfully used by agencies throughout the Mediterranean for preparedness and real oil spill and search and rescue incidents.
- Currently used in Cyprus, Italy, Malta, Israel, Spain, Russia, Tunisia, etc
  - Pre-operationally used in the Black and Baltic seas
- Coupled with EMSA CSN and ESA ASAR imageries
  - For 24th forward and backward predictions
  - for supporting the response agencies to implement the EU Directive 2005/35 to identify the ships carrying out illegal oil spills
- Incorporates the use of forecasts of currents and wind data from GMES MyOcean MCS and the associated downscaled ocean forecasting systems
- Uses wind forecasts from SKIRON weather forecasting system

MEDSLIK

- MEDSLIK-II is based upon the existing MEDSLIK model

- The MEDSLIK-II evolution is supported by a Memorandum of Agreement for the Operation and Continued Development of MEDSLIK-II) signed by:

- The code is now freely available under the GNU Free Software License with the aim of attracting a critical mass of scientists and users:

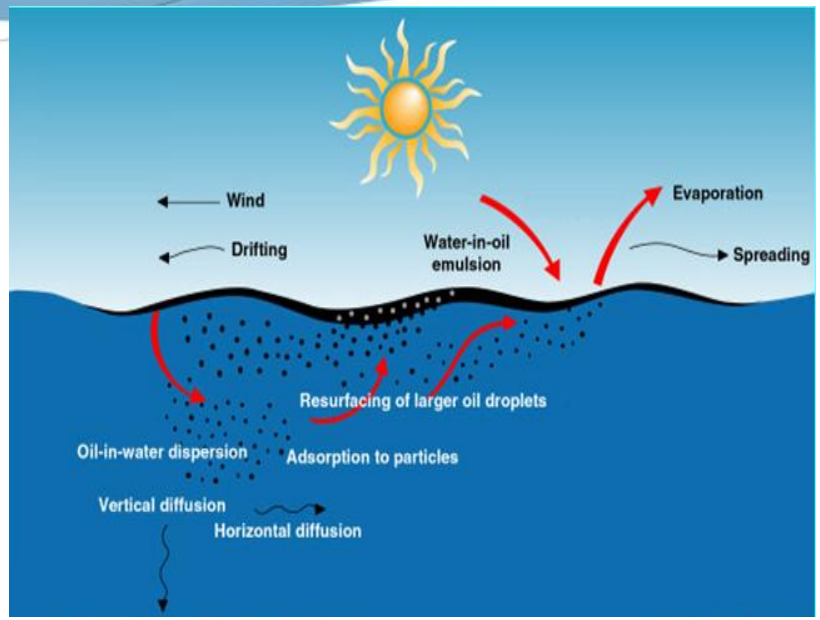
- to contribute to the further development of the code

- to use the model in very different conditions and check its performance

MEDSLIK general description

- The oil spill is modelled using a Monte Carlo method. The spill is divided into a large number (up to 500,000) of Lagrangian parcels of equal size. At each time step, each parcel is given a convective and a diffusive displacement.

- The lighter components of the oil evaporate at a rate dependent on water temperature and wind speed. Emulsification of the residual component is simulated, and the viscosity changes of the oil are computed according to the amounts of emulsification and evaporation of oil.



Mackay schematic of fate processes (evaporation, dispersion and emulsification)

The evaporation of volatile oil components is a fast process and takes place in a period of hours.

Emulsification is the process of the formation of water-in-oil emulsion, called "chocolate mousse"

MEDSLIK incorporates the fate processes of evaporation, emulsification, viscosity changes, dispersion in water column and coastal impact and adhesion.

MEDSLIK model characteristics

- **Slick Transport**
  - The transport of the surface slick is governed by currents, waves (Stoke's drift) & wind.
  - Diffusion of the slick is modelled by a random walk (Monte Carlo) model.
  - Oil may be dispersed into the water column by wave action (Mackay & Buist algorithm).
  - Dispersed oil is moved by currents only.
  - Mechanical spreading of the initial slick is included (modified Fay algorithm).

