ODYSSEA

Creating products and knowledge
for the Mediterranean

ΔΗΜΟΚΡΙΤΕΙΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΘΡΑΚΗΣ
DEMOCRITUS UNIVERSITY OF THRACE

INTRODUCTION TO OPERATIONAL OCEANOGRAPHY
THE ODYSSEA CONCEPT AND ITS DEVELOPMENTS

2nd ODYSSEA Summer School, Alonissos, 2-6/9/2019

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Horizon 2020

ODYSSEA

Horizon 2020 is the biggest EU Research and Innovation program ever with nearly €80 billion of funding available over 7 years (2014 to 2020) – in addition to the private investment that this money will attract.

Achievements: scientific breakthroughs, discoveries and world-firsts by taking great ideas **from the lab to the market**.

Horizon 2020

Four H2020 “key-elements of success” driving EU research:

a) Cost-effectiveness

b) Interoperability

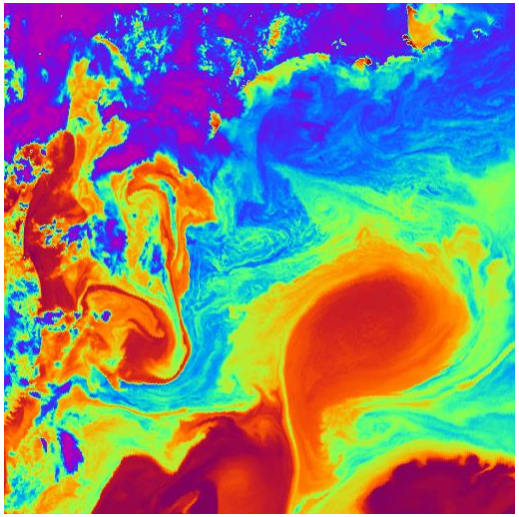
c) Open and freely available data

d) Sustainability

Cost-effectiveness

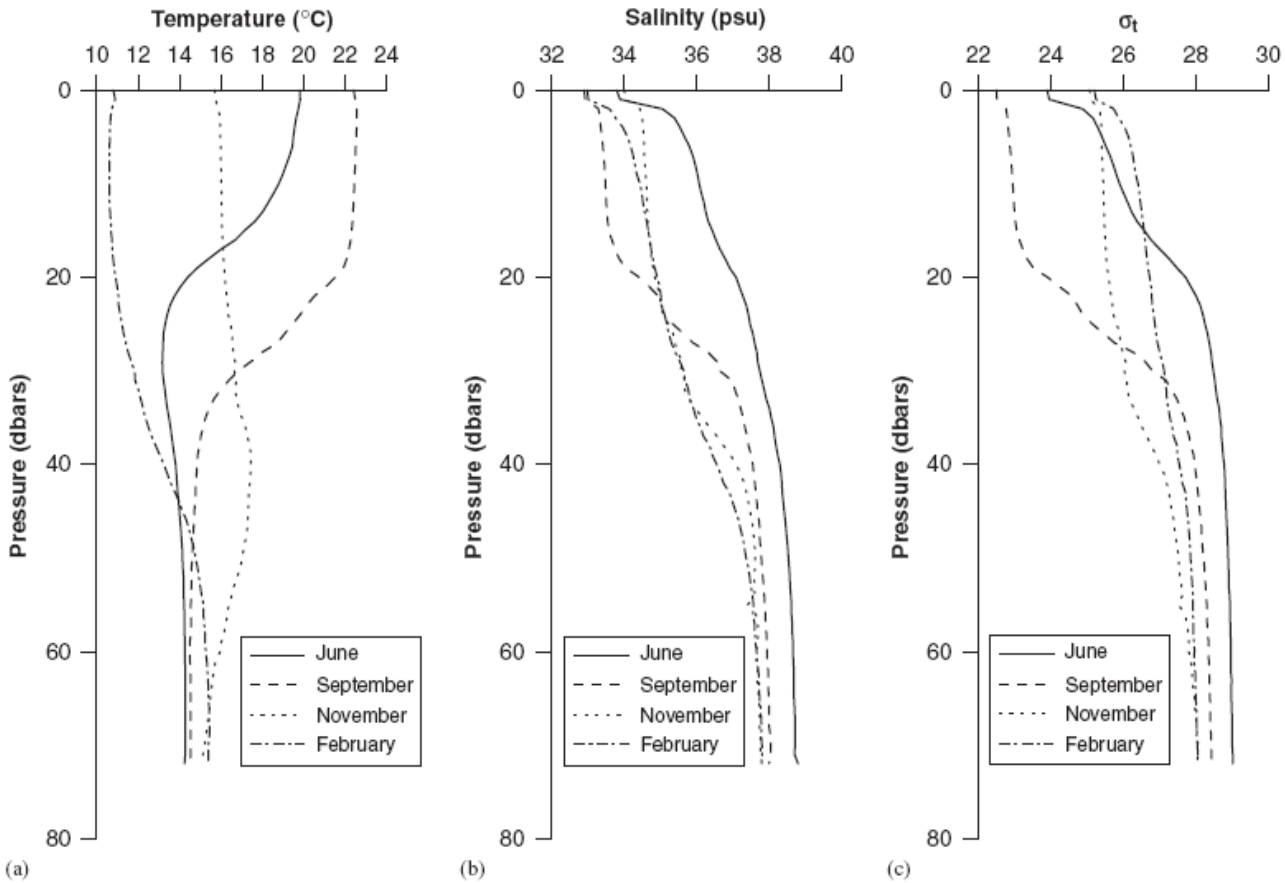
ODYSSEA

Get more with less



Interoperability

Measure once use it for multiple purposes



Interoperability

ODYSSEA

Measure once use it for multiple purposes

- From observations (sparse and non-consistent) to models (continuous in space and time)
- Fish – Mussel Farms
- Fisheries, Marine mammals, Invasive species
- Benthic biodiversity
- Anoxia
- Ocean energy
- Submarine outfalls (Wastewater, Heat)

Open data

ODYSSEA

EMODnet European Marine Observation and Data Network

NOAA

NASA

JAXA

EGO

Copernicus Europe's eyes on Earth

USGS science for a changing world

OneGeology

AquaMaps

ECMWF

BirdLife INTERNATIONAL

COCONET

British Oceanographic Data Centre NATURAL ENVIRONMENT RESEARCH COUNCIL

Euro Argo

emso ERIC EUROPEAN RESEARCH INFRASTRUCTURE CONSORTIUM

General Bathymetric Chart of the Oceans GEBCO

JRC EUROPEAN COMMISSION

FixO3 FIXED-POINT OPEN OCEAN OBSERVATORIES

Geo-Seas

GFCM CGPM

mongoos

SeaDataNet

UNEP

MAP

Open data – D13.1

ODYSSEA

Biota abundance biomass and diversity

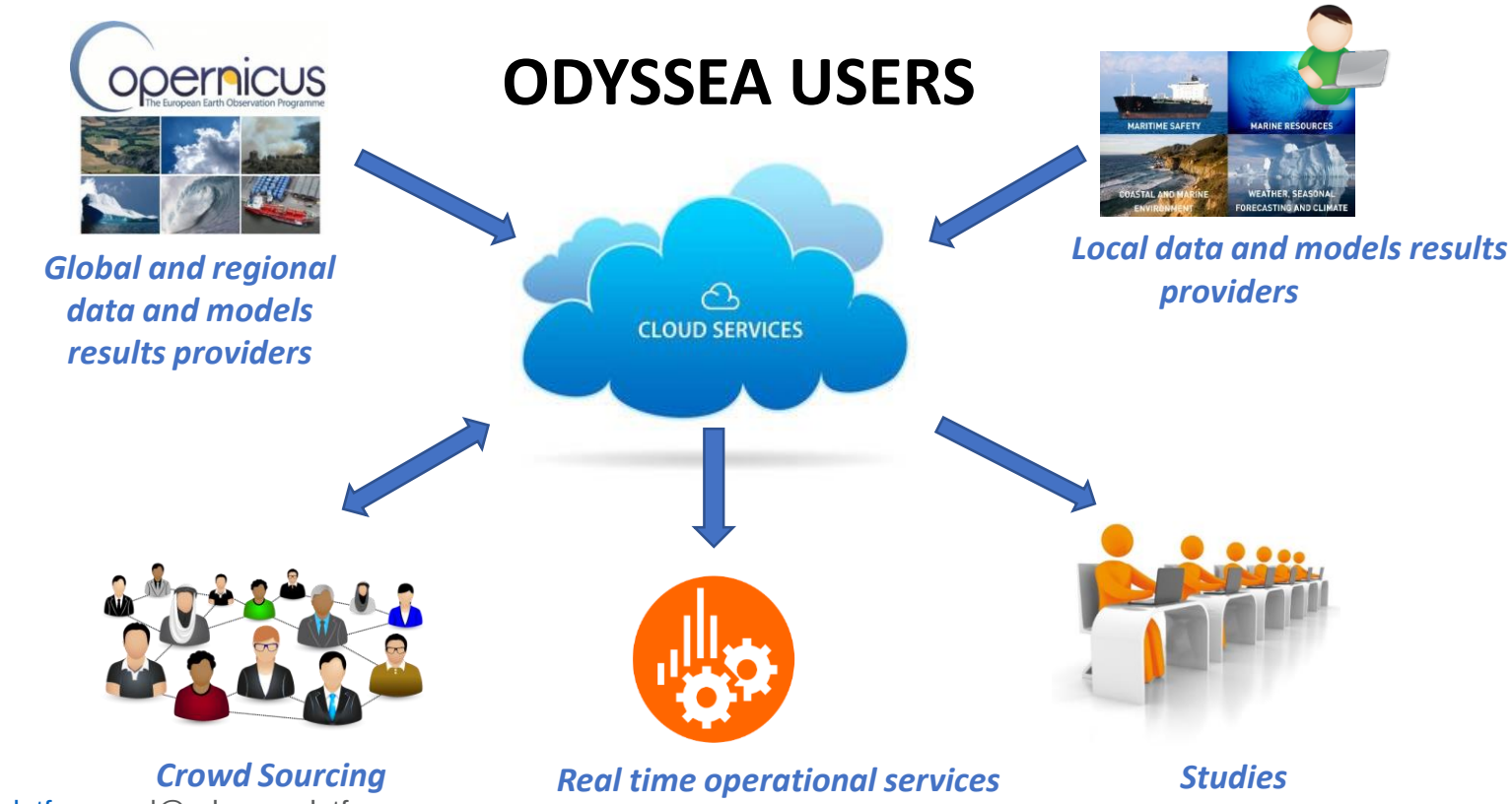
These data originate from the following platforms:

ACCOBAMS, Agence des aires marines protégées, AQUAMAPS for Marine Species, CoL-001 - Catalogue Of Life, EEA – EIONET, EoL-001 - Enciclopedia of Life - Global access to knowledge about life on Earth, GBIF - Global Biodiversity Information Facility, Instituto Español de Oceanografia (IEO), IUCN-001 - Spatial Data for the Red List of Threatened Species, IUCN-003 - Global Distribution of Important Marine Mammal Areas (IMMAs), MYOCEAN, NCEAS-004 - Knowledge Network for Biocomplexity (KNB), OBIS - Ocean Biogeographic Information System , PANGAEA - Data Publisher for Earth & Environmental Science, SeaDataNet, SIH - Système d'Informations Halieutiques, SWOT-003 - Global Distribution of Sea Turtles, VLIZ-006 - World Porifera Database – WDP (sponges), VLIZ-008 - World Register of Introduced Marine Species (WRIMS), WCMC-003 - Global Sea Turtle Species Richness, WCMC-015 - Global Seagrass Species Richness, WCMC-019 - Global Patterns of Marine Biodiversity, WCMC-037 - Species+, WCMC-039 - Ocean Data Viewer (ODV), WoRMS - World Register of Marine Species.

The Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS) is a legal conservation tool based on cooperation. Its purpose is to reduce threats to cetaceans notably by improving current knowledge on these animals.

Sustainability

Business strategy to provide end-user services and ensure long-term sustainability



The Scope of ODYSSEA Summer Schools

ODYSSEA

1. Focus on ODYSSEA Platform, the first platform providing easy-to-use, integrated marine **datasets**
2. Understand the issue of transforming data into **information**
3. Develop capacity to transform information into **services and products**
4. Use ODYSSEA Platform as a interdisciplinary system to set up a business in the **Blue Economy**

Data – The raw material

ODYSSEA

Data – an actual issue

- 90% of the present data was produced in a period

less than the last 5 years

- The rate is increasing
- The data sources and availability also

Data to Information

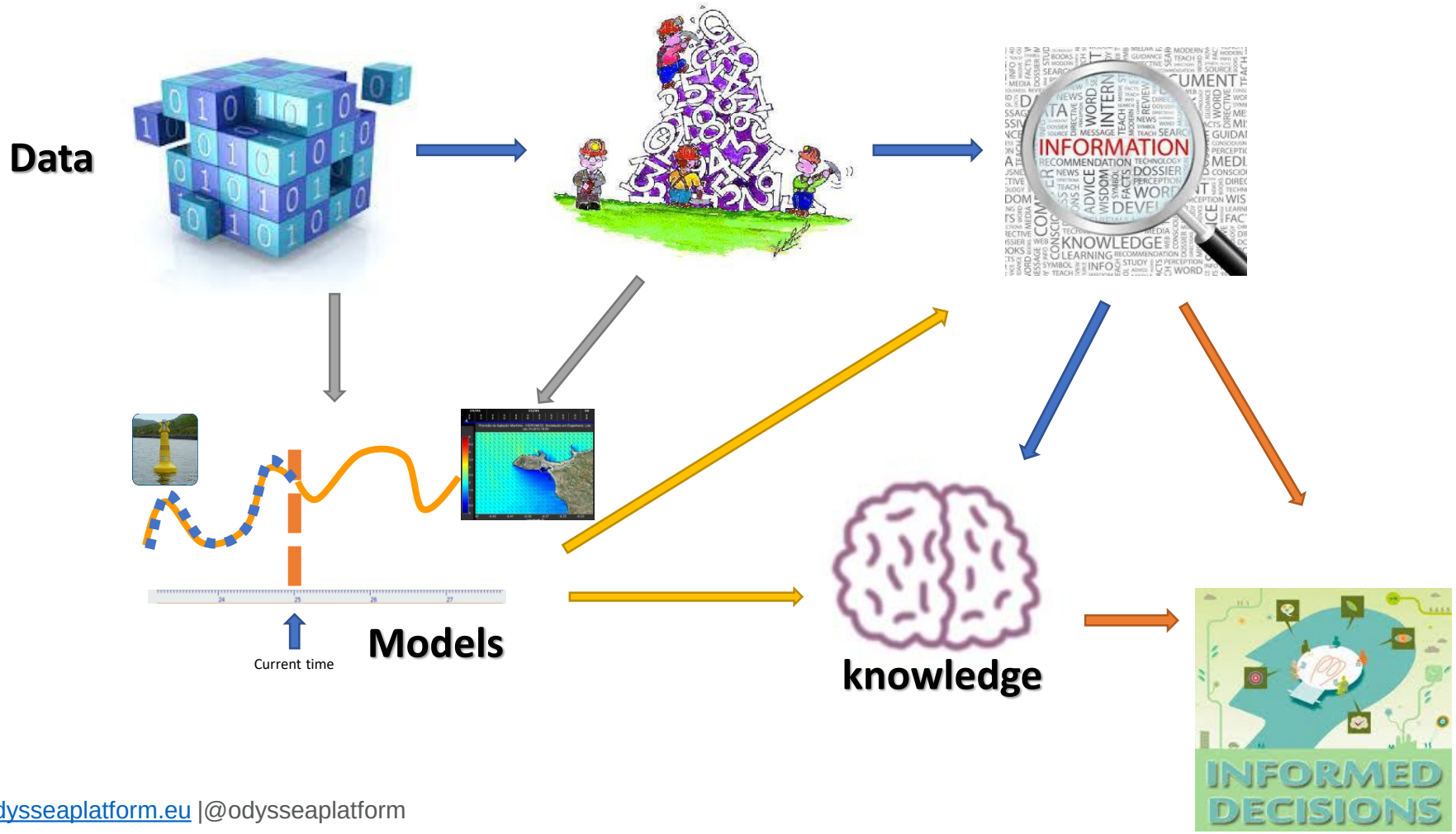
Data

Water Temperature is 28°C

If Water Temperature is higher than 26°C for more than 5 days then ‘HEAT STRESS”

High probability of fish mortality

Data to Information



Marine Information System

- Big data (large data sets and updated at high frequency)
- Cloud services
- Data privacy
- Standartization
- Service sustainability (who will pay for it?)

The ODYSSEA Summer School Knowledge Base

ODYSSEA

1. Explore and retrieve datasets from external sources
2. Use ODYSSEA Platform, follow examples, work on real test cases, make comments/suggestions
3. Combine oceanographic, environmental and biological data to understand the hidden processes
4. Focus on ecosystem models, follow examples and run test cases
5. Oceanographic and marine biology monitoring in practice

Contents

- The EU Blue Growth Strategy
- The essence of Operational Oceanography
- The structure and developments of ODYSSEA Project
    - ODYSSEA Platform
    - Monitoring Actions in ODYSSEA
    - Modelling in ODYSSEA
    - Services and Products generation
- Conclusions

The EU Blue Growth Strategy

- Long term strategy to support sustainable growth in the **MARINE** and **MARITIME** sectors as a whole.
- Leads to achieving the Europe 2020 Strategy for Smart, Inclusive and Sustainable Growth.
- Recognizes that seas and oceans have great potential for innovation and growth.
- Considers the blue economy as a driver for Europe's welfare and prosperity.
- **KEY ISSUES: Jobs and Sustainability**

Jobs and Blue Economy

ODYSSEA

- EU marine and maritime sector represents roughly 5 million jobs,
- generates a gross added value of almost €500 billion a year
- It has the potential to create more jobs
- Traditional sectors (ship building, fisheries)
- Innovative industries (renewables, biotech)
- Volume sectors (maritime tourism)
- Niche sectors (oil exploitation, seabed mining)

Blue Growth requires balanced, social-economic and environmental aspects underpinned by marine Ecosystem Services

Actions

- Implementation of persuasive incentives and/or dissuasive incentives that could reduce the consumption of non-renewable energy
- Monitor relevant MSFD descriptors and promote an effiective implementation of EU environmental-related policies
- Follow EU guidelines for compatibleness with EU Nature legislation
- Reduce wild fish inputs into marine aquaculture fish feed formulations
- Adopt more ecologically sound management practices
- Promote eco-tourism and encourage links to other sustainable actions
- Development of key matrices and treshold indicators for marine biodiversity, abundance, habitat quality, population connectivity, heterogeneity levels and community productivity
- Use of the best available science on marine and coastal ecosystems; acknowledge uncertainties and knowledge gaps

Legislation

- Blue Energy Action needed to deliver on the potential of ocean energy in European seas and oceans by 2020 and beyond
- Marine Strategy Framework Directive
- Natura 200 in the marine environment: Birds and Habitats Directives
- Common Fisheries Policy
- Maritime Spatial Planing
- Recommendations on European Tourism Quality Principles
- A European Strategy for more Growth and Jobs in Coastal and Maritime Tourism
- United Nations Convention on the Law of the Sea
- United Nations Convention on Biological Diversity

Blue Growth

'realising the potential of our seas and oceans for jobs and growth'

Good Environmental Status

- Provisioning
- Regulating and maintenance
- Cultural

- Abiotic provisioning
- Regulating and maintenance by physical structures
- Cultural by physical structures

Ecosystem services

Biomas: plants and animals — **Marine aquaculture**

Biomas: all biota for direct use or processing — **Blue biotechnology**

Energy: algae biomass/ renewable abiotic sources — **Blue energy**

Interactions: environmental/ physical settings — **Maritime, coastal and cruise tourism**

Supply

Abiotic outputs

Abiotic sustances, materials, energy — **Marine mineral resources**

Human well being

Demand

Fish protein for human consumption

Active compounds for nutraceutics, cosmetics; pharmaceutics

Reduce the dependency on non-renewable abiotic energy sources

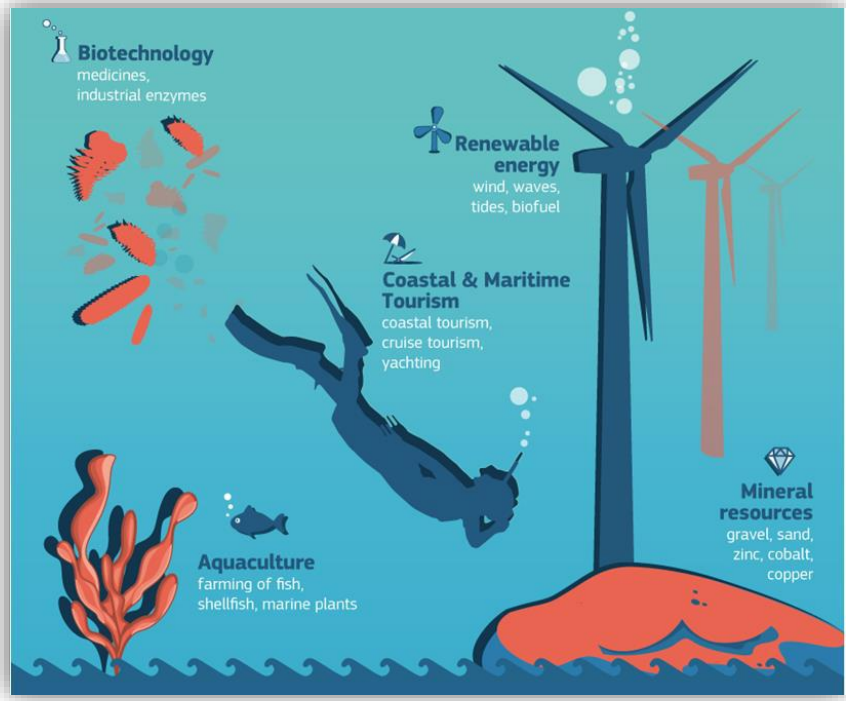
Cultural experiences

Rare earth elements, commonly used industrial metals. non-renwable energy

Blue Growth Pillar I

Develop sectors that have a high potential for sustainable jobs and growth, such as:

- **aquaculture**
- **coastal tourism**
- **marine biotechnology**
- **ocean energy**
- **seabed mining**



Blue Growth Pillar II

ODYSSEA

Provide knowledge, legal certainty and security in the blue economy

- **marine knowledge to improve access to information about the sea;**
- **maritime spatial planning to ensure an efficient and sustainable management of activities at sea;**
- integrated maritime surveillance to give authorities a better picture of what is happening at sea.

Blue Growth Pillar III

ODYSSEA

Develop sea basin strategies to ensure tailor-made measures and to foster cooperation between countries

- Adriatic and Ionian Seas
- Arctic Ocean
- Atlantic Ocean
- Baltic Sea
- Black Sea
- **Mediterranean Sea**
- North Sea

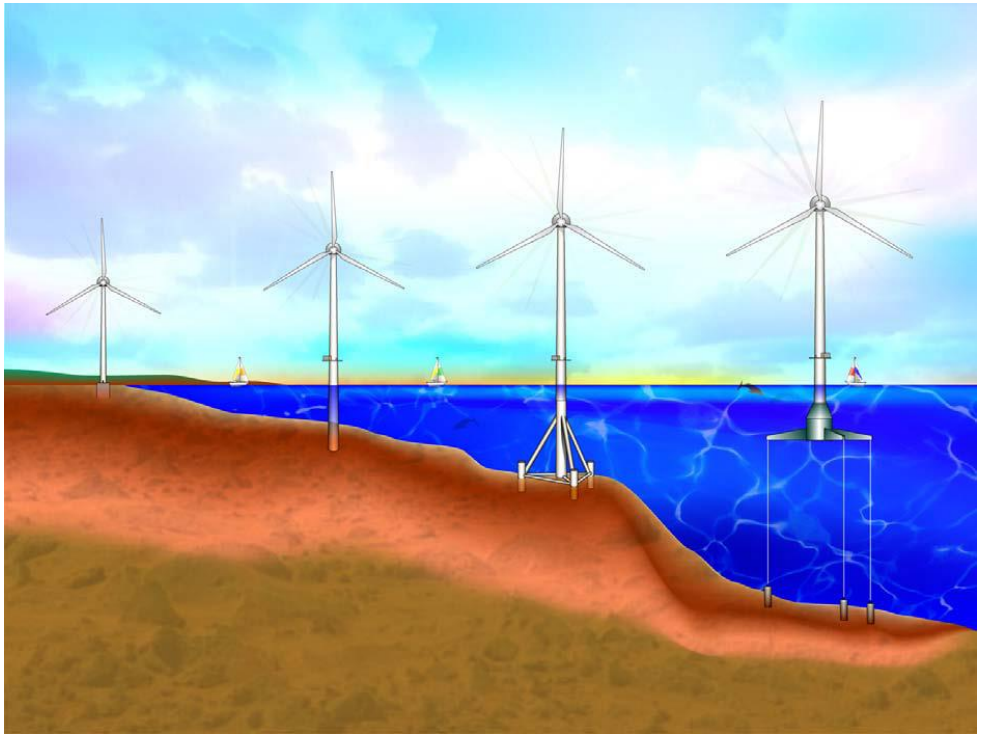
Blue Renewables

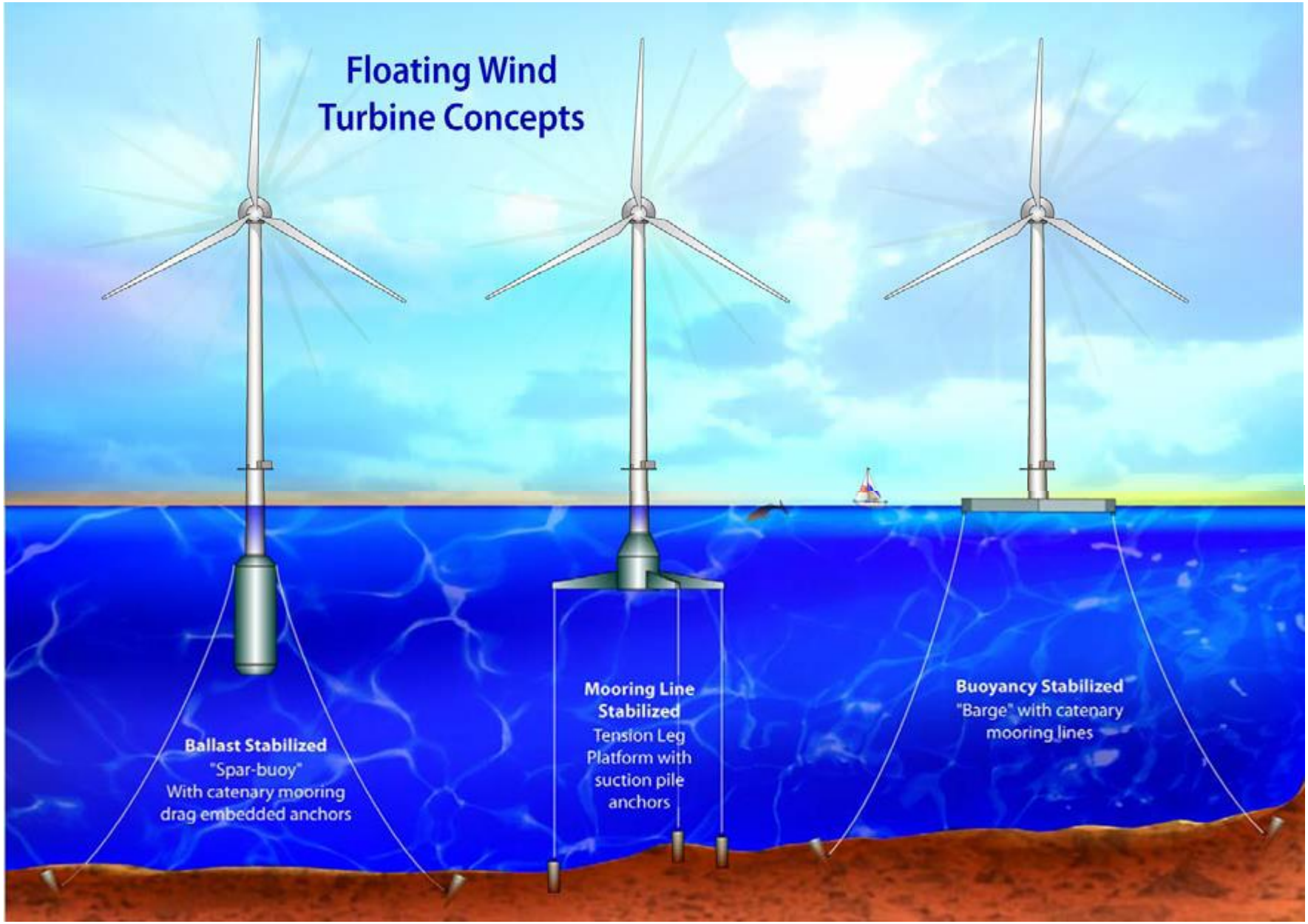
- Offshore wind is the fastest growing activity in Blue Economy
- The average marine capacity factor is higher than in land, the impact of landscape is less
- Presently, 12,631 MW of capacity was connected to the grid10 installed mostly in the shallow waters of Europe’s northern seas
- Main challenges: maritime spatial planning, technical rules, safety regulations, expand to deeper waters

Wind Farms

Nearshore to Offshore wind deployment types

From Monopile Foundation type to Tripod Foundation and to Offshore Floating Wind Turbines



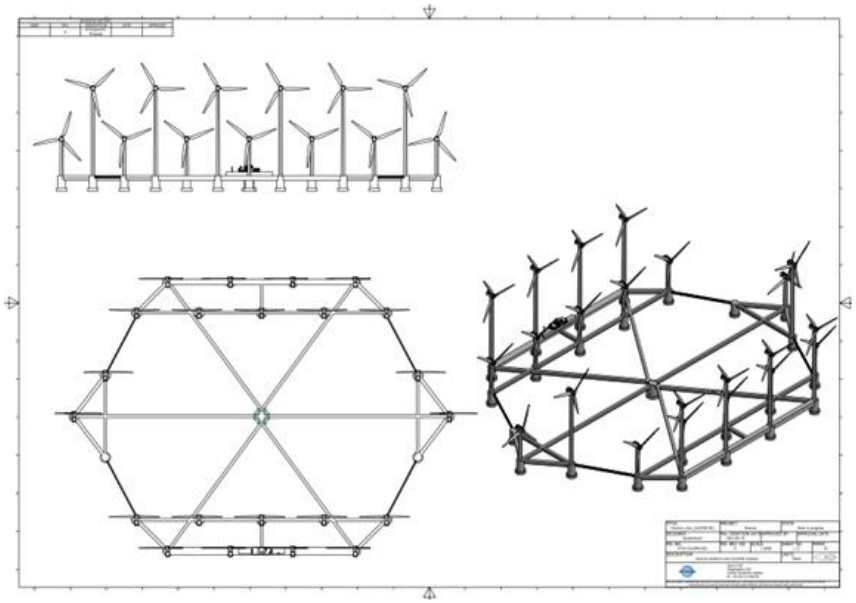

Floating Wind
Turbine Concepts
Ballast Stabilized
"Spar-buoy"
With catenary mooring
drag embedded anchors
Mooring Line
Stabilized
Tension Leg
Platform with
suction pile
anchors
Buoyancy Stabilized
"Barge" with catenary
mooring lines

Offshore Floating Wind Farms

Wind power: the floating wind turbine prototype in Brindisi harbour in December 2007

TLP type Offshore Floating Wind Farm (Blue T Technologies) to be deployed at Tricase off Italy's southern coast

Hexicon concept (Sweden)



- Platform length : abt. 700m
- Platform width : abt. 500m
- Lower hub height: 71 m
- Upper hub height: 170 m
- Installed capacity: 24 x 3 MW = 72 MW

Offshore Floating Solar Farms

ODYSSEA

Many companies have come out with different concepts for floating solar plants. For instance, DNV (Global consultancy and certification firm) unveiled designs of such floating solar arrays that would directly rival offshore wind turbines. The project aimed to create artificial islands linked together, supporting more than 4,200 PV panels across a field with the size of a football pitch.

Seawater could prove to be a “game changer" for solar panels manufacturers.
A key component in PV panels is Cadmium Chloride, which is extremely toxic and expensive.
Seawater contains Magnesium Chloride, which could replace the highly toxic and pricy Cadmium Chloride.
Extracting $MgCl_2$ from seawater also means that supply is in abundance.
Cadmium Chloride costs around 300$ per kg while Magnesium Chloride costs just 1$ per kg.

ODYSSEA

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Marine Data and Marine Renewables

ODYSSEA

- Offshore winds (speed, direction, gust, events frequency of occurrence, extreme events)
- Waves (wave height, period, direction, frequency of occurrence, extreme waves)
- Currents (speed, direction, frequency of occurrence, extreme events)
- Temperature, Salinity, Chlorophyll-a Data (time-series, profiles)
- Seabed properties
- Marine habitats, biodiversity, seabed organisms

Aquaculture

- Today it accounts for more than 50% of worldwide seafood production
- In EU it employs directly 80,000 people
- Volume production grew by 40%
- The sector meets high quality, sustainability and consumer protection standards
- Focuses on local products, traditional methods and high value species and protein-rich products
- Challenges: aquaculture management, marine spatial planning

Marine Data and Aquaculture

- Winds (speed, direction, gust, frequency of occurrence, extreme events)
- Waves (wave height, period, direction, frequency of occurrence, extreme waves)
- Currents (speed, direction, frequency of occurrence, extreme events)
- Temperature, Salinity, Nutrients, DO, pH, Chlorophyll-a Data (time-series, profiles)
- Seabed properties
- Marine habitats, biodiversity, seabed organisms

Marine Data and Fisheries

ODYSSEA

- Winds (forecasts in speed, direction, gust)
- Waves (forecasts in wave height, period, direction)
- Thermal/Density Fronts
- Currents (forecasts in speed, direction)
- Temperature, Salinity, Chlorophyll-a Data (forecasts time-series, profiles)
- Seabed properties
- Marine habitats, biodiversity, seabed organisms

Marine Data and Ports

- Winds (speed, direction, gust, frequency of occurrence, extreme events)
- Waves (wave height, period, direction, frequency of occurrence, extreme waves)
- Currents (speed, direction, frequency of occurrence, extreme events)
- Temperature, Salinity, Nutrients, DO, pH, Chlorophyll-a Data (time-series, profiles)
- Water Renewal Time
- Seabed properties
- Biodiversity, seabed organisms

Marine Data

- Marine data are held by hundreds of public and private organizations in Europe.
- Making these data more interoperable and more available to users can improve the productivity of private industry, public authorities, researchers and civil society.
- The three main EU initiatives aiming to achieve these goals,

(a) the Copernicus Marine Environment Monitoring Service providing space data and oceanographic forecasts,

(b) the European Marine Observation and Data Network (EMODnet) which assembles, processes and distributes all other marine data and data products, and

(c) the Data Collection Framework which supports the collection and processing of fisheries and aquaculture data

Marine Data

- Marine data could be used to

(a) Achieve better short and long term forecasts of marine conditions, especially extreme events forecasts (e.g., storms, extreme waves, eutrophic, anoxic conditions)

(b) Improve maritime sectoral spatial planning (e.g., in aquaculture, marine renewables)

(c) Protect marine environment, restore degraded ecosystems, adapt to climate change

The essence of Operational Oceanography

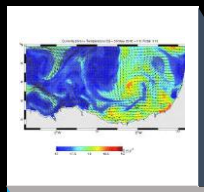
ODYSSEA

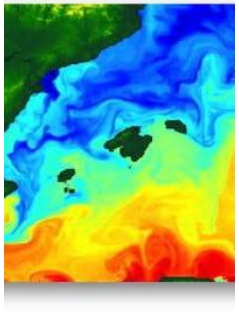
OO involves the integration of RT and NRT measurements from satellites and in-situ sensors; the utilization of model results; the transfer, analysis, processing of data to provide sustained marine measurements, analyses, predictions and assessments to users for

(a) Public safety improvement;

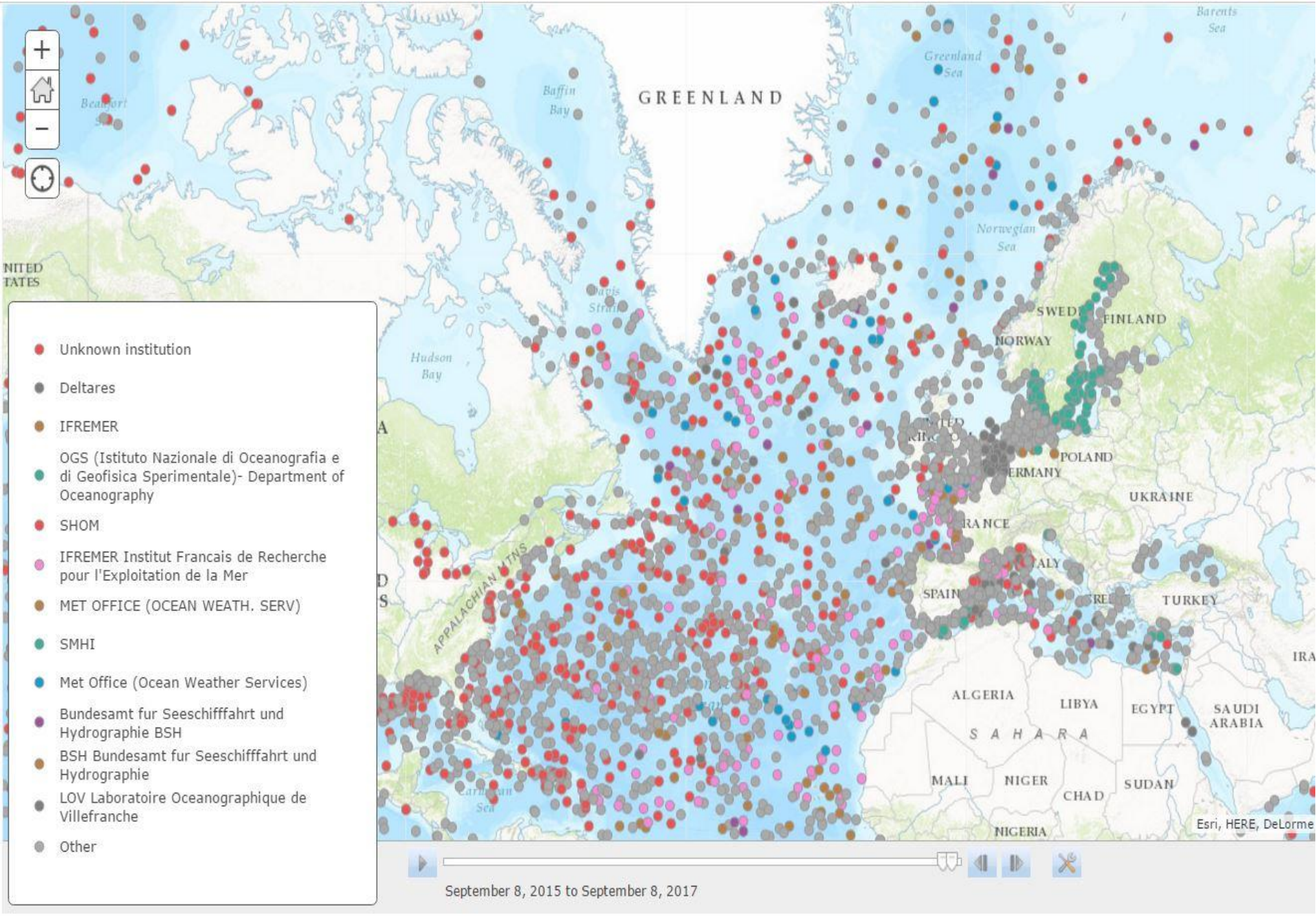
(b) Marine environment protection; and

(c) Marine and maritime sectors support.





OO Tools and Methods


GREENLAND
Baffin Bay
Greenland Sea
Barents Sea
Norwegian Sea
Hudson Bay
Davis Strait
Beaufort Sea
NITED TATES
SWEDEN
FINLAND
NORWAY
POLAND
UKRAINE
FRANCE
SPAIN
TURKEY
ALGERIA
LIBYA
EGYPT
SAUDI ARABIA
S A H A R A
MALI
NIGER
CHAD
SUDAN
NIGERIA
APPALACHIAN MTNS
Esri, HERE, DeLorme
Unknown institution
Deltares
IFREMER
OGS (Istituto Nazionale di Oceanografia e di Geofisica Sperimentale)- Department of Oceanography
SHOM
IFREMER Institut Francais de Recherche pour l'Exploitation de la Mer
MET OFFICE (OCEAN WEATH. SERV)
SMHI
Met Office (Ocean Weather Services)
Bundesamt fur Seeschifffahrt und Hydrographie BSH
BSH Bundesamt fur Seeschifffahrt und Hydrographie
LOV Laboratoire Oceanographique de Villefranche
Other
September 8, 2015 to September 8, 2017

Blue Growth and H2020

ODYSSEA

- Horizon 2020 is strongly supporting the Blue Growth strategy with a dedicated Focus Area for the 2014/2015 WP.
- The EU commitment was translated into the current Blue Growth calls with 195M € in the 2014-2015 Work Program and 57M € "earmarked" as Galway Statement follow-up calls.
- **International cooperation is needed to join forces globally in order to tackle global challenges** in these areas, and the Transatlantic Ocean Research Alliance.

BG-11 - Basic Call Requirements

ODYSSEA

1. Develop a new Mediterranean Sea Observing Platform to
   - ✓ describe the functions of vulnerable marine ecosystems
   - ✓ support biodiversity conservation
   - ✓ forecast and manage risks and emergencies
   - ✓ place the above within the context of sea-related activities and economic sectors

BG-11 - Basic Call Requirements

1. Develop a new Mediterranean Sea Observing Platform to
   - ✓ describe the functions of vulnerable marine ecosystems
   - ✓ support biodiversity conservation
   - ✓ forecast and manage risks and emergencies
   - ✓ place the above within the context of sea-related activities and economic sectors

BG-11 - Basic Call Requirements

ODYSSEA

2. Develop the Platform together with tools and solutions in line to main EU policy instruments, as
   - ✓ the EU Integrated Maritime Policy (IMP),
   - ✓ the Marine Strategy Framework Directive (MSFD),
   - ✓ the Common Fisheries Policy (CFP),
   - ✓ the EU neighborhood policy,
   - ✓ the ICZM Barcelona Convention and
   - ✓ the EU BLUEMED Initiative.

BG-11 - Basic Call Requirements

ODYSSEA

- The developed platform should **integrate information from existing platforms** and systems already in operation in the Med, as:

✓ EMODNet

✓ Copernicus

✓ GEOSS

✓ GOOS

✓ ESFRI

EMODnet
European Marine Observation and Data Network

Copernicus
Europe's eyes on Earth

GEO GROUP ON EARTH OBSERVATIONS

GEOSS Portal
Discover, Access, Contribute
Earth Observations, Information and Services

esa

Research Infrastructures

The Global Ocean Observing System
GOOS

BG-11 - Basic Call Requirements

ODYSSEA

To conduct research and innovation activities **to address and fill in observational gaps** in the Med, in particular those related to the *in-situ* component of the observation system.

- ✓ Improve existing **in-situ operational systems**
- ✓ Expand towards **new ocean observation technologies**
- ✓ Integrate the **biological dimension** into sea observing systems
- ✓ To build **cost-effective in-situ systems**
- ✓ Utilize the information collected to **calibrate and validate models and satellites** (Sentinel, Earth Explorer)

ODYSSEA Central Objective

ODYSSEA is a user-centred project aiming to make Mediterranean marine data easily accessible and operational to multiple end-users, by

- harmonizing existing Earth Observing systems,
- upgrading operational oceanographic capacities,
- supporting EU policy implementation,
- improving interoperability in monitoring,
- fostering blue growth jobs creation, and
- opening participation to non-EU member states.

In more detail

What is ODYSSEA

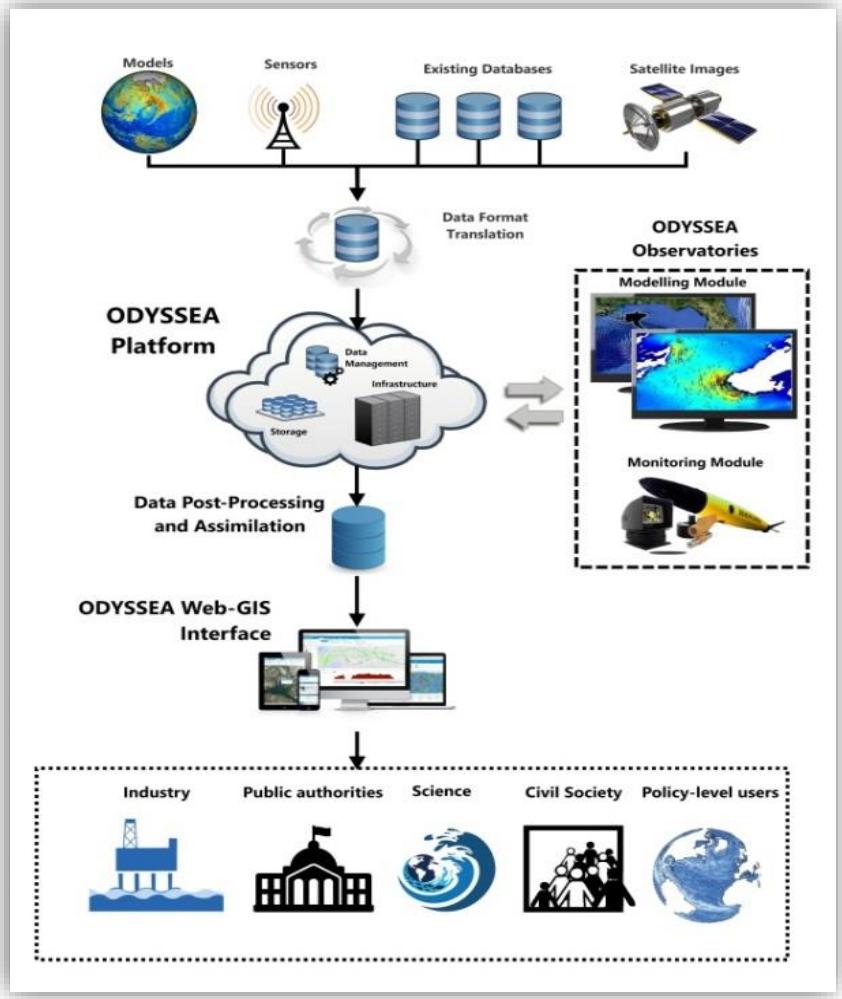
ODYSSEA is a Mediterranean-focused research project funded by EU Research and Innovation Program Horizon 2020

- 28 partners from 14 countries (6 non-EU)
- 8.398 Meuros budget
- 54 months duration
- Starting date 1st June 2017
- Ending date 30th November 2021
- 932 PMs in total
- 118 researchers involved
- 7 Advisory Board Members

What is ODYSSEA ?

ODYSSEA is a system bridging the gap between operational oceanography capacities and the need for information on marine conditions from the community of end-users.

ODYSSEA's ambition is to develop an **interoperable, fully-integrated and cost-effective multiplatform network of observing and forecasting systems** across the Mediterranean basin, addressing both the open sea and the coastal zone.



What is ODYSSEA ?