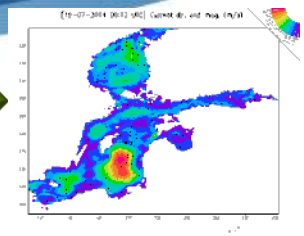
- **Fate processes included in the model**
  - Evaporation of the lighter oil fractions (Mackay)
  - Mixing in the water column by wave action (Buist & Mackay)
  - Oil viscosity changes
  - Beaching on the coast and absorption depending on the coastal type (Shen, Yapa &Petroski, after Torgrimson)

- The fate algorithms of the model have received extensive experimental calibration in the past.

Ocean data forcing for MEDSLIK

MEDSLIK adapted to use the ocean products from MyOcean regional systems, those of the Med, Black and Baltic seas.

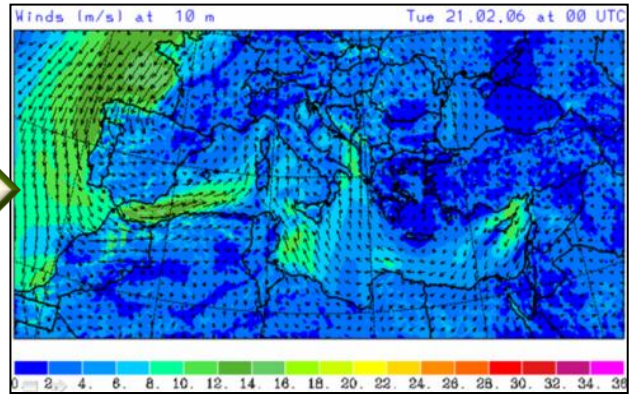
Baltic Sea: currents, temperature



Black Sea: currents, temperature

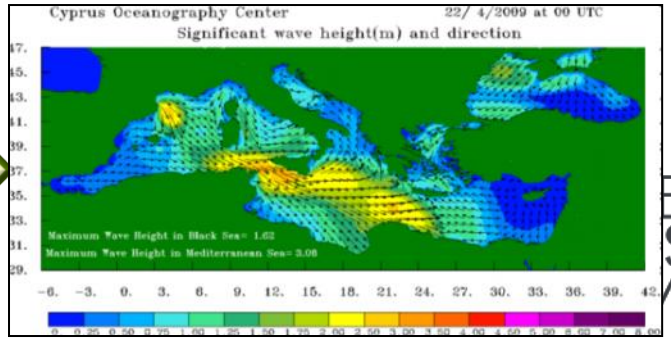
Mediterranean : currents, temperature,

The SKIRON winds for the Med and Black seas are used in MEDSLIK. The ECMWF and UK Met office winds may also be used.



In addition, MEDSLIK has been adapted to use the sub-regional and coastal forecasting system of MONGOOS

MEDSLIK uses the waves forecasts for estimating the influence of waves to the oil drift; i.e. Stoke's drift.



Major features of MEDSLIK

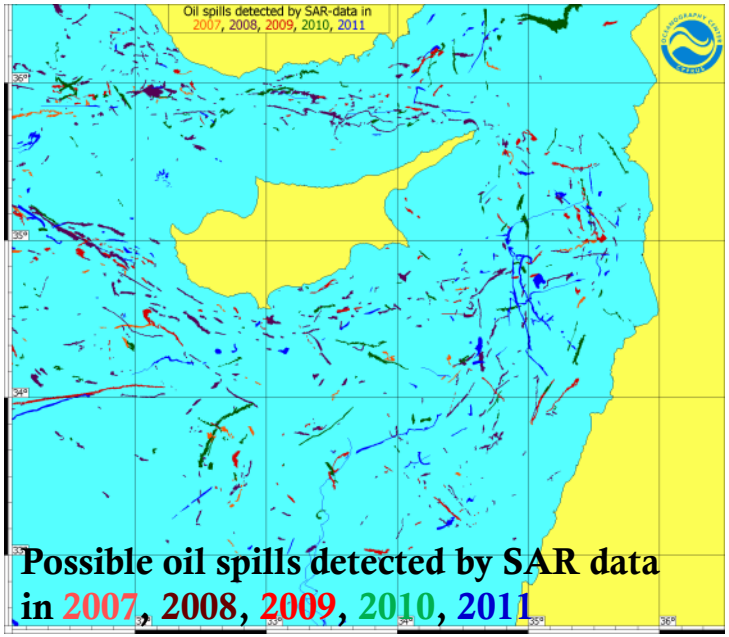
- Allows to switch from coarse to high resolution forecasting data, when the slick passes from a coarse to a higher resolution domain
- Allows assimilation of slick and drifters locations to correct the predictions
- Allows to locate the slick source at any given water depth
- The effect of deployment of oil booms can be examined
- Simultaneous oil spills or floating objects from moving or drifting ships can be modelled together
- Integration with satellite data detecting possible oil spills
- Identification of the source of slicks or floating objects
- Includes a simple GIS to allow information on resources
- Integration with AIS-Automatic Identification of Ships