ODYSSEA

A ‘Babushka’ type project

A Sea of Platforms
An Ocean of Datasets

ODYSSEA

EMODnet
European Marine Observation and Data Network

NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

NASA

JAXA

EGO

Copernicus
Europe's eyes on Earth

USGS
science for a changing world

OneGeology

AquaMaps

ECMWF

BirdLife INTERNATIONAL

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British Oceanographic Data Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

Euro Argo

emso
ERIC
EUROPEAN RESEARCH INFRASTRUCTURE CONSORTIUM

General Bathymetric Chart of the Oceans
GEBCO

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EUROPEAN COMMISSION

FixO3
FIXED-POINT OPEN OCEAN OBSERVATORIES

Geo-Seas

GFCM
CGPM

mongoos

SeaDataNet

UNEP

MAP

Many Platforms
Too few people Informed

1. Systems are disparate
2. Inhomogeneous Datasets (formats, types)
3. Difficult to access multiple datasets
4. Data stored and maintained by various agencies
5. In some cases, data access requires authorization by agencies
6. Gaps in datasets, especially chemistry and biology
7. Gaps along N. African Middle East Coastlines
8. Mostly static data, collected from past cruises, lack in reporting parameters as micro-pollutants, fisheries, etc., limited satellite data, no meteorological/hydrologic data
9. Lack on data transformation to information
10. Datasets are not linked to EU policy instruments
11. Limited end-users involvement and training

Existing Platforms Analysis

ODYSSEA

Science of the Total Environment 668 (2019) 531–546

Contents lists available at ScienceDirect

Science of the Total Environment

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

An identification and a prioritisation of geographic and temporal data gaps of Mediterranean marine databases

Davide Astiaso Garcia [a,*], Marina Amori [b], Franco Giovanardi [b], Giuseppe Piras [c], Daniele Groppi [c], Fabrizio Cumo [c], Livio de Santoli [a]

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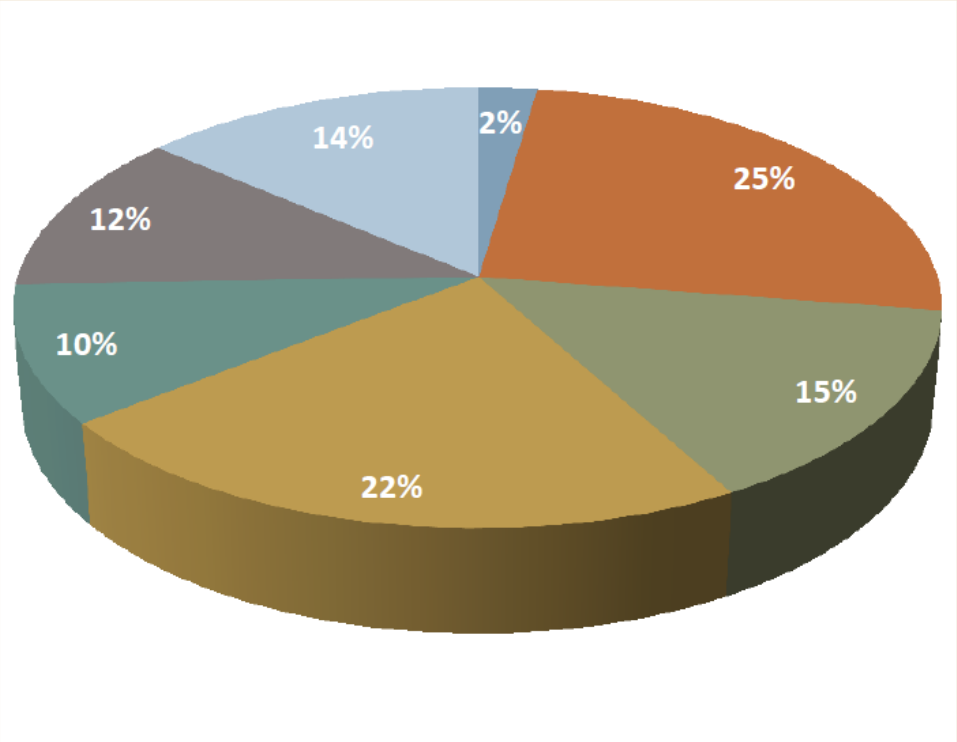
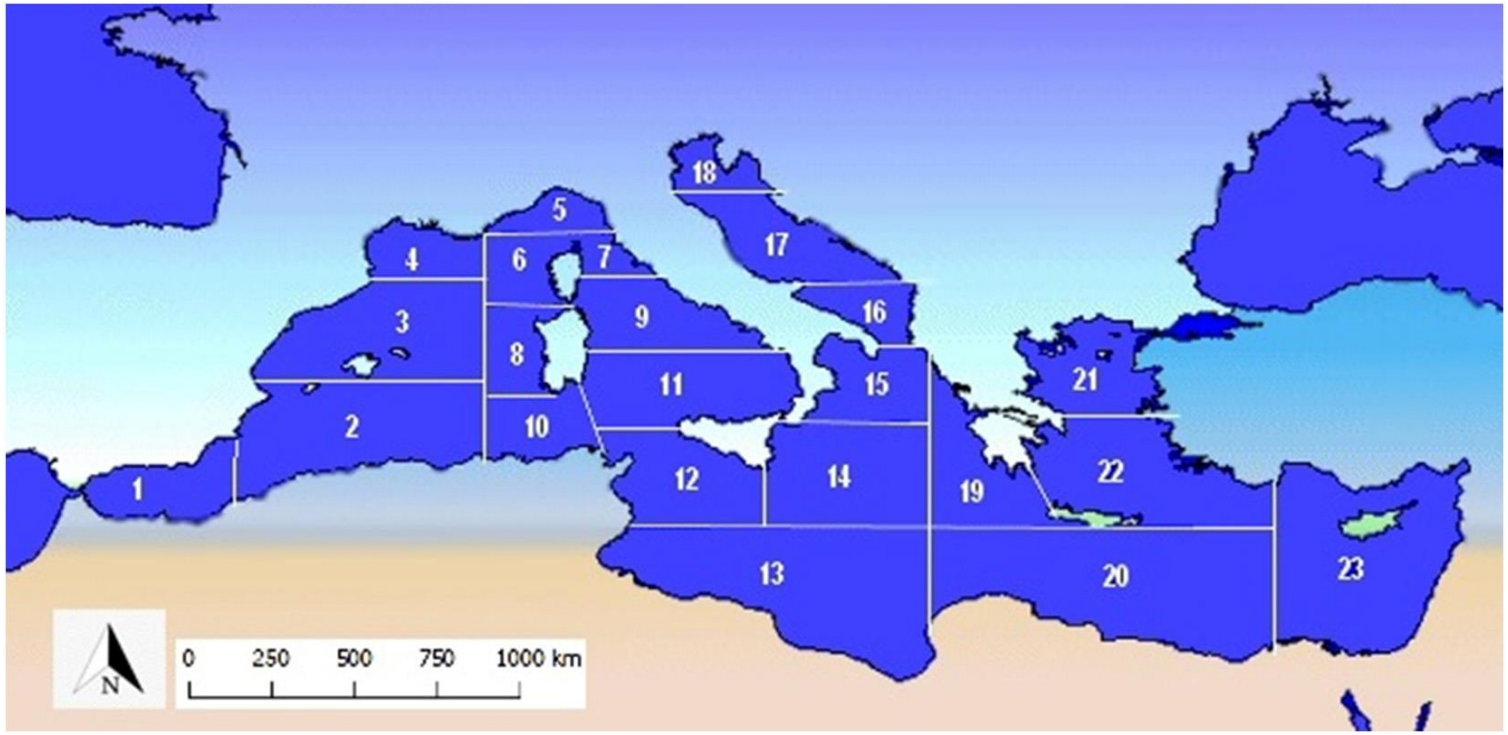
Existing Platforms Analysis

ODYSSEA

Diagram 1: Variability in platform typologies



Existing Datasets Analysis



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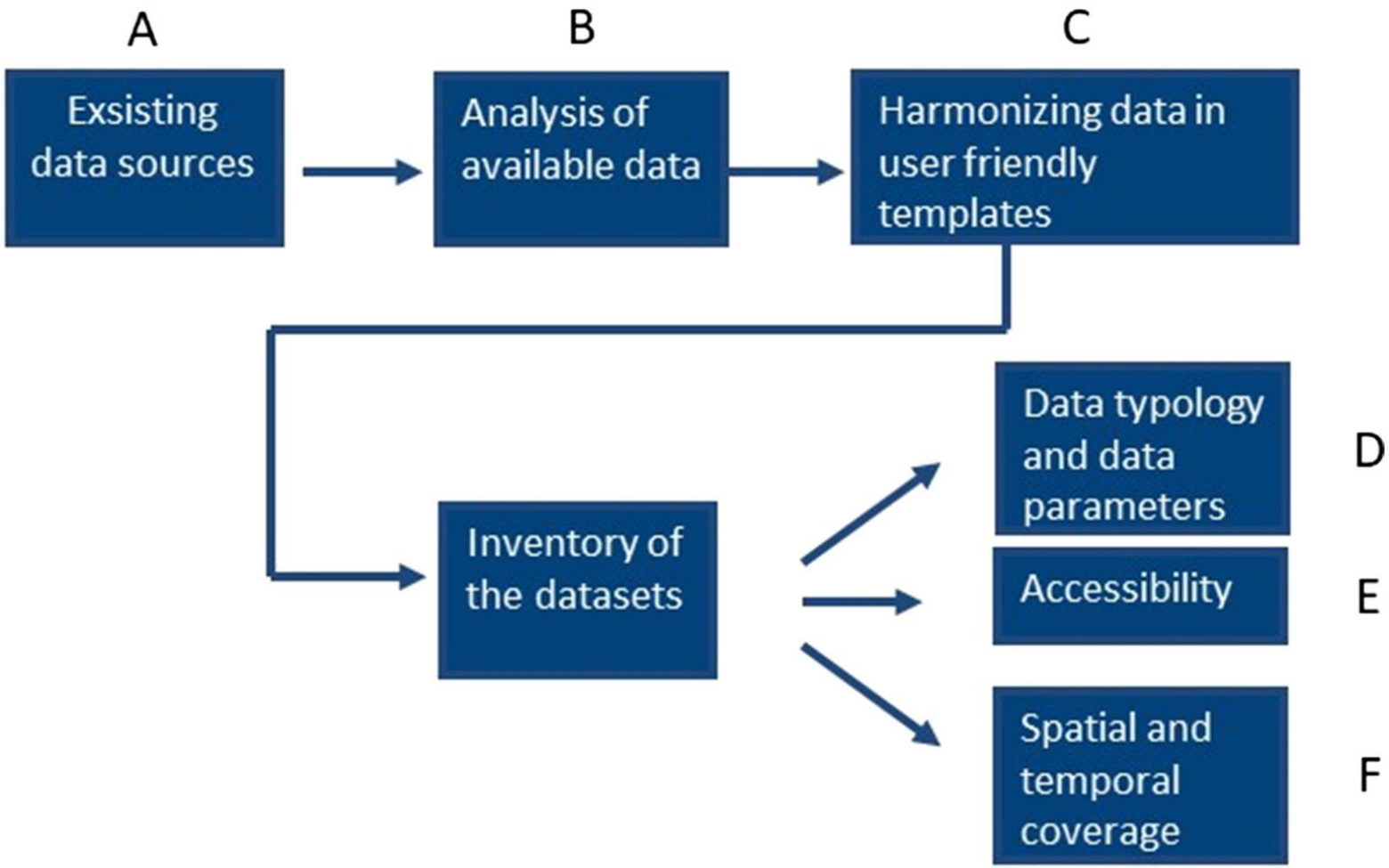


Existing Datasets Analysis

Data Typology	Data Typology code	Data Typology	Data Typology code
Meteorology	M010	Rock and sediment sedimentology	GSED
Biota abundance biomass and diversity	B070	Terrestrial including bathymetry and under-sea features	T001
Birds mammals and reptiles	B015	Positioning references and data management	Z005
Fish	B020	Habitat	B050
Anthropogenic contamination	H001	Macroalgae and seagrass	B055
Construction and structures	H002	Pigments	B035
Fisheries	H004	Dissolved gases	C015
Human activity	H005	Carbon nitrogen and phosphorus	C005
Currents	D030	Sedimentation and erosion processes	G060
Sea level	D032	Rock and sediment physical properties	G040
Water column temperature and salinity	D025	Optical properties	D015
Waves	D034	Suspended particulate material	G015
Rock and sediment lithology and mineralogy	G045	Earth science oceans marine volcanism	VOLC

Existing Datasets Analysis

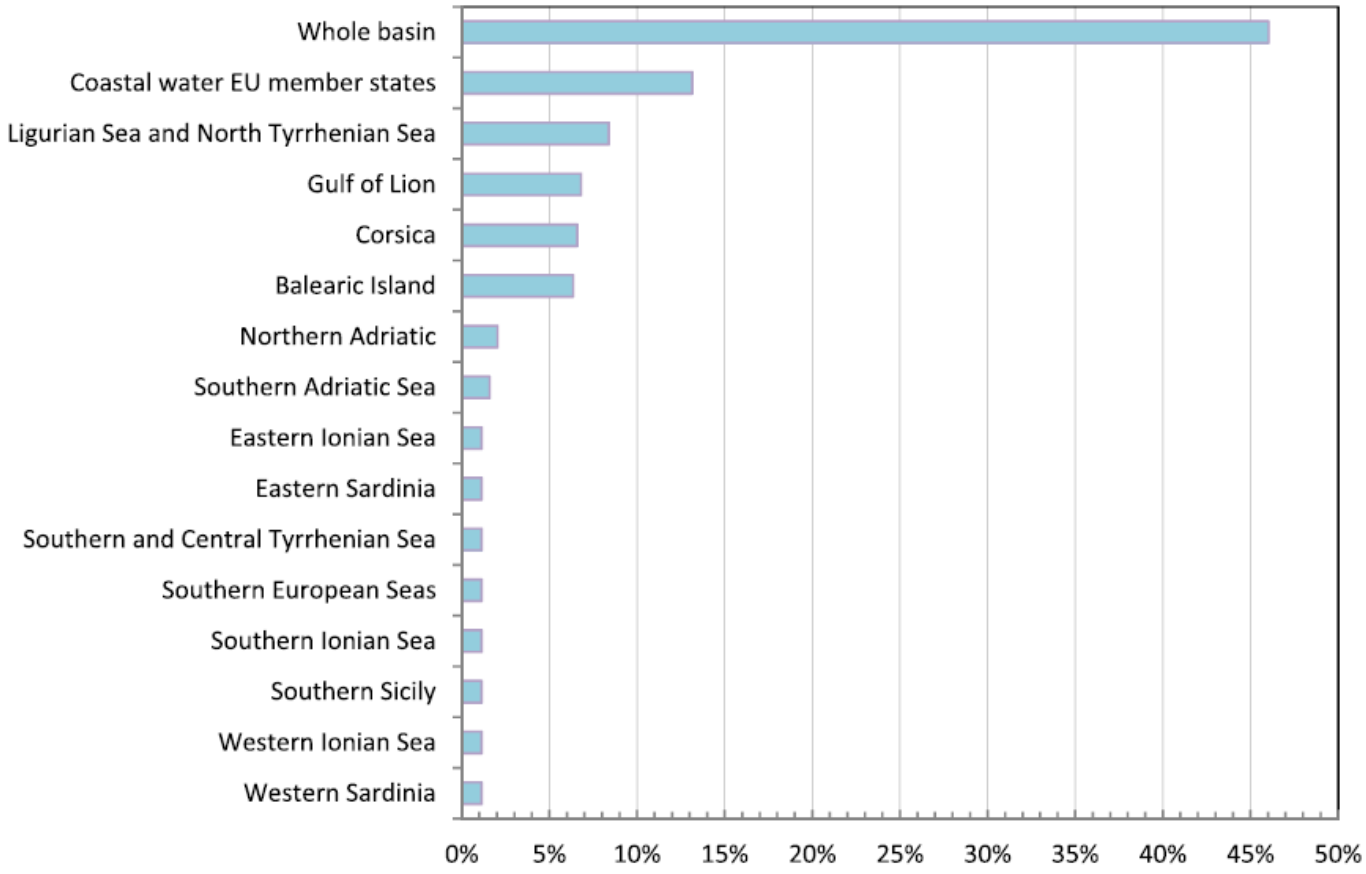
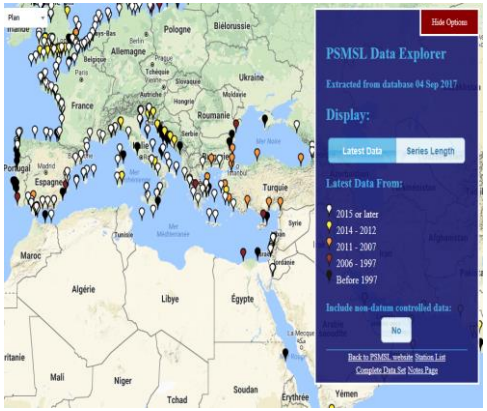


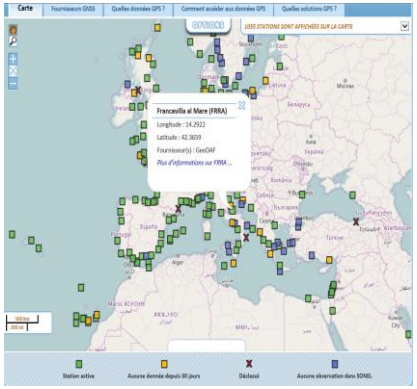
Fig. 7. Geographical coverage: No. of occurrences of the monitored sea in the Whole_Master_Data sheet.

Data Gap Analysis

Southern and eastern shore of Mediterranean is poorly served in information and oceanographic data due to :

- Lack of **scientific knowledge and data** on ocean environment,
- Lack and insufficient use of the **scientifical and technological tools** to gather, process and analyse data,
- Lack of relevant **socio-economic data**,
- **Geopolitical issues** and **understanding interests of stakeholders**, their distributional implication and equity considerations,





A real need to **monitor and protect the Mediterranean ecosystem** (cf. Convention of Barcelona)

Portails presented in this study are mainly for a scientific audience and are **not intuitive for public users as fisherman**

Specific Objectives

ODYSSEA

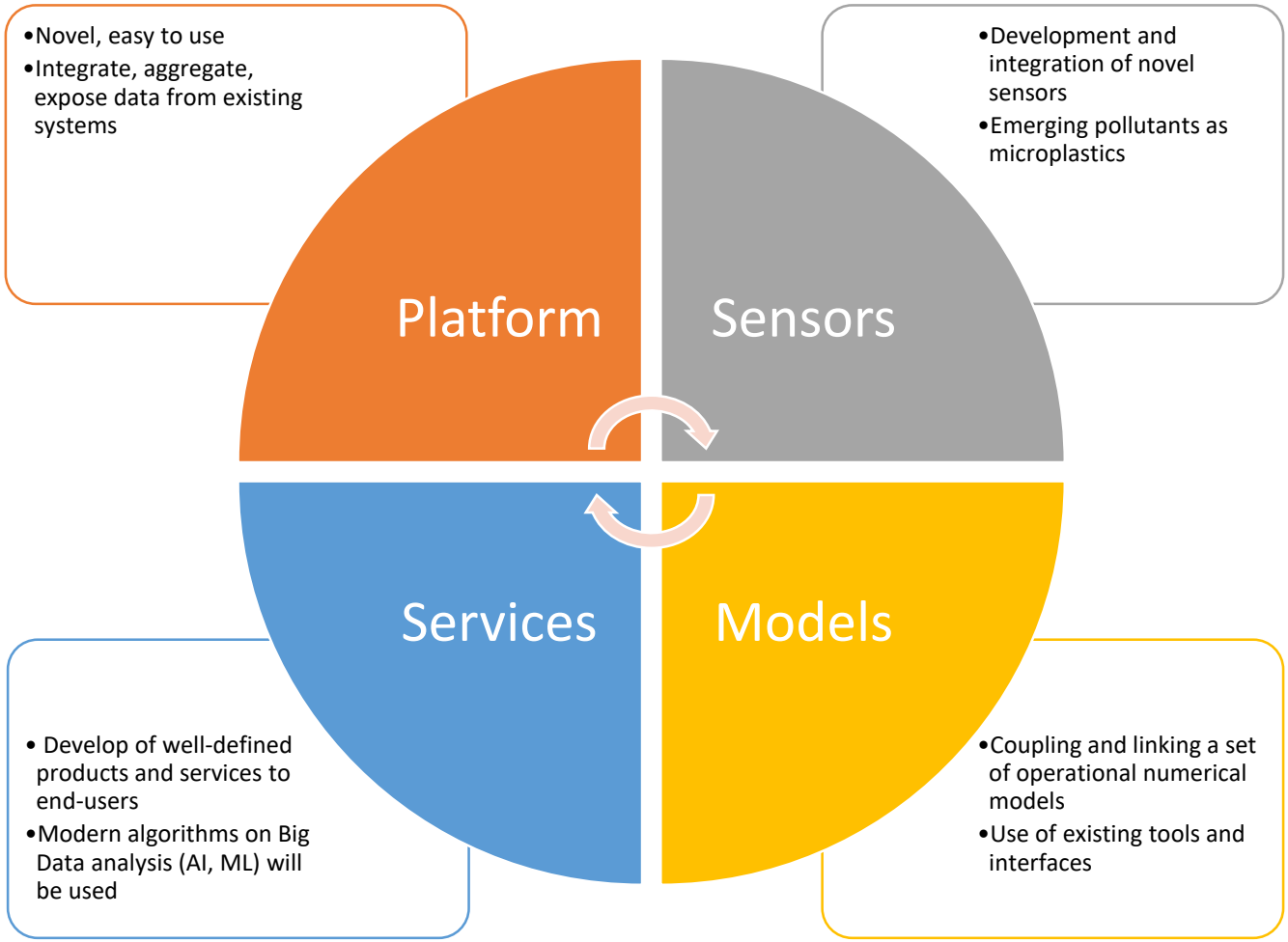
1. Develop a platform to discover, integrate and process datasets obtained from an expanded range of existing observation platforms
2. Fill-in data gaps & increase spatial and temporal resolution by establishing ODYSSEA Observatories
3. Develop a prototype ‘chain’ of models providing data never previously reported
4. Expand existing operational monitoring systems capacity
5. Emphasize on biological datasets
6. Combine data to extract secondary indicators
7. Link indicators to EU policies
8. Involve end-users on platform design, data collection and day-to-day operations
9. Train and educate policy-makers and end-users on platform usage
10. Improve professional skills and competences - focus on Northern Africa capacity building

ODYSSEA's Main Novelties

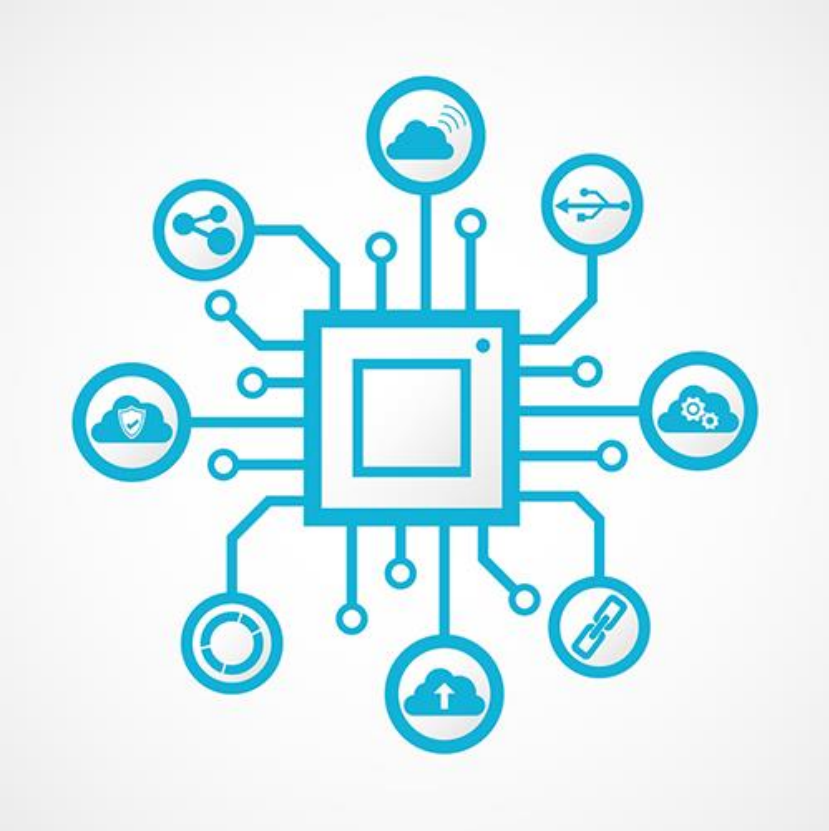
- Both primary data and on-demand derived data services will be made available and accessible through **a single command and via a single public portal**.
- The platform will allow to **search, collect, retrieve and integrate datasets** obtained from an expanded range of existing observational systems.
- To reduce costs and ensure active participation of end-users on ODYSSEA platform, **existing facilities (onshore and offshore)**, such as oil and gas terminals and rigs, mariculture installations, ports and harbours, **will be used to deploy static sensors**.
- Gliders will **integrate marine microplastics sensor and novel sensors** for real-time biological monitoring.
- Operational models will be coupled and running in each Observatory providing forecasts and **informing end-users on emergencies and risks**.
- Local/regional/national policy-makers and end-users will be **trained on the optimal platform usage**.

ODYSSEA Pillars

ODYSSEA

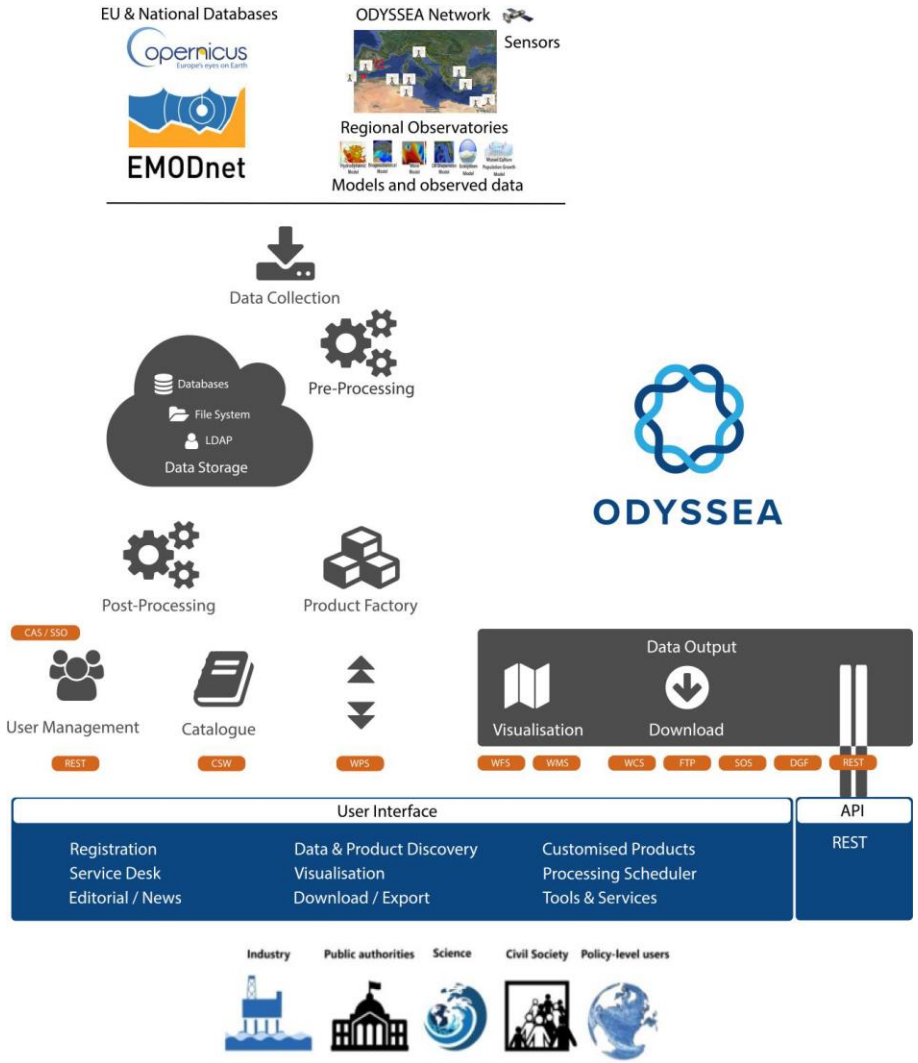


The Platform



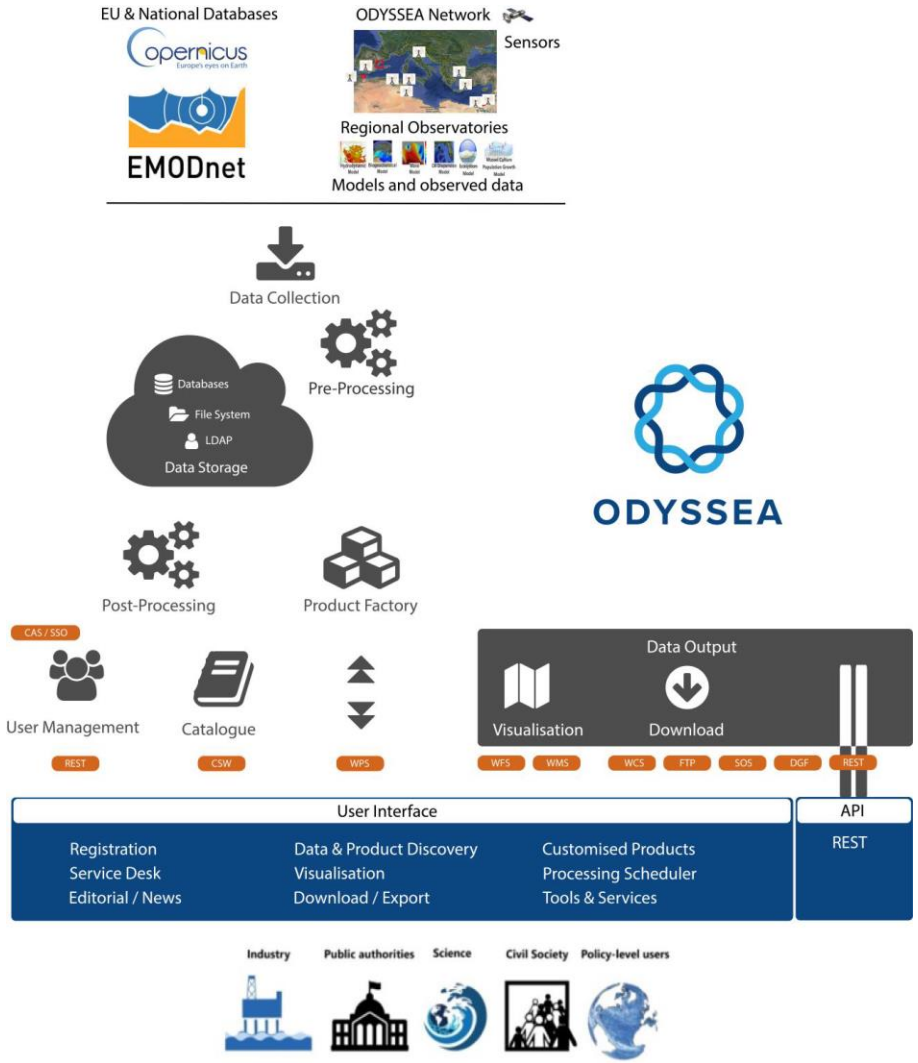
The Platform

1. Integrate marine data from existing databases maintained by Earth Observing facilities,
2. Receive and process novel newly produced datasets (through models, remote sensing and on-line sensors) from nine prototype Observatories,
3. Transform marine data into meaningful information, ultimately developing, testing, validating and disseminating marine data products and services to end-users,
4. Stimulate Blue Growth throughout the Mediterranean basin, creating businesses, advancing science and supporting the societal use of digital information

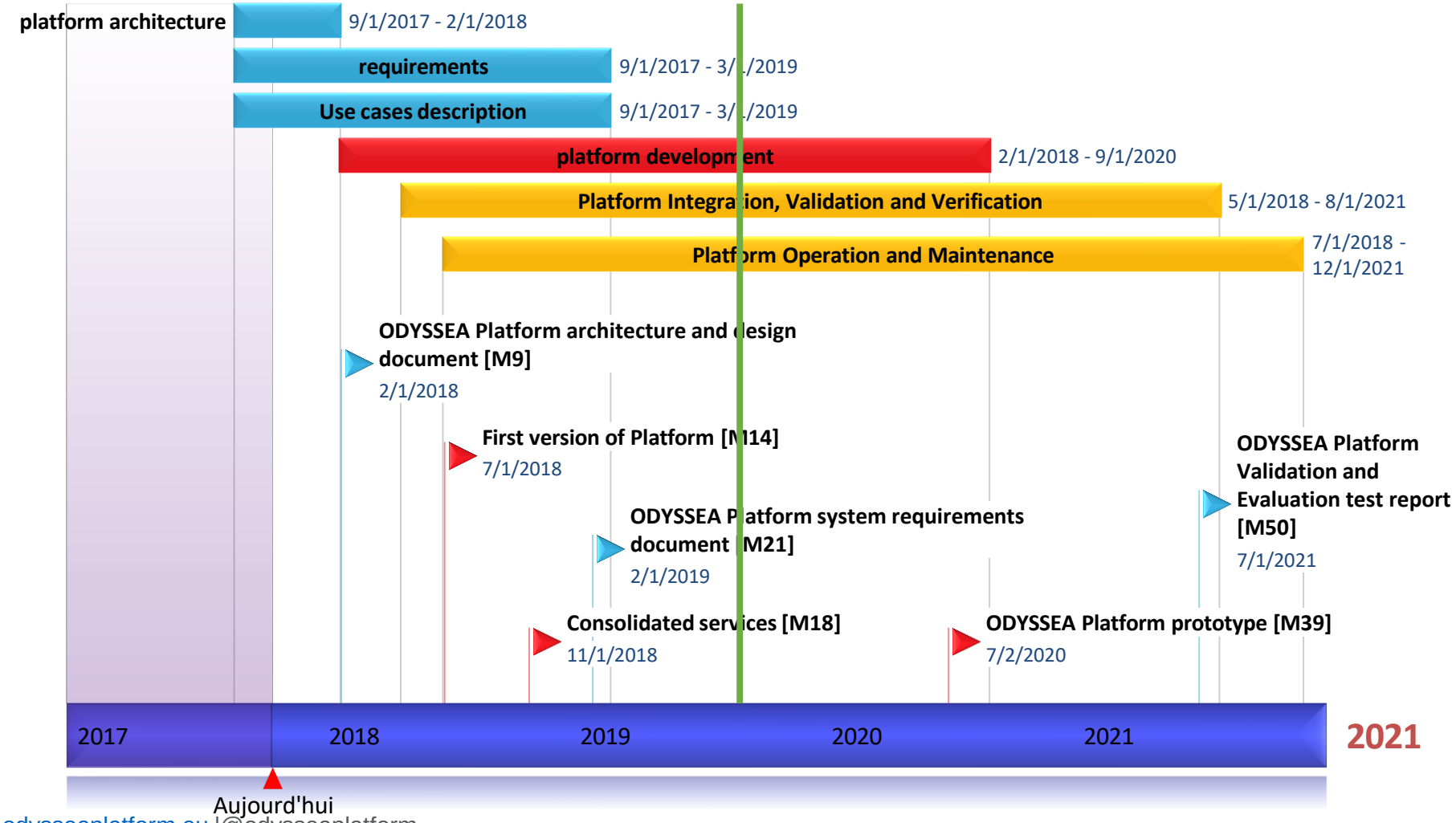


The Platform

- ✓ Have a modular and highly versatile structure,
- ✓ Collect, process and homogenize datasets,
- ✓ Provide geo-referenced datasets in common formats,
- ✓ Allow indexing, storage, documentation, presentation and exchange of geospatial datasets,
- ✓ aggregate physical, chemical geological, biological, biodiversity and fishery datasets,
- ✓ follow an ontology approach and apply semantic information fusion to provide functionalities and services.



ODYSSEA Platform RoadMap

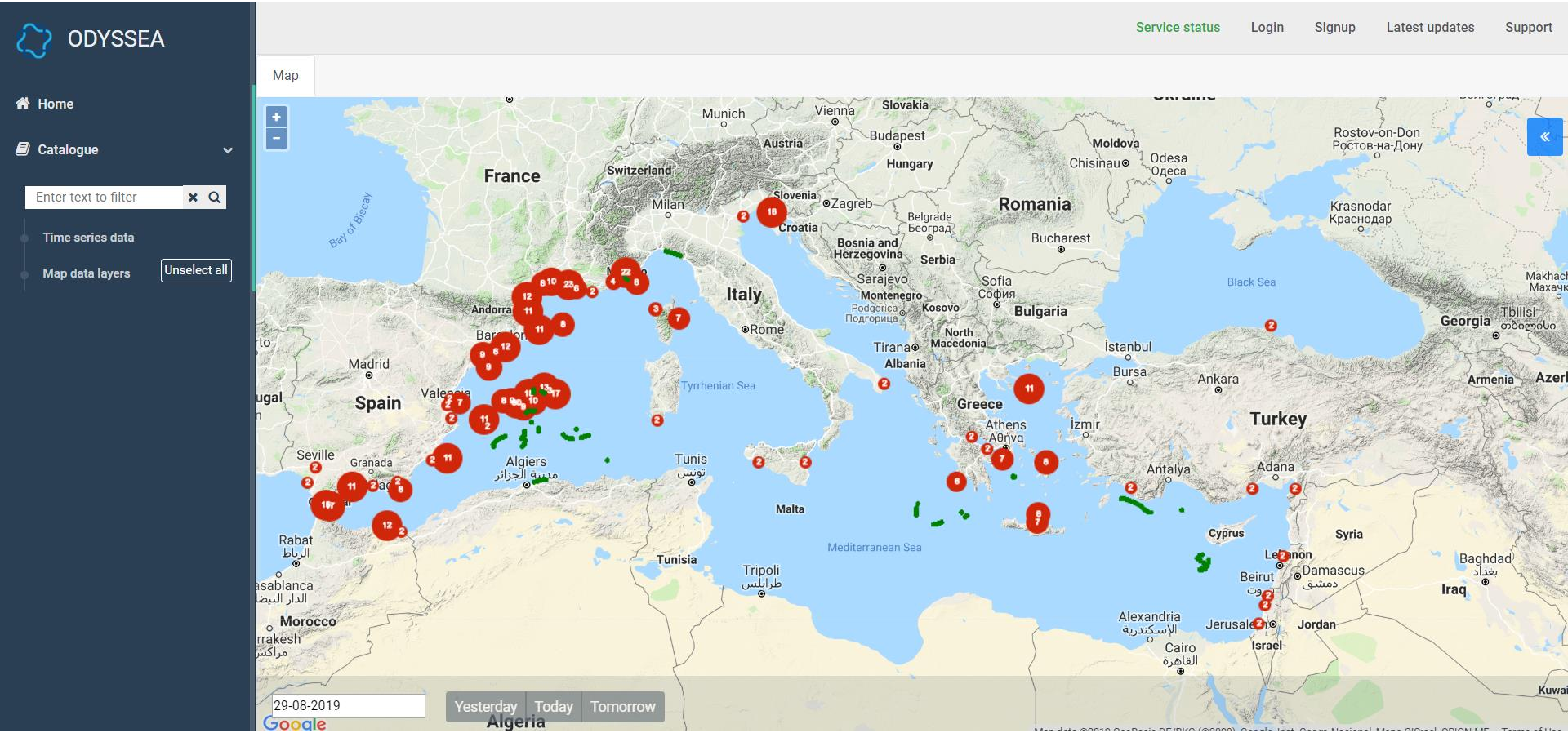


ODYSSEA Platform v1

ODYSSEA

Ocean Bathymetry – Mediterranean Sea

ODYSSEA Platform v1



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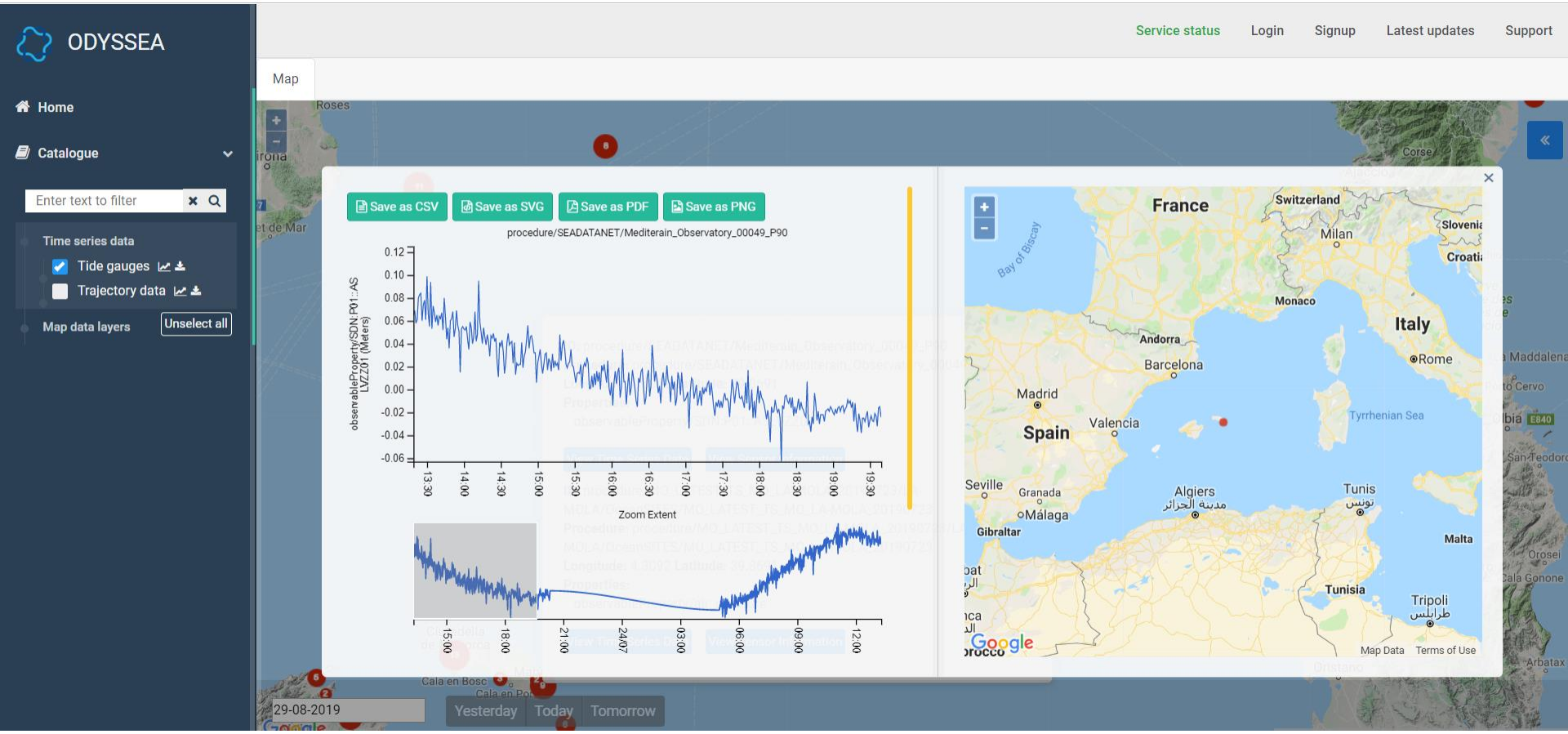
ODYSSEA Platform v1



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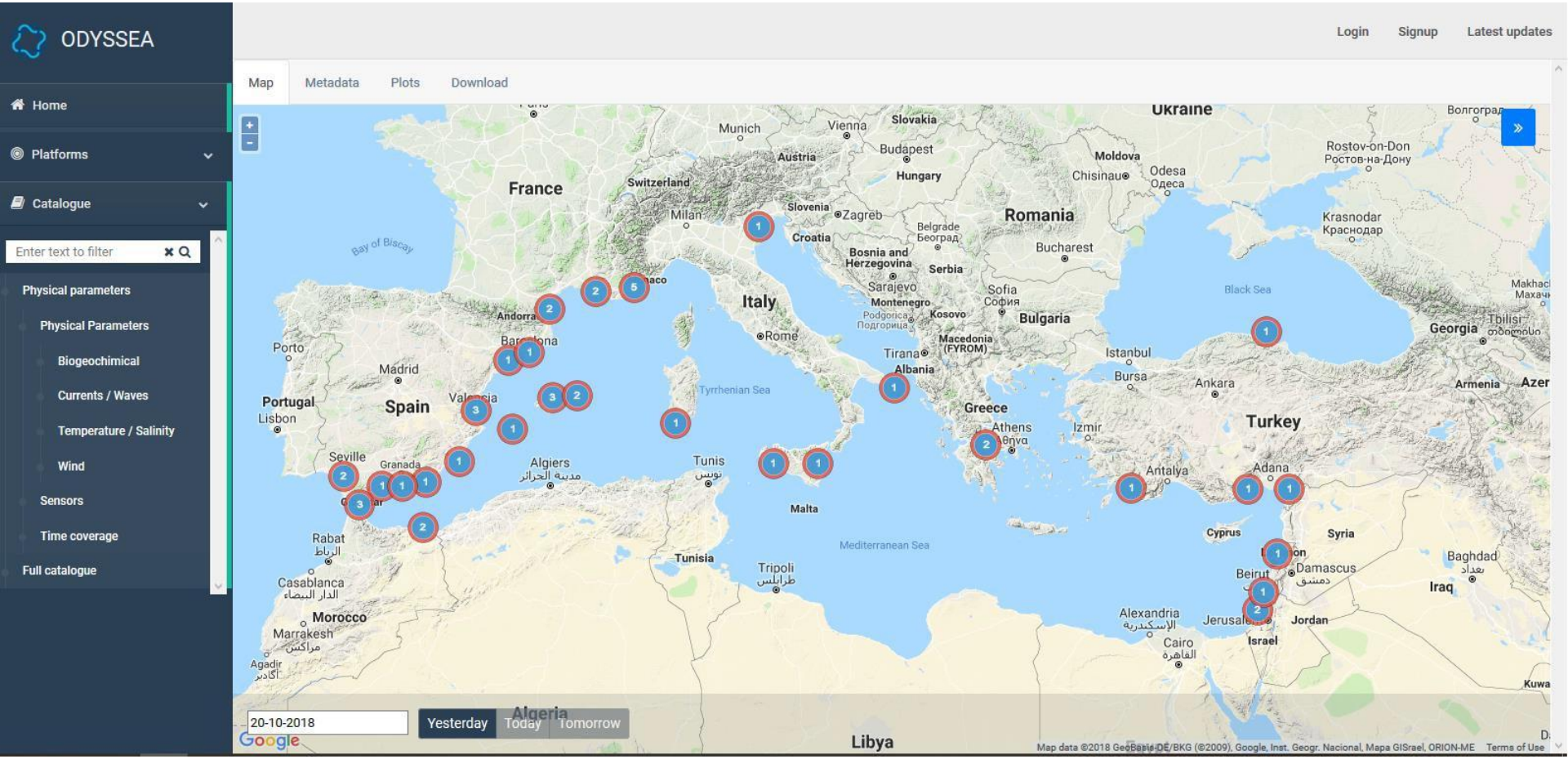
ODYSSEA Platform v1