+ many other features

- A transport prediction model for general pollutants is incorporated.
- The Run module has the ability to restart a run that has finished and carry on the simulation for an extended period.
- Ice data form and moving source of oil are incorporated
- The REMPEC db with more than 220 different types of oil parameters is included
- Additional regions can be added by the user to the Select Map menu.
- **Adaptation in complicate coastlines, such as for example estuaries and ports**
- The user can choose the 'pixel' size to be used for graphing the slick.
- The wind, currents and SST at points along a trajectory can be shown.
- More information on the state of the oil is printed on the output form.
- The beaching algorithm has been modified to provide a reduction in the rate of absorption of beached oil, when the existing loading becomes high.
- A help menu is incorporated

Epilogue: a

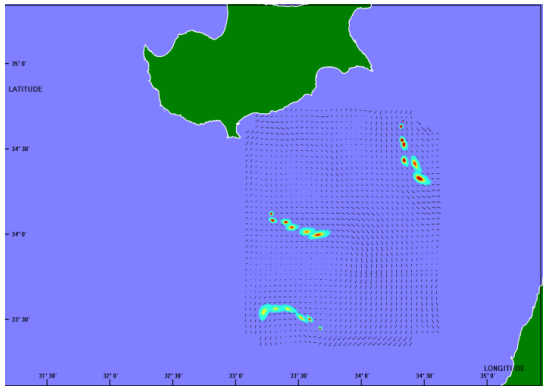
The role of MEDESS-4MS will become important in view of the hydrocarbon exploration in the Eastern Mediterranean Levantine and the increase of the maritime traffic in the entire region.



Possible oil spills detected by SAR data in 2007, 2008, 2009, 2010, 2011

- MEDESS-4MS will made possible to assist the response agencies in the implementation of the EU Directive 2005/35, in order to identify the polluter.

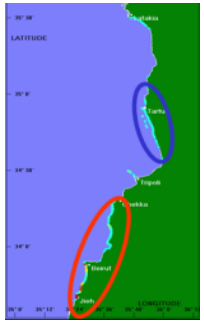
Risk map assessment from hypothetical oil spills from Cyprus EEZ areas 2,9,12: oil spill predictions for 18–21/5/12



Epilogue: b

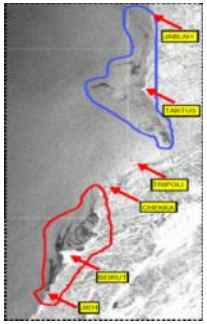
- MONGOOS partnership demonstrated in practice its ability to provide operational support to EU and response agencies during major oil pollution crisis.
- MEDSLIK implementation during the Lebanon oil pollution crisis, in summer 2006, demonstrates the benefit of having an operational ocean forecasting system in place.

MEDSLIK



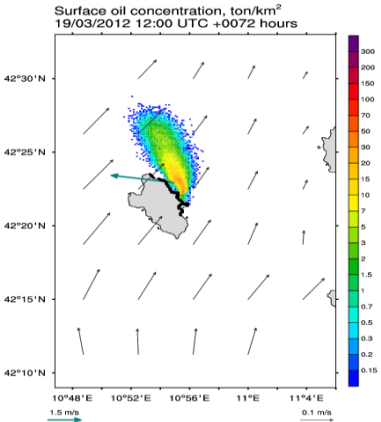
MODIS

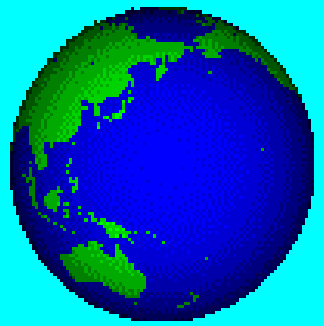
SAR



UN map

- MEDSLIK-II has been used daily to forecast the possible spill from the "Costa Concordia" accident on the 13 Jan 2012, until the end of the oil unloading operations





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