ODYSSEA

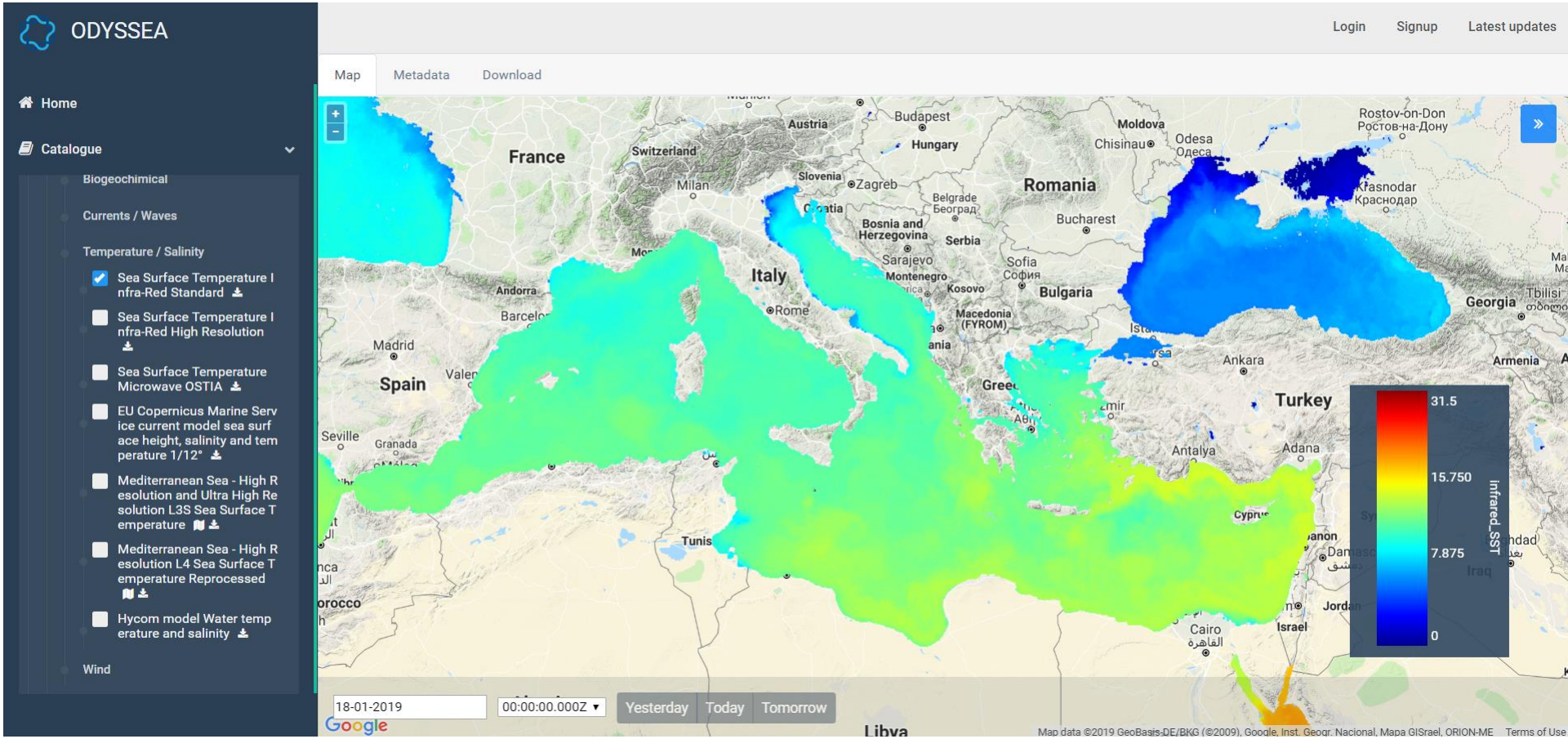
Tidal gauges – Mediterranean Sea



ODYSSEA Platform v1

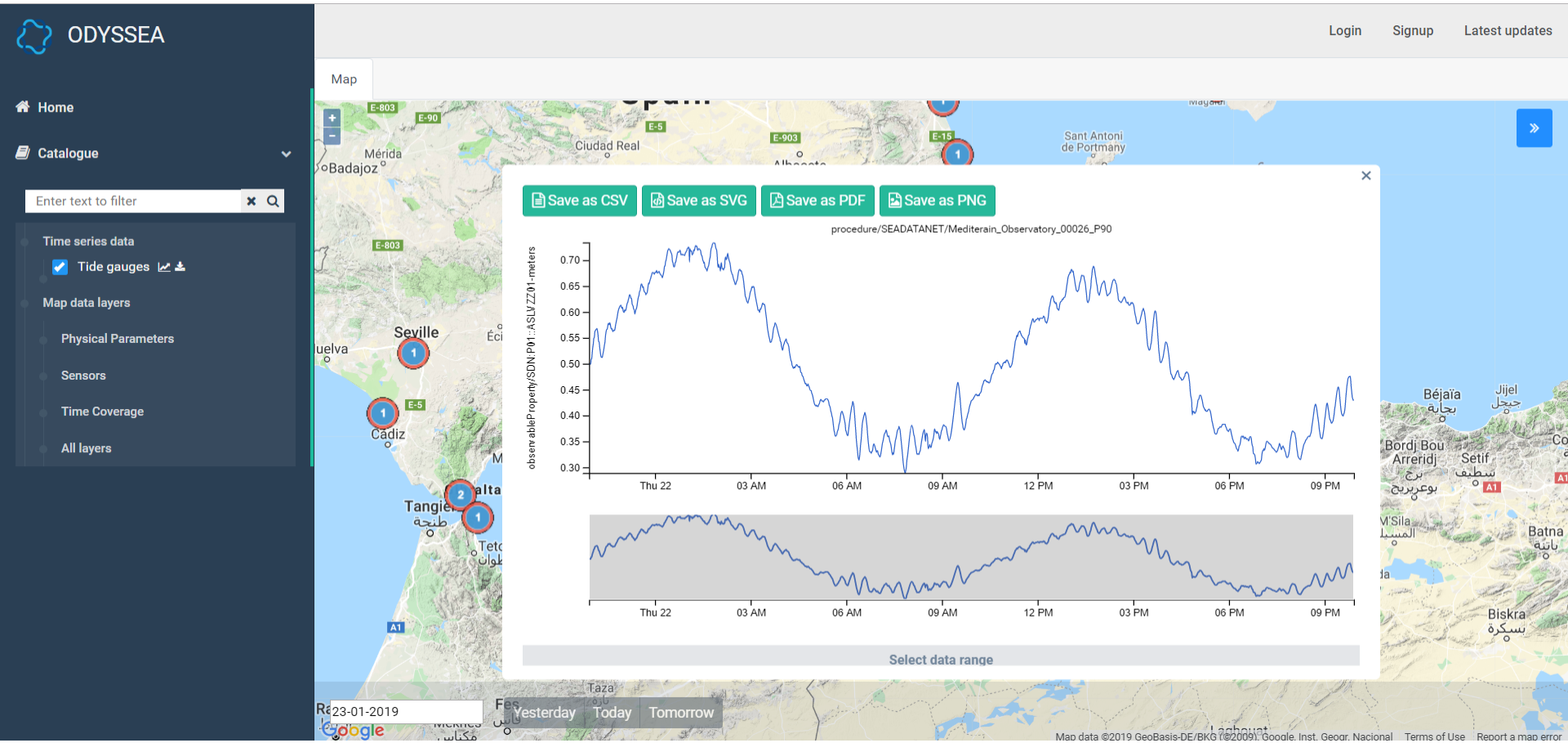
ODYSSEA

Sea Surface Temperature – Mediterranean Sea



ODYSSEA Platform

Tidal Sea Level Variability – Mediterranean Sea



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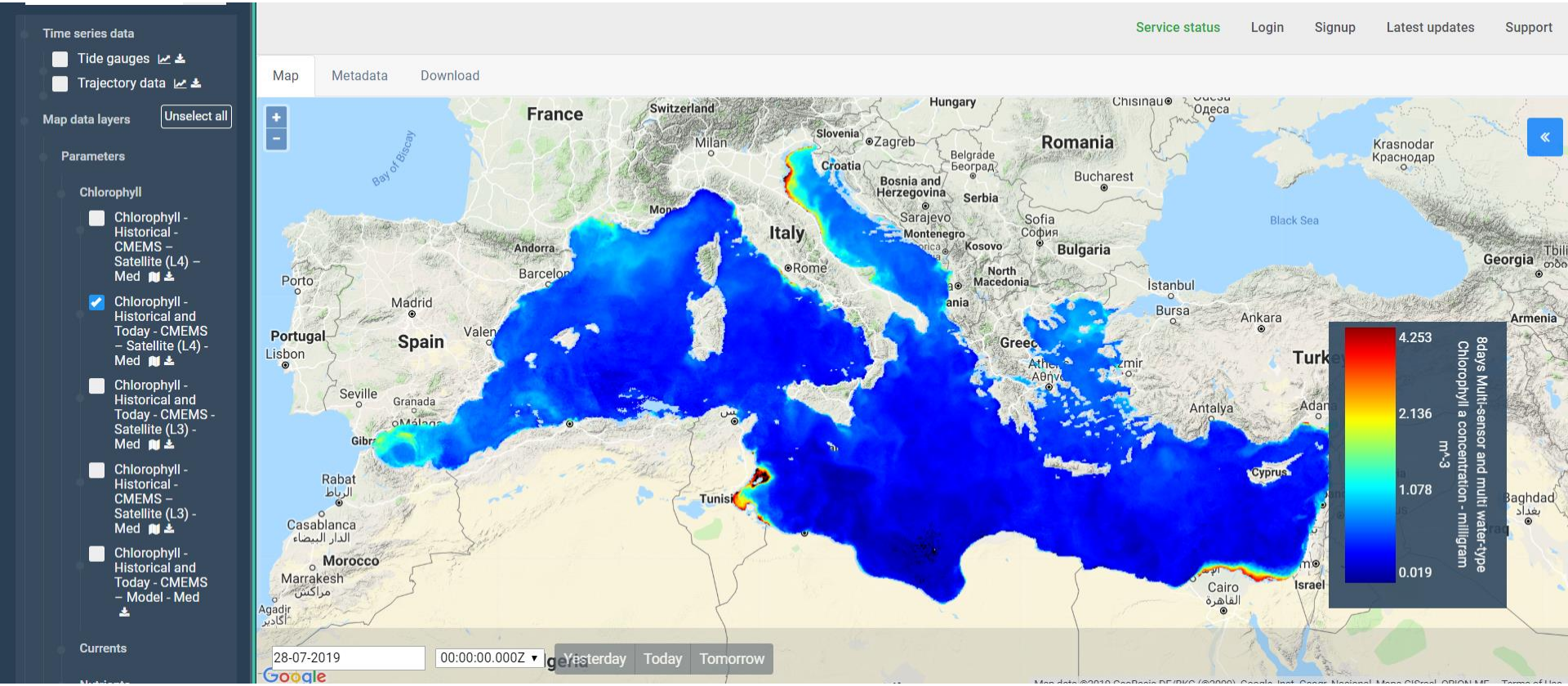
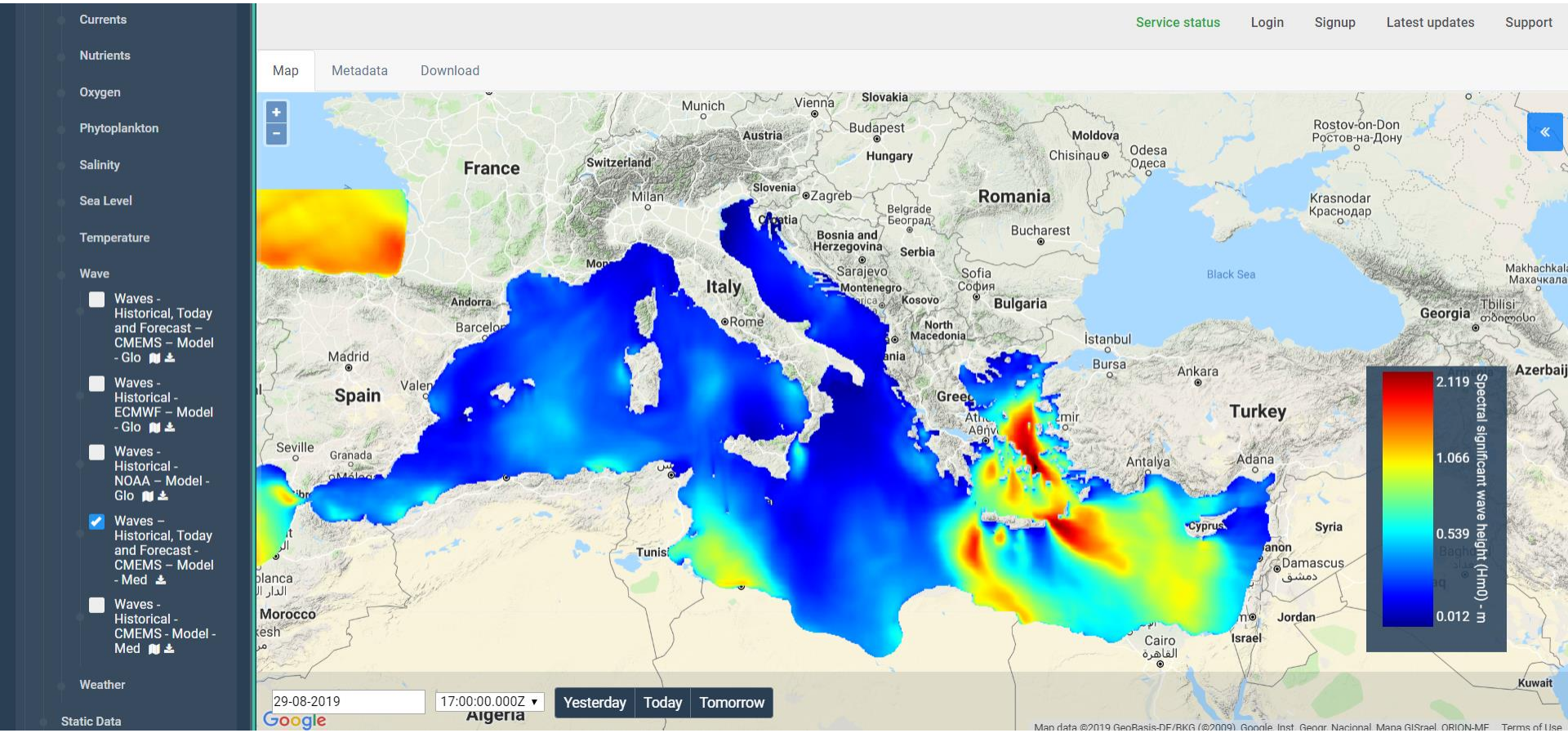
ODYSSEA Platform

Sea Surface Chlorophyll-a – Mediterranean Sea, Satellite



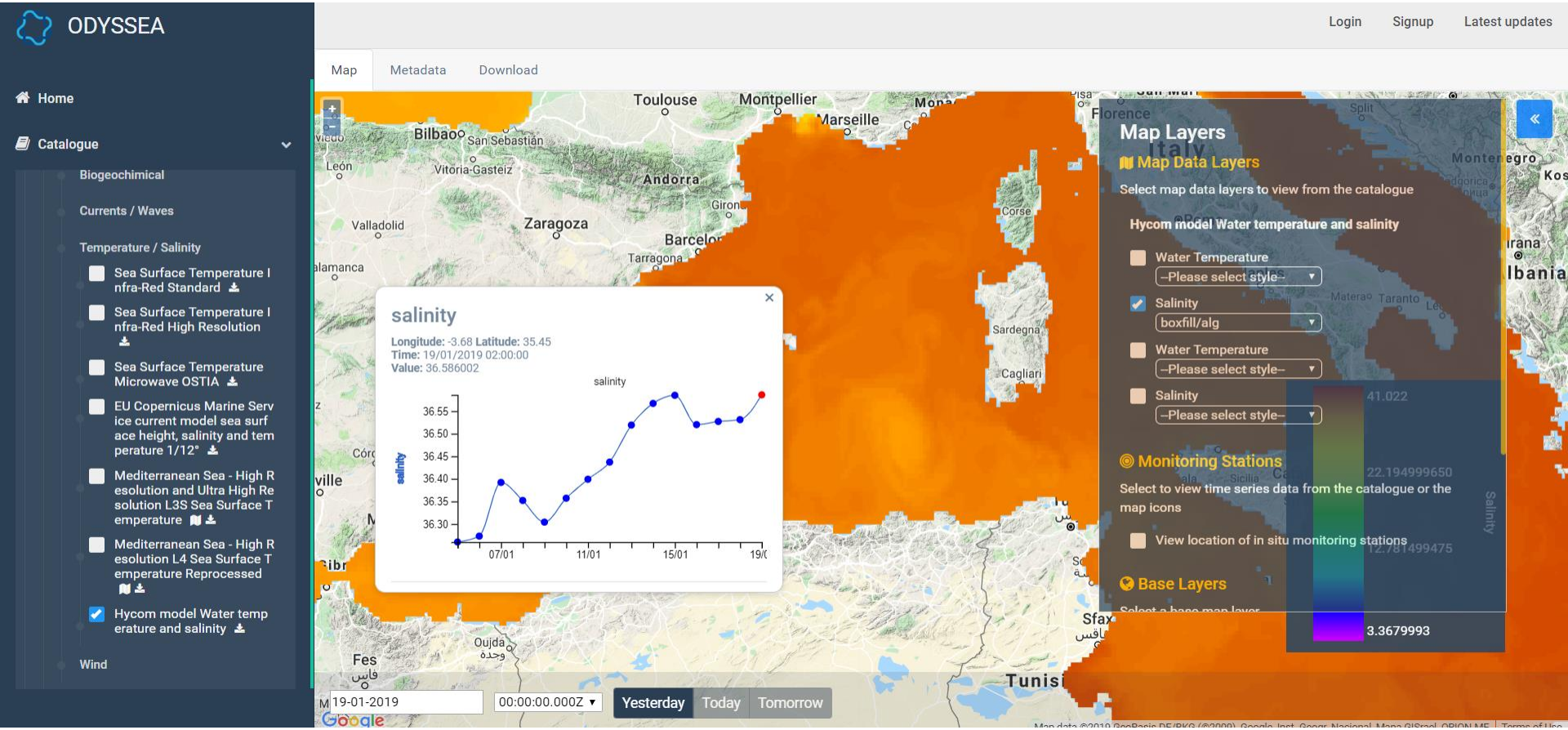
ODYSSEA Platform

Significant Wave Height – Mediterranean Sea, Model



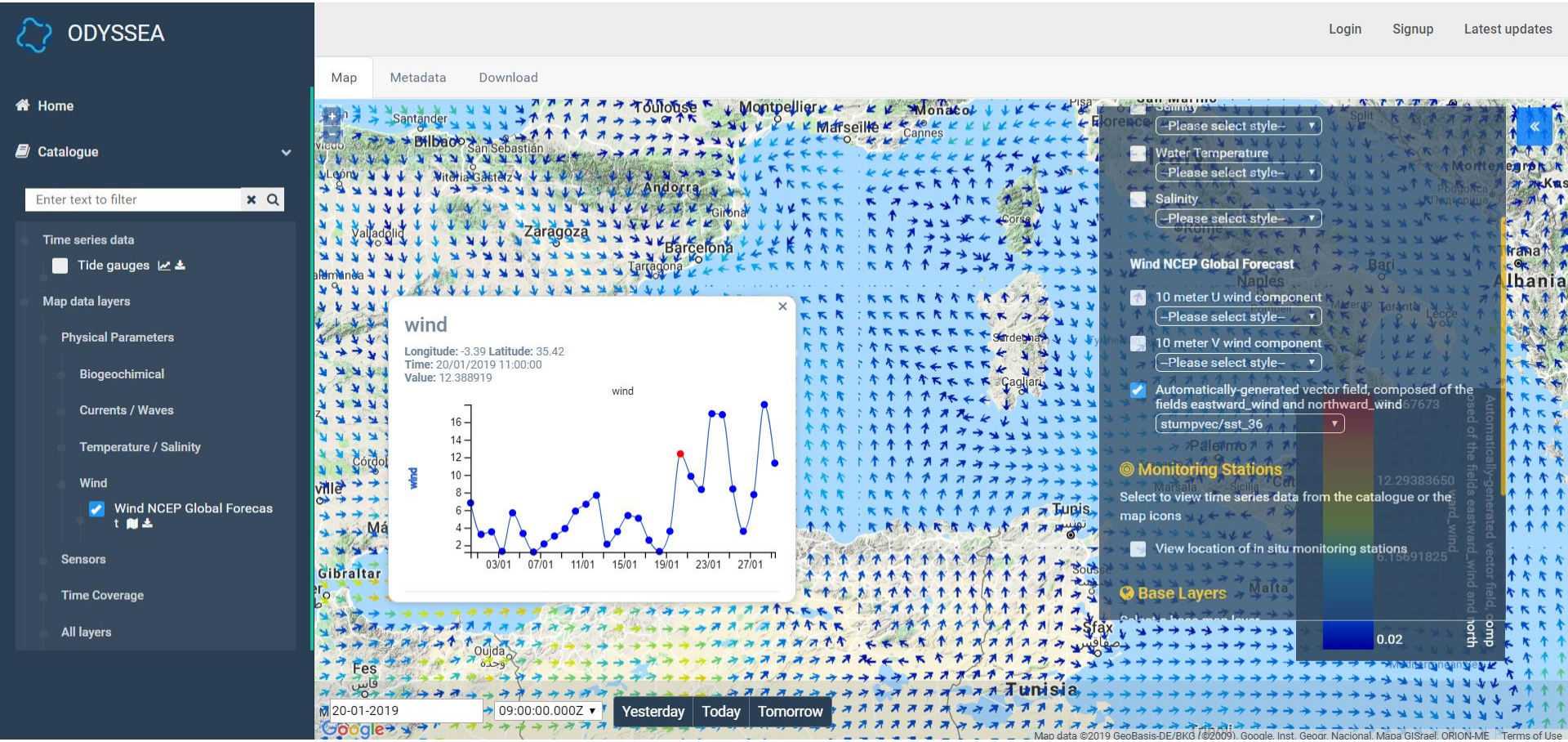
ODYSSEA Platform

Sea Surface Salinity – Mediterranean Sea



ODYSSEA Platform

Winds, Speed and Direction – Mediterranean Sea



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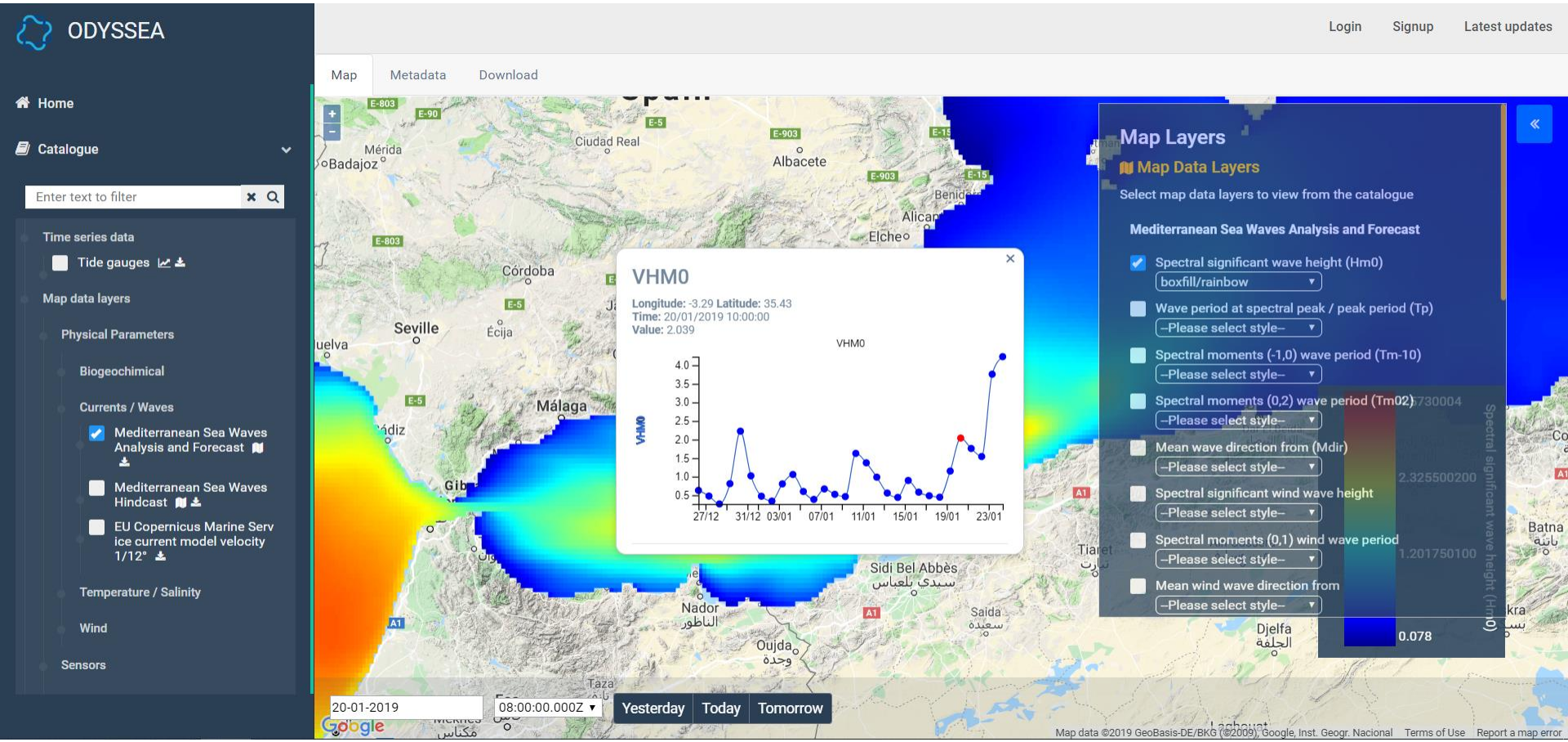
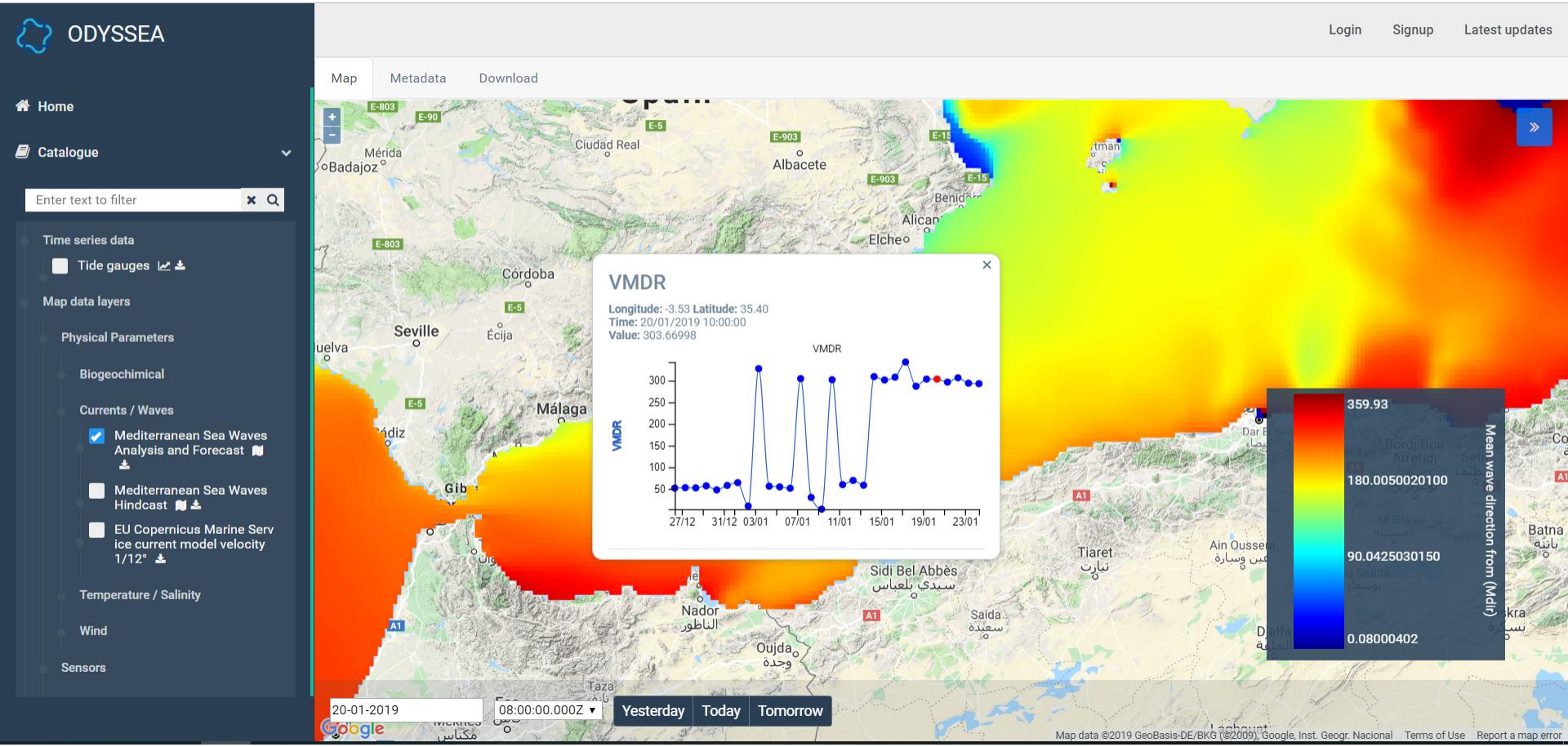
Waves, Significant Wave Height – Mediterranean Sea



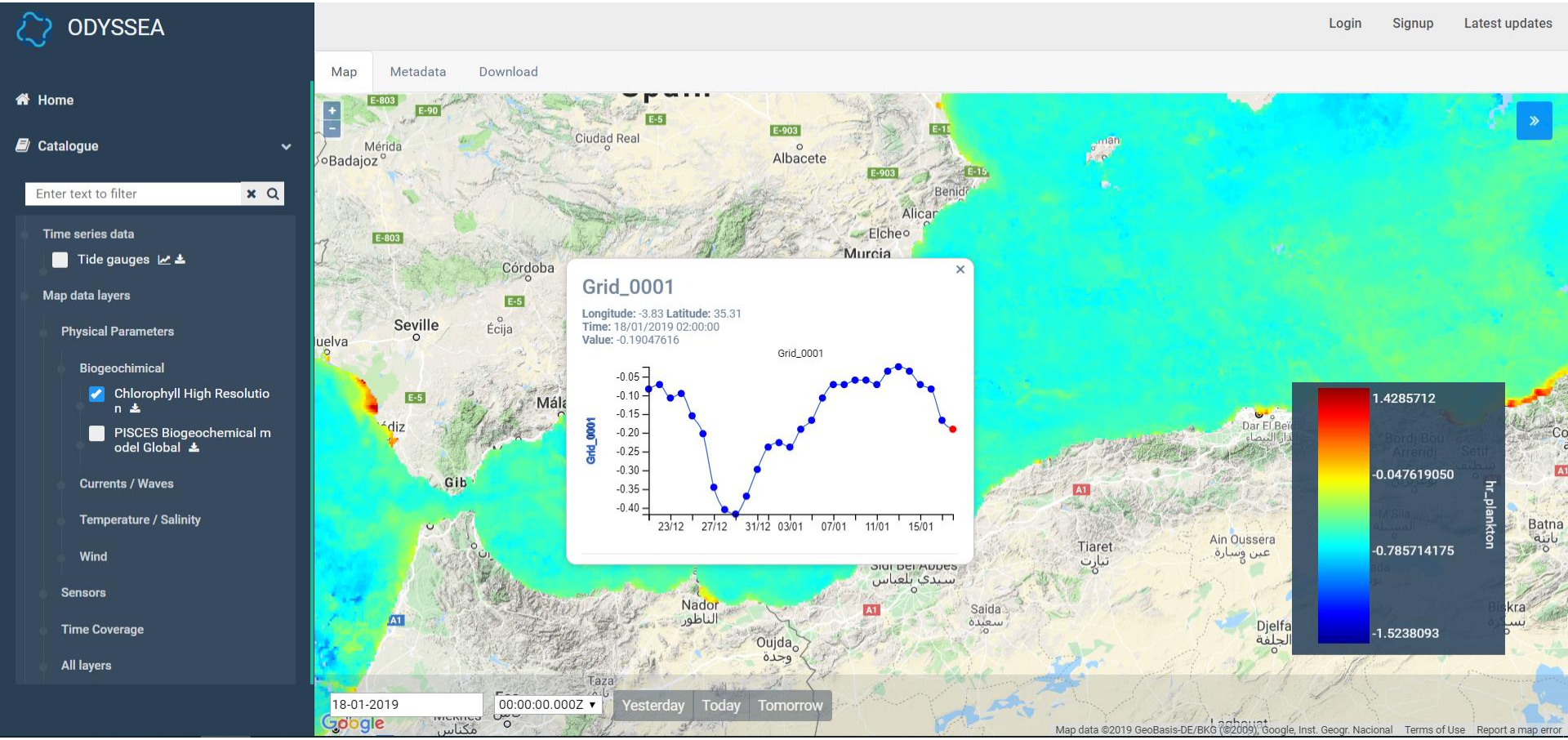
ODYSSEA Platform

Waves, Mean Wave Direction – Mediterranean Sea



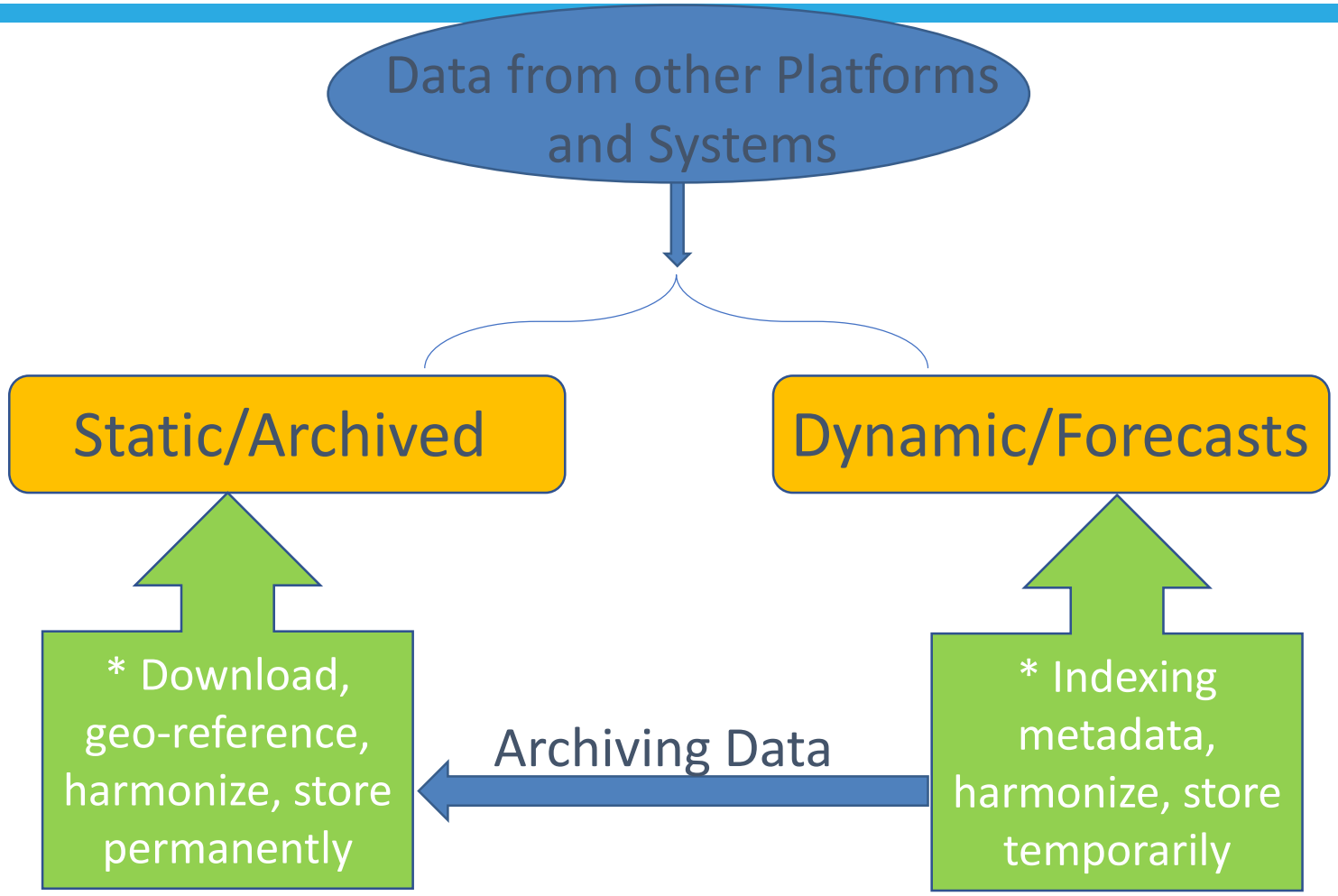
ODYSSEA Platform

Chlorophyll-a, Concentration (mg/m^3) – Mediterranean Sea

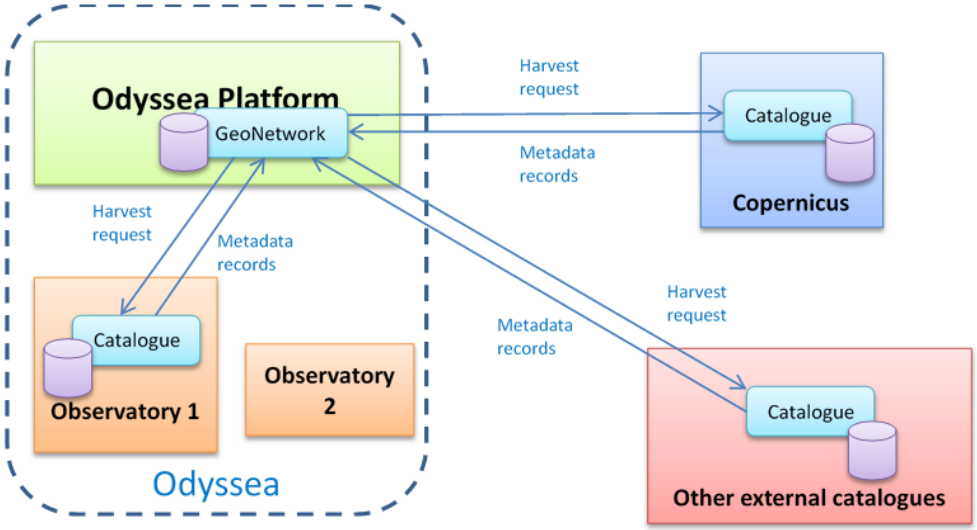


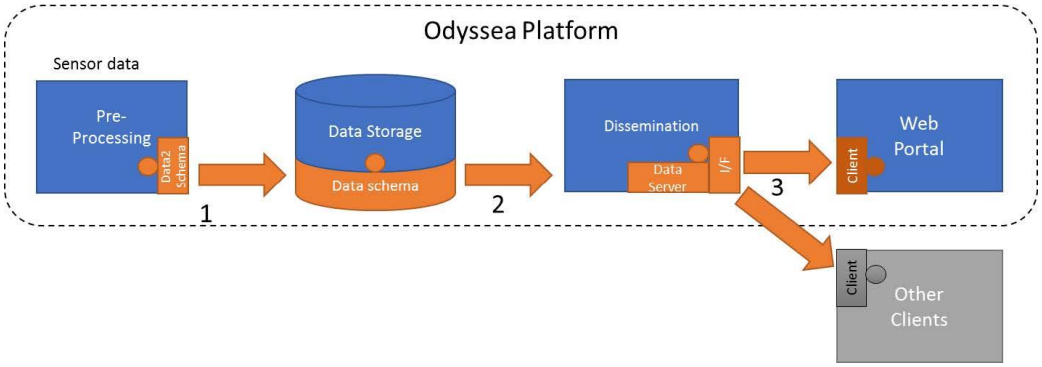
Meteorology, Climate & Climate Change, Topography, Bathymetry, Hydrology, Geology, Physics, Biology, Chemistry

ODYSSEA

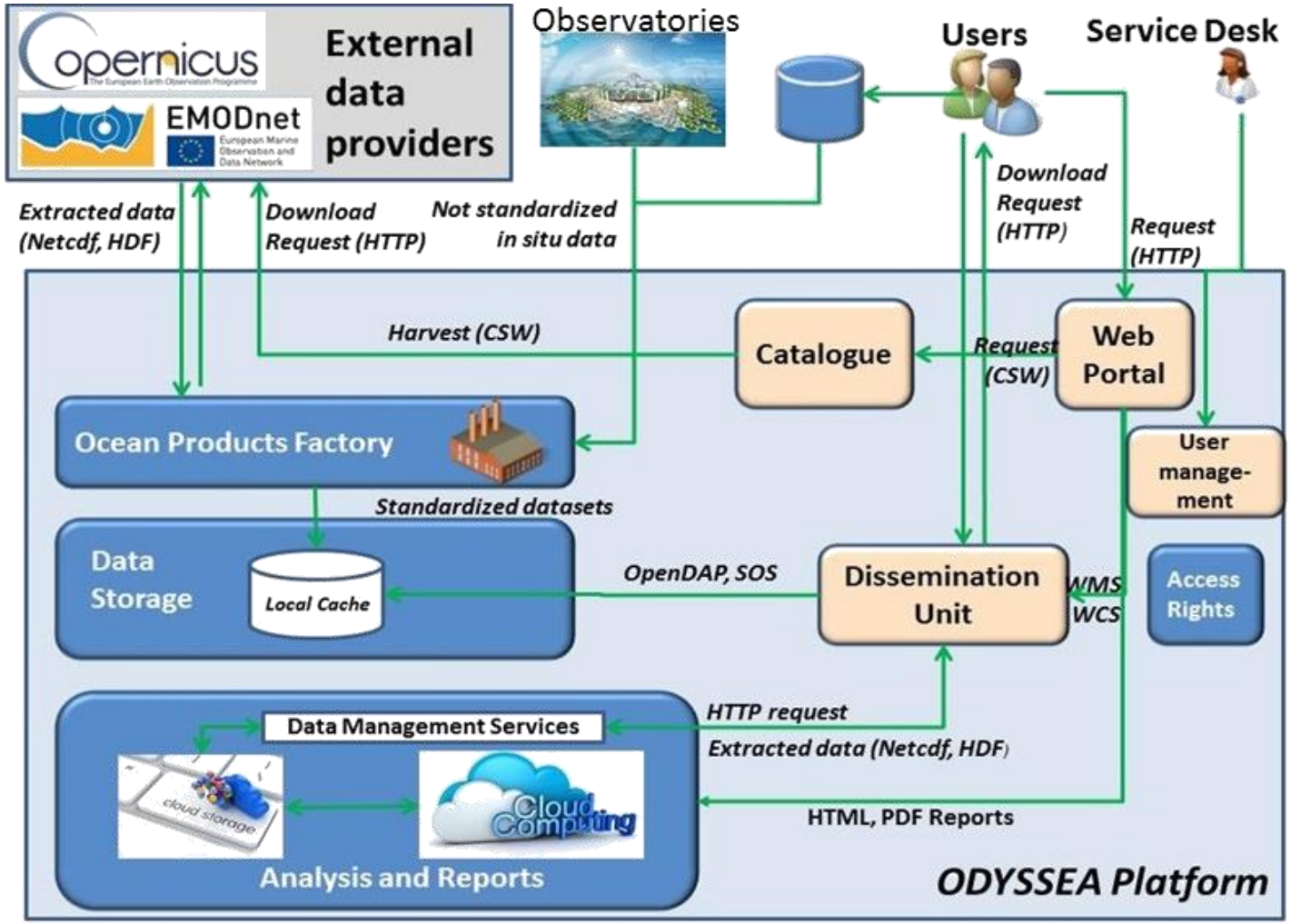


ODYSSEA Platform Components



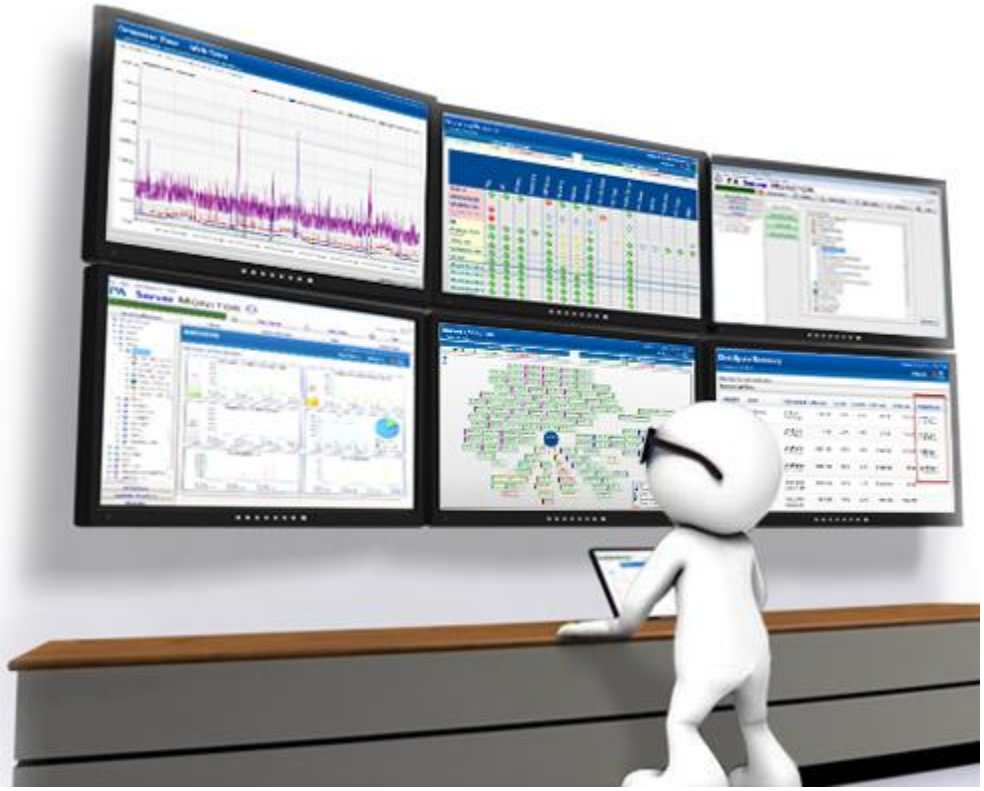


ODYSSEA Platform Structure



ODYSSEA Data Center

The Sensors



Novel ODYSSEA Systems

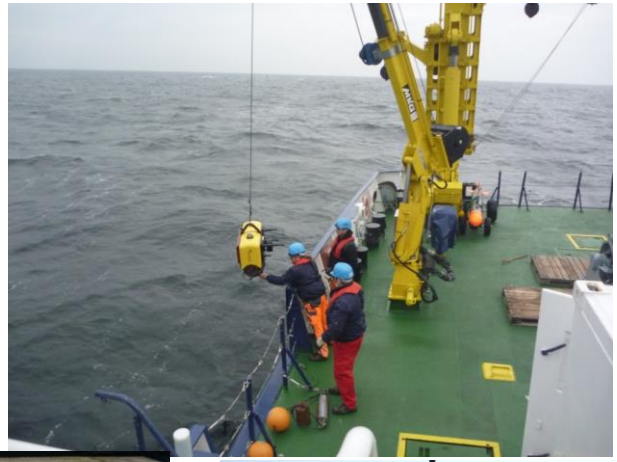
Expand existing operational monitoring systems capacity

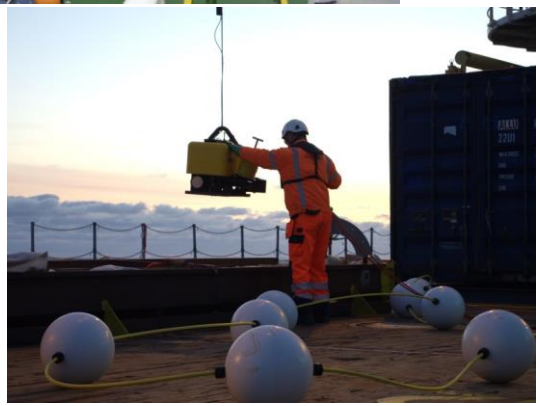
ODYSSEA will develop a prototype monitoring module:

- Two data collection systems: static and mobile
- Deployed at each ODYSSEA Observatory
- Continuous real-time monitoring at each site
- Surface platforms include typical sensors as: temperature, salinity, DO, turbidity, fluorimeter.
- Bottom platforms additionally will include ADCP and novel sensors for emerging pollutants, such as micro-plastics, submarine cameras and hydrophones.
- To reduce costs and to ensure active participation of end-users on ODYSSEA platform, existing facilities (onshore and offshore) will be used to deploy static sensors.

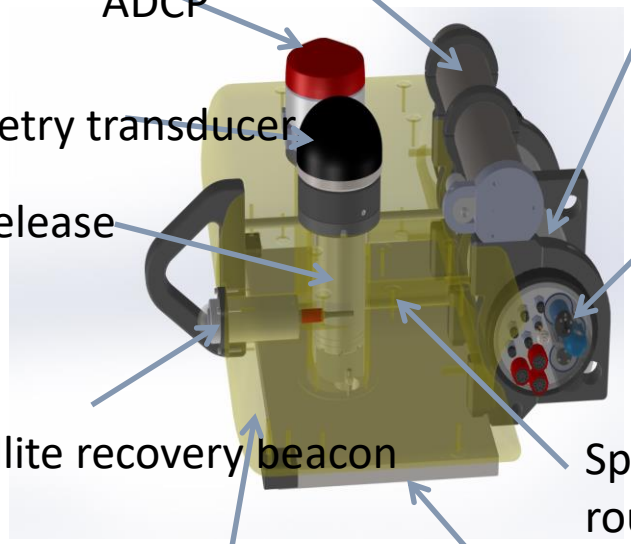
ODYSSEA Monitoring Systems

Static ODYSSEA System



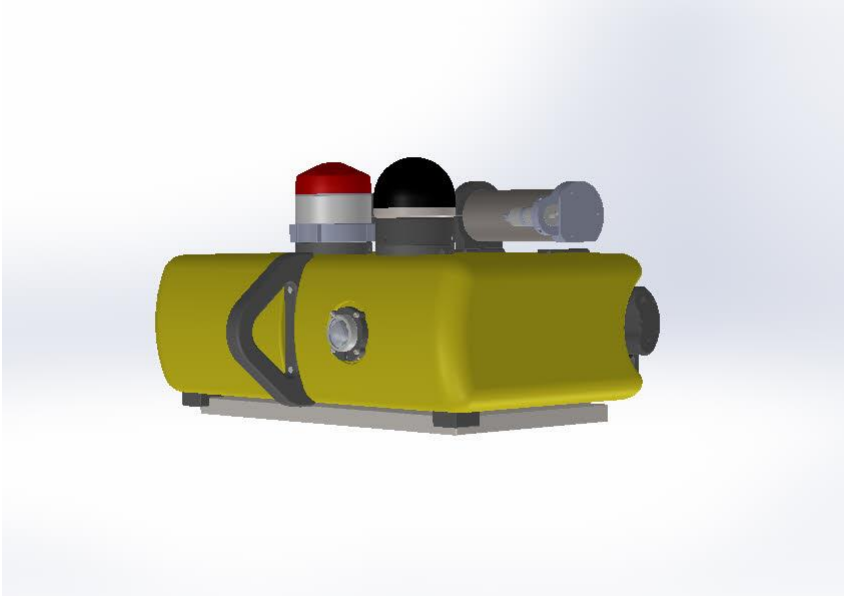


Static ODYSSEA System



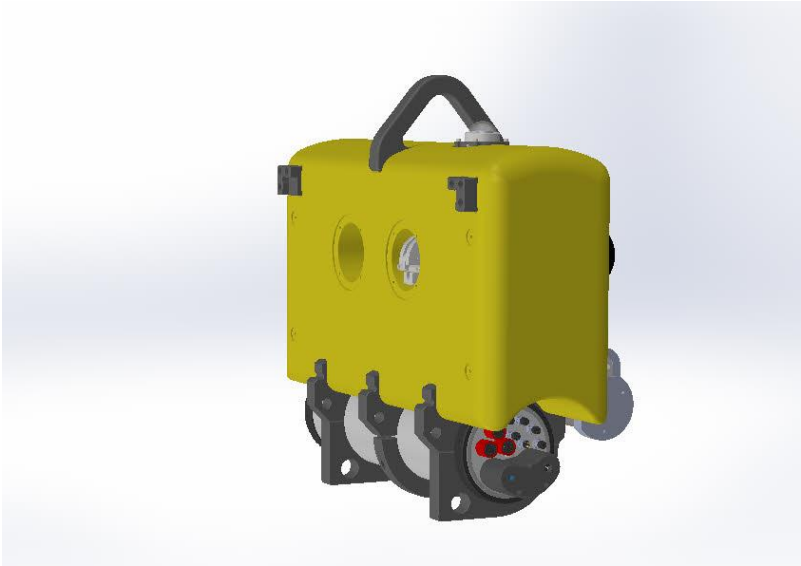
– Sensors
  - Temperature
  - Salinity, pH
  - Pressure
  - Dissolved Oxygen
  - Hydrophone to record marine mammals
  - Submarine camera to record fish
  - Currents
  - Microplastics sensor

MSL Descend / Ascend



Horizontal descend with ballast locked

- Ballast plate sits on sediment
- Drop velocity approx. 1.5m/s



Vertical after release of ballast plate

- Low drag, quick ascend
- Ascend velocity up to 1.2m/s

MSL Communication

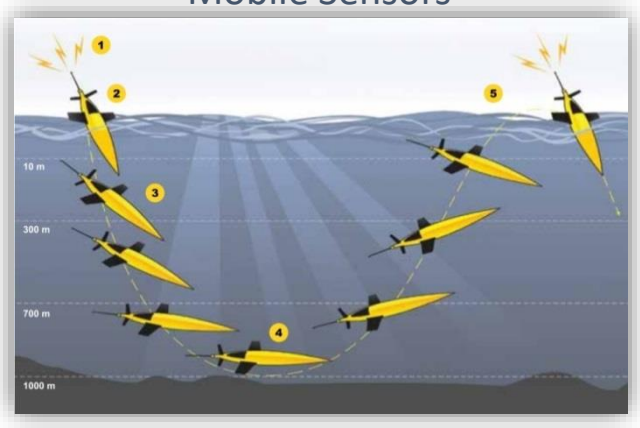
Lander communication

- Hydro acoustic modem or HAM.BASE for wireless communication with lander
- Bi-directional
- For downloading measured data and device status
- Can be used for re-configuring the lander
  - For more or less measurements
  - For power saving
  - Changing the CSV output format
- Manually operated from boat or ship
  - Laptop and training required
  - Data output in CSV format

Mobile ODYSSEA System

A series of gliders will be used to monitor physical, chemical, biological and acoustical parameters at selected Observatories
SEA EXPLORER will move at a speed of 1 knot, covering the surface, the whole water column and the benthos.

Mobile Sensors



ODYSSEA Monitoring Systems

Three glider payloads will be tailored:

1. GPS, CTD, DO, Chl-*a*, SPM, CDOM , Turbidity
2. ADCP, acoustic
3. CTD, micro plastic

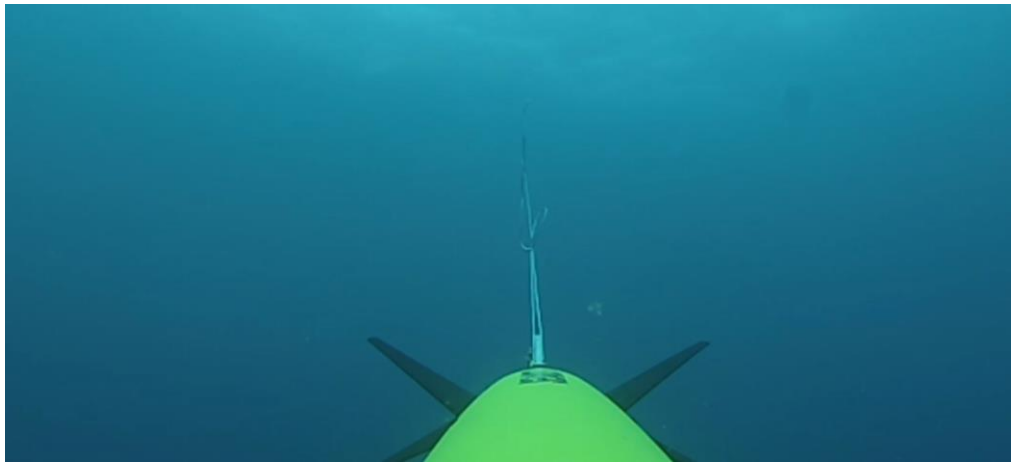
Mobile Monitoring Systems

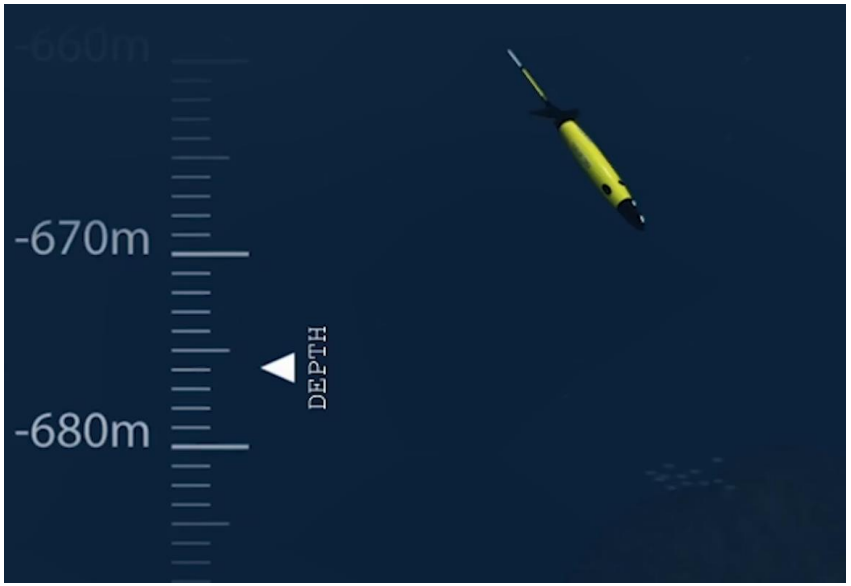
ODYSSEA

- 2 SEAEXPLORER GLIDERS

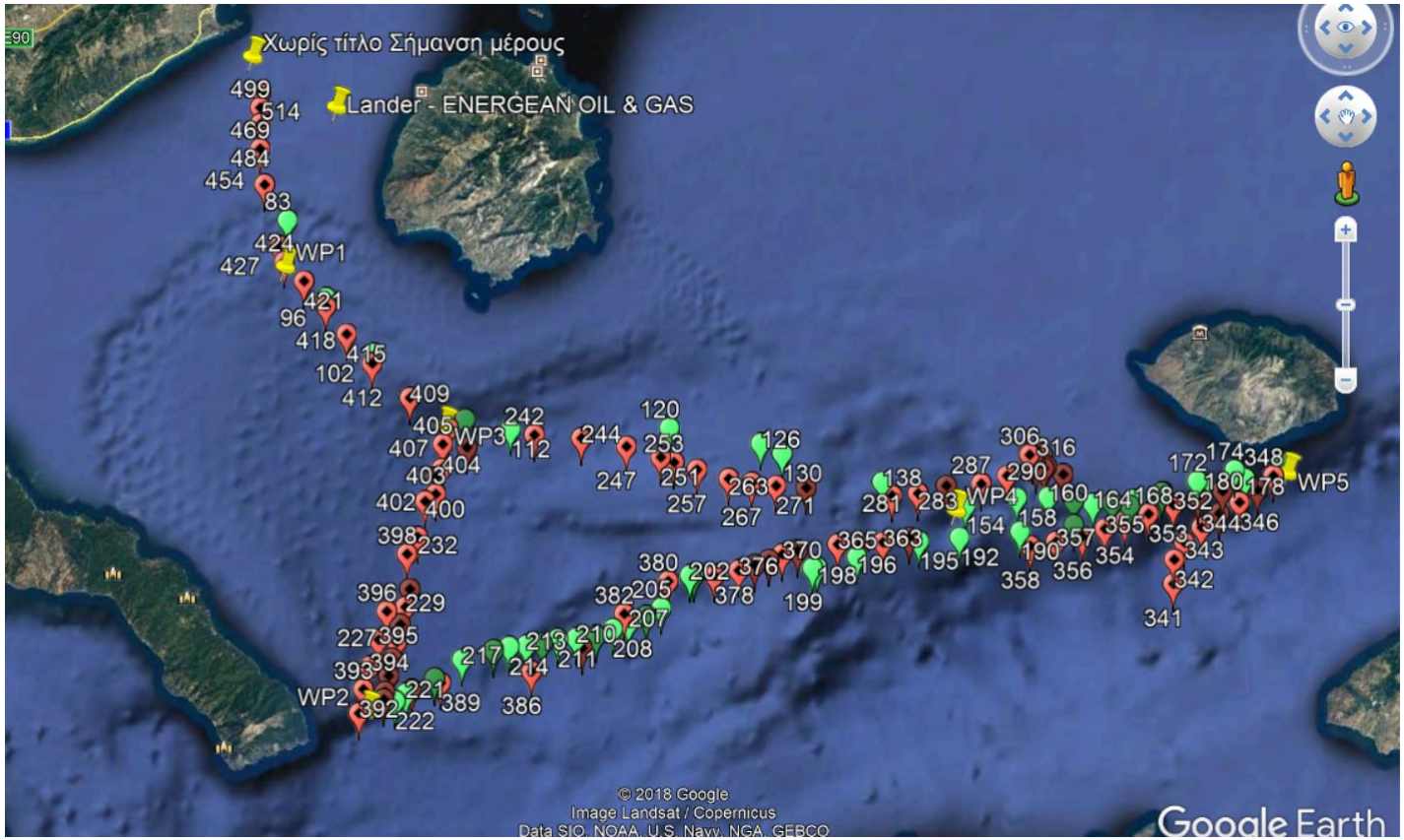
- 3 sensor payloads:
  - ❖ Payload 1
    - ✓ Temperature, salinity, pH, dissolved oxygen, chlorophyll-a, turbidity, CDOM
  - ❖ Payload 2
    - ✓ Passive Acoustic Monitoring (PAM)
  - ❖ Payload 3
    - ✓ Temperature, salinity, microplastics

Mobile Monitoring Systems

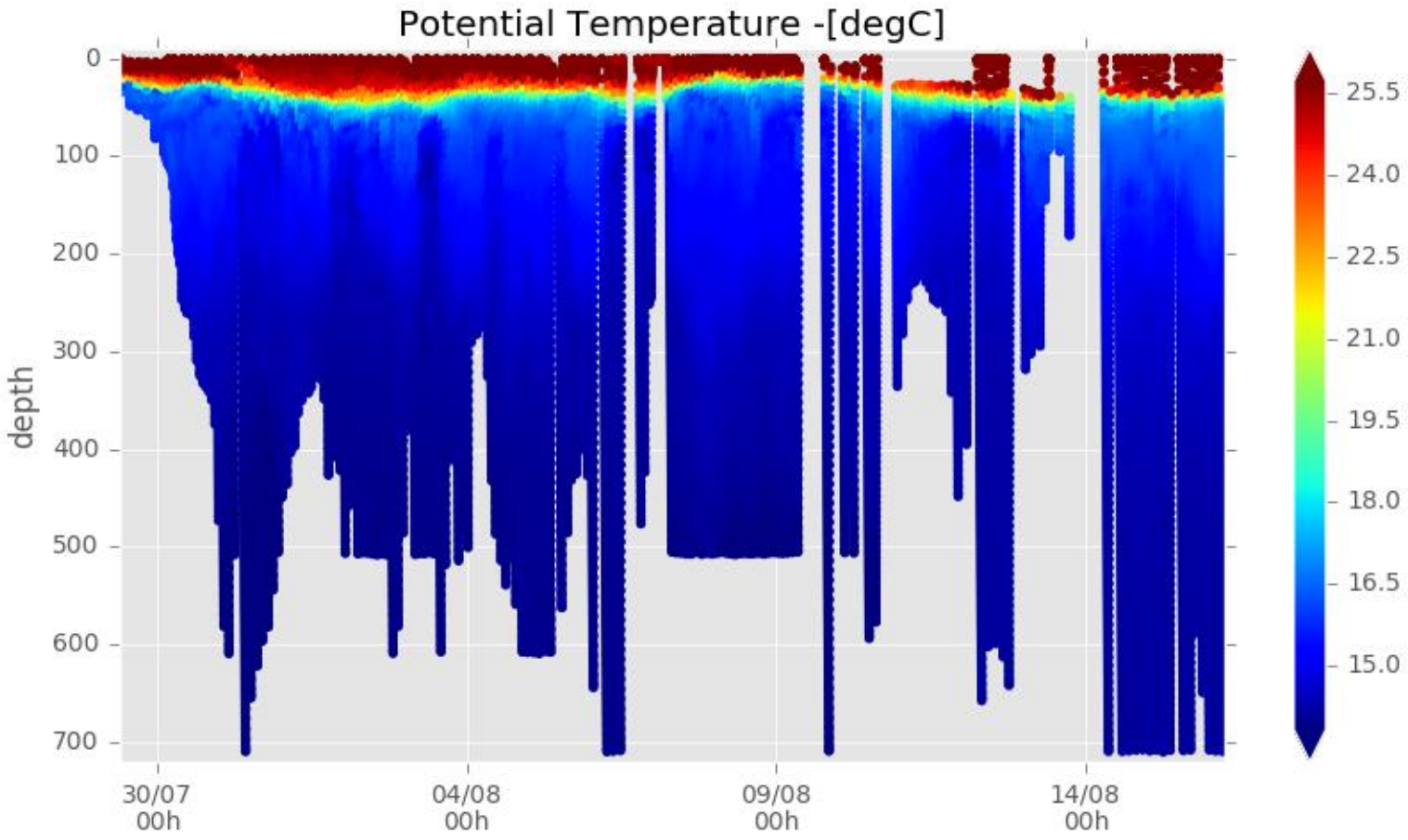




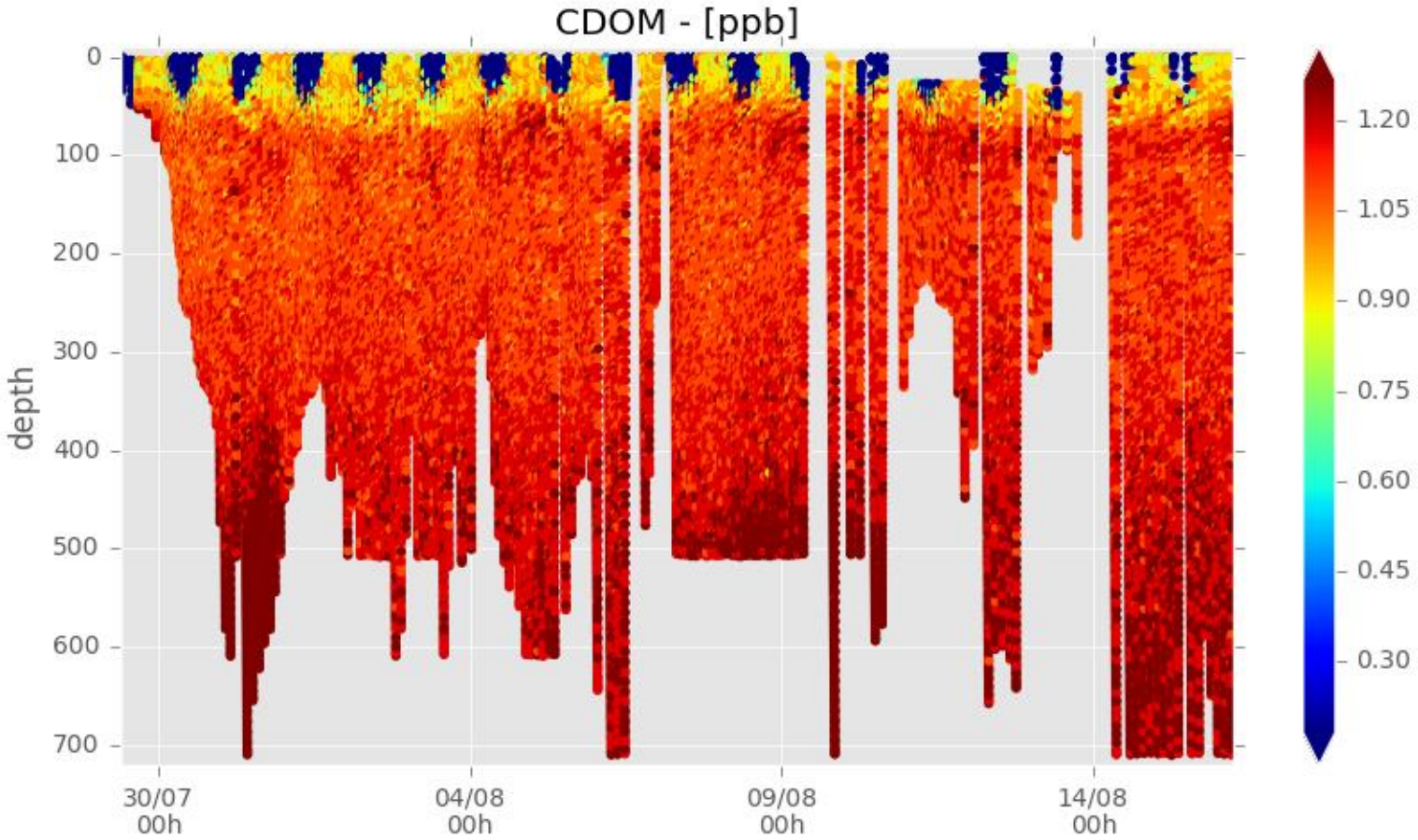
Mobile Monitoring Systems



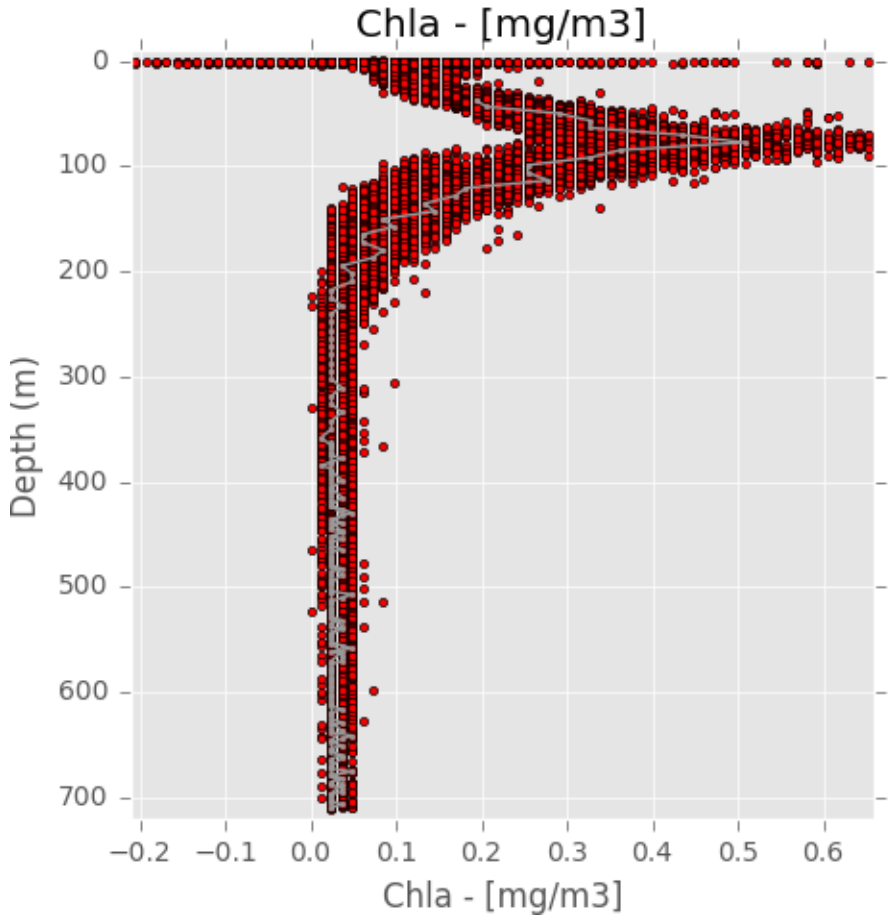
Mobile Monitoring Systems



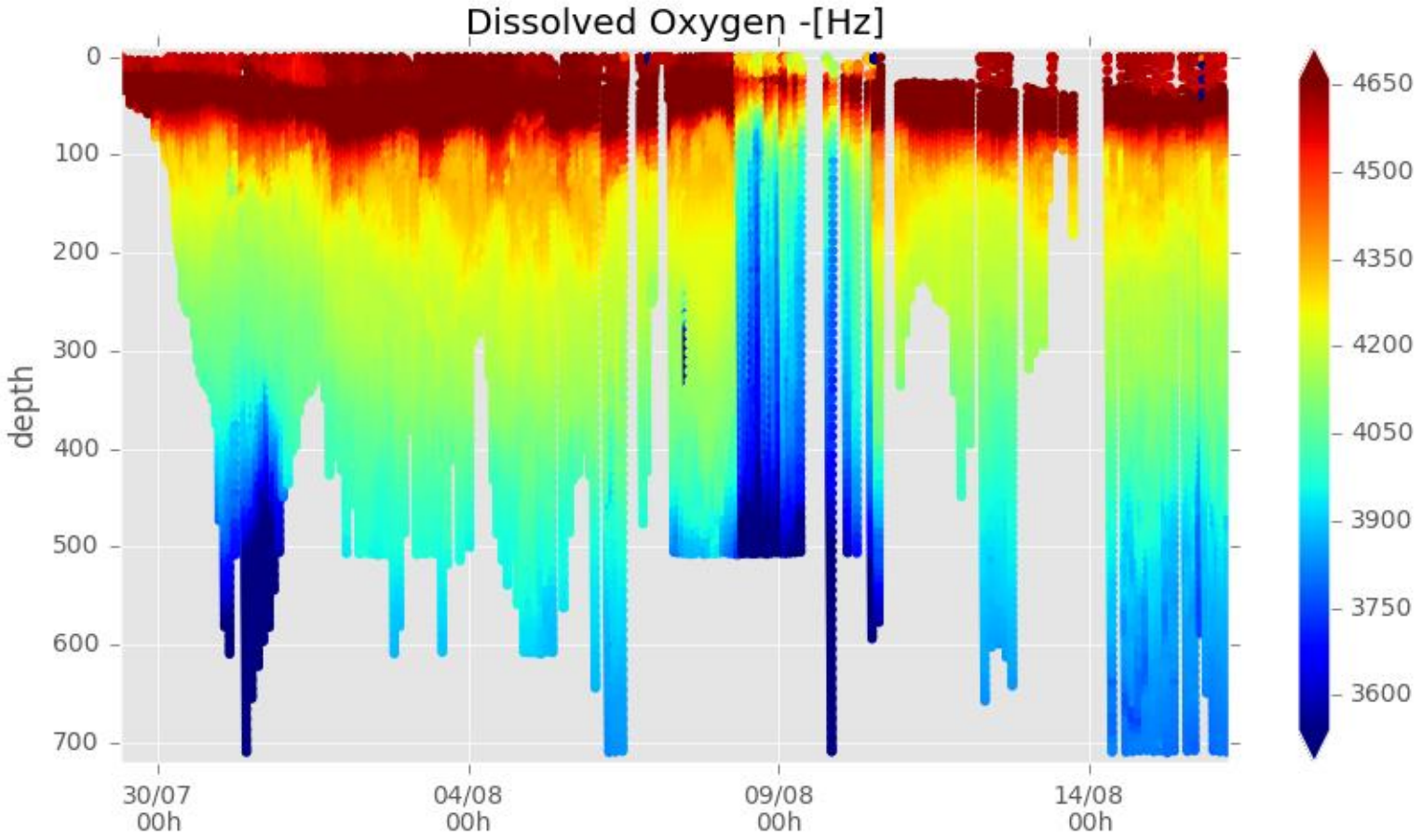
Mobile Monitoring Systems



Mobile Monitoring Systems

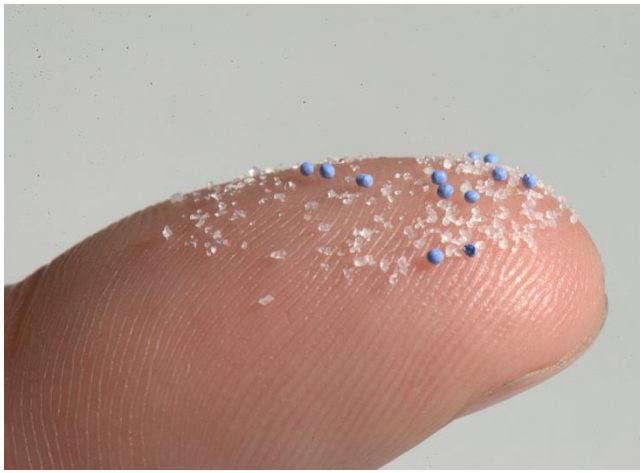


Mobile Monitoring Systems



The Microplastic Sensor – ODYSSEA Global Novelty

ODYSSEA



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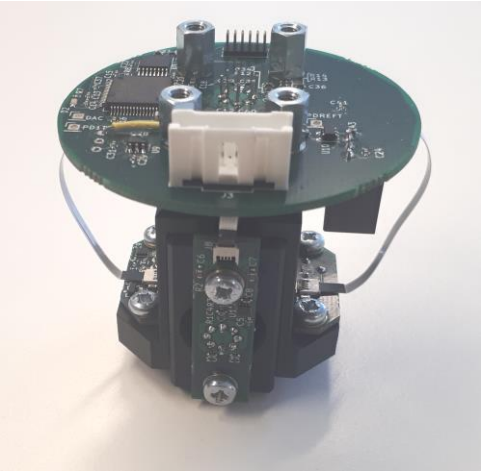
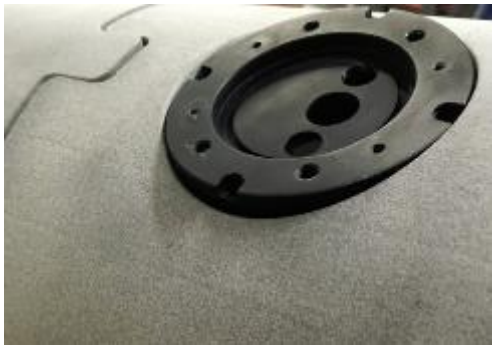
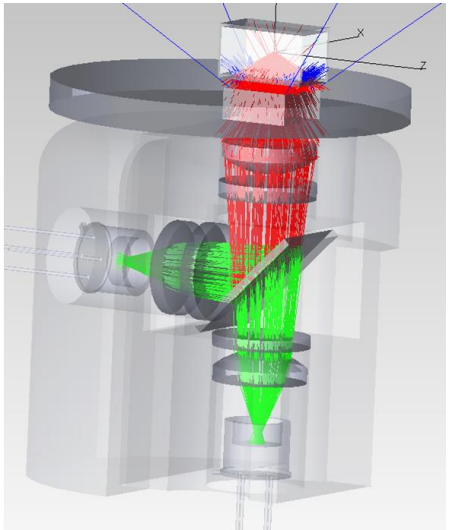
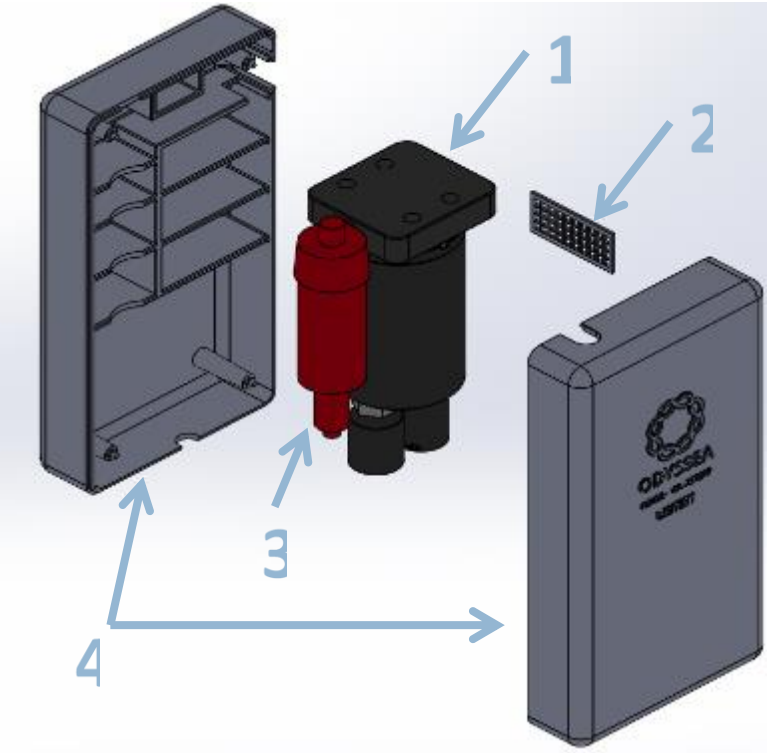
The Microplastic Sensor – ODYSSEA Global Novelty

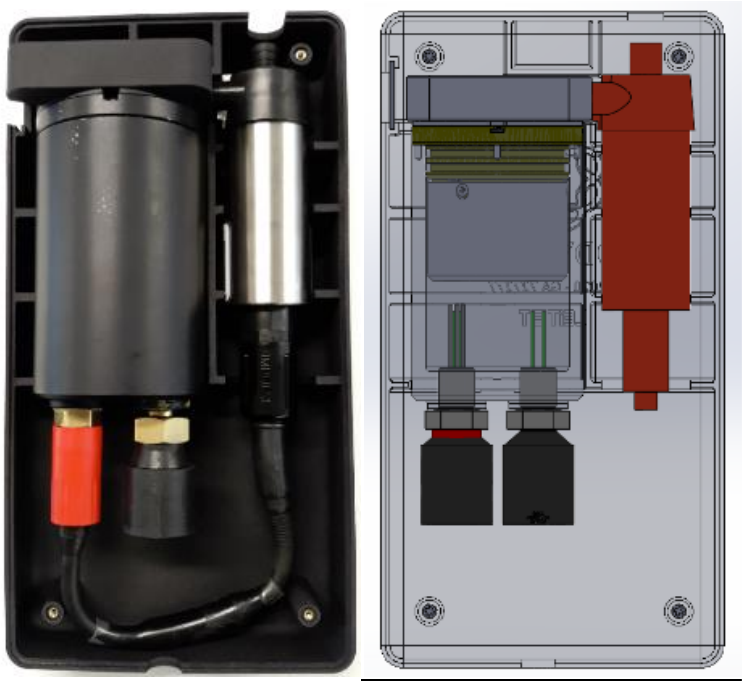






The Microplastic Sensor – ODYSSEA Global Novelty





Lander/Sea Surface MPS assembly. (1) MPS / (2) housing net / (3) water pump / (4) external housing

Sensors Integration

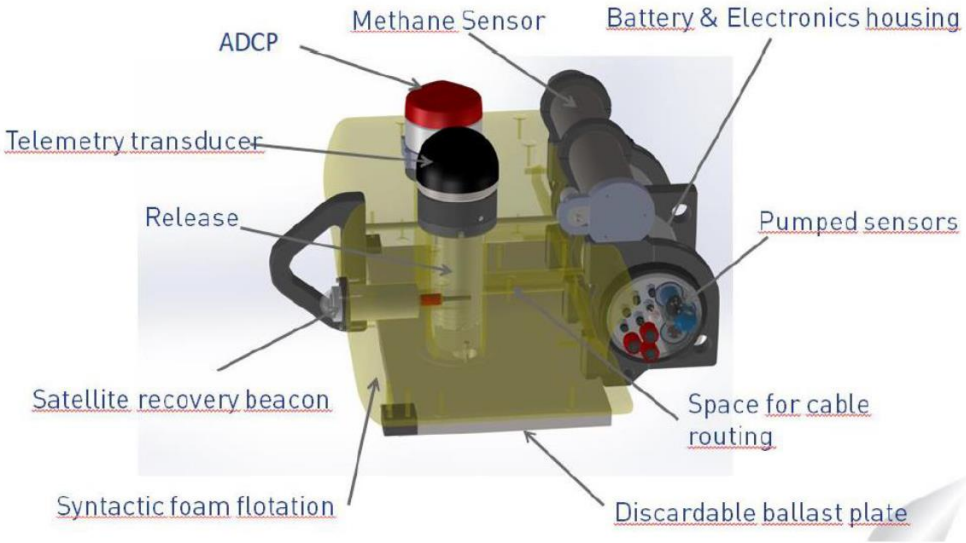
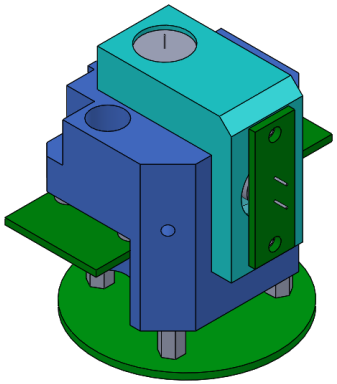
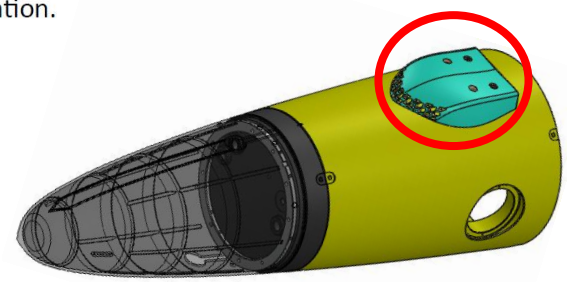
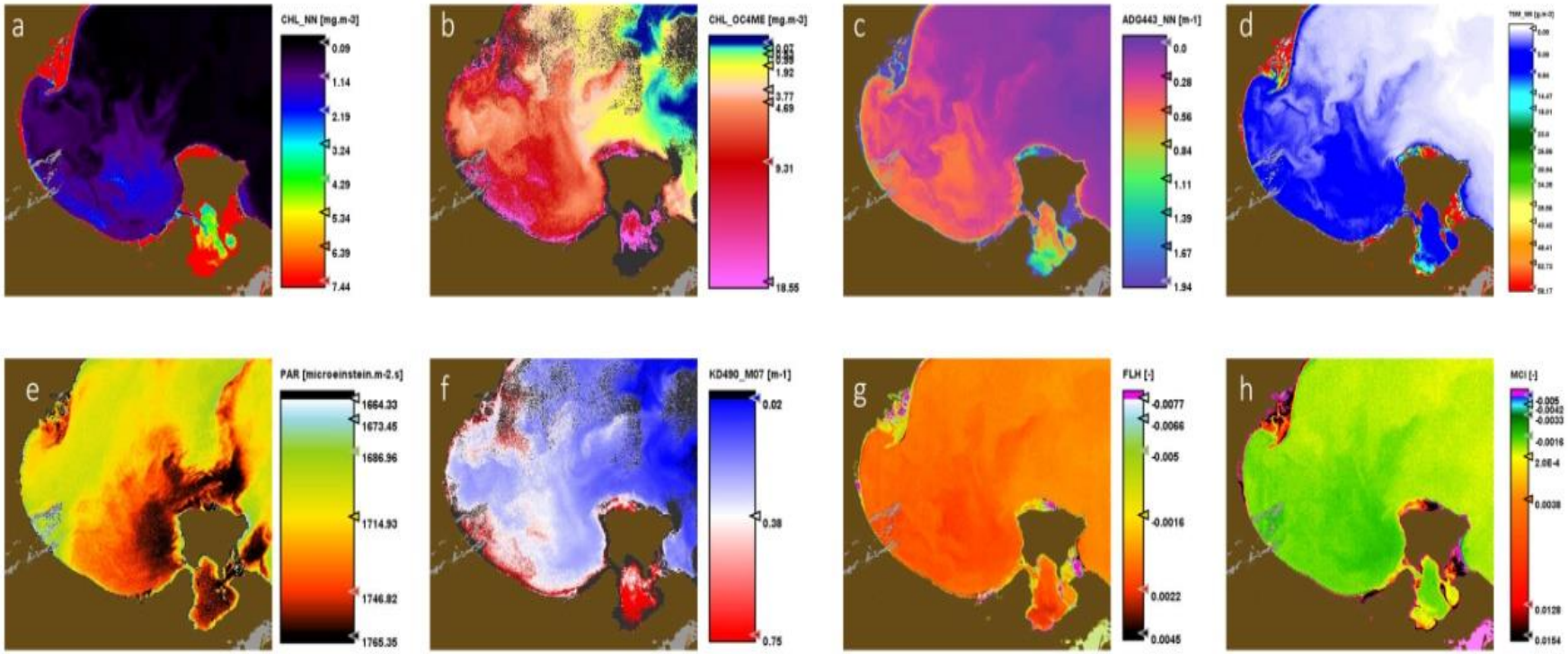


Figure 2. The Modular Seafloor Lander (MSL) and its components and configuration.



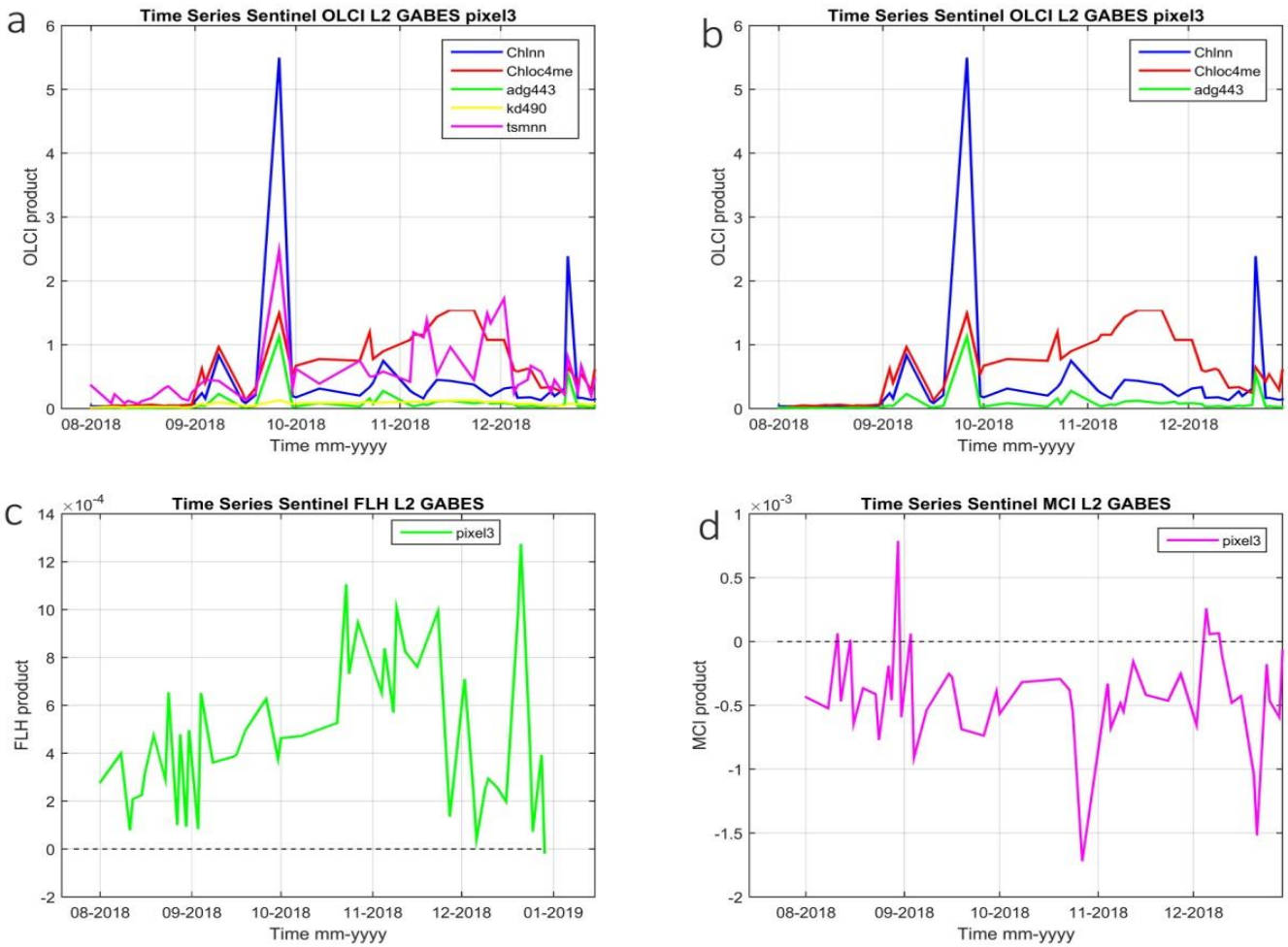


Remote Sensing

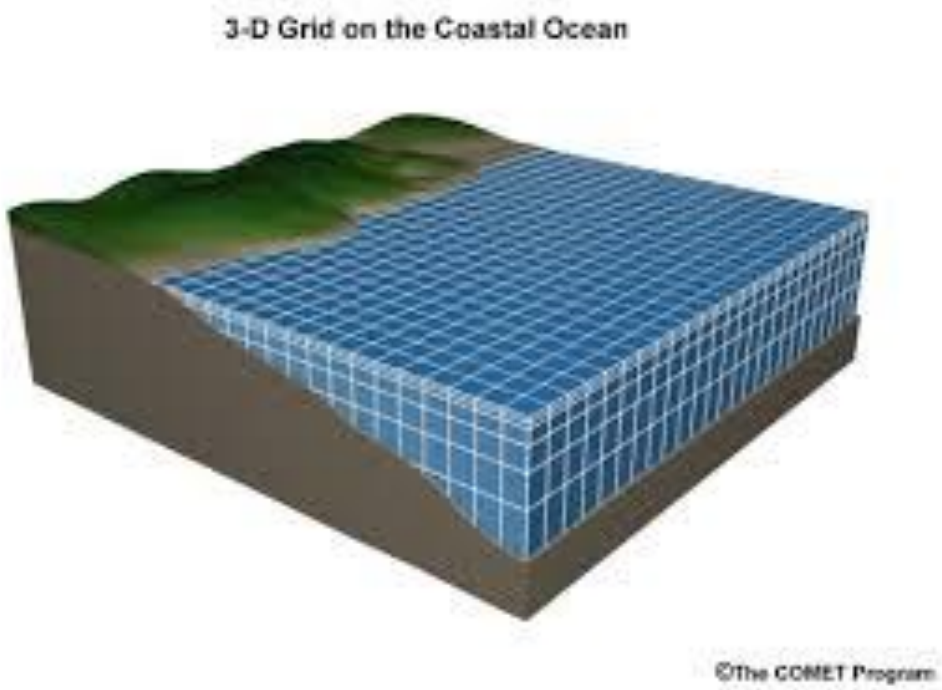


Sentinel-3 Level2 spatial distributions of a) chlorophyll-a conc (mg m^{-3}) Oc4me algorithm, b) chlorophyll-a conc (mg m^{-3}) chlnn neural network algorithm, c) absorption of CDOM at 443 nm (m^{-1}), d) TSM concentration (gm^{-3}), e) PAR in the spectral range 400-700 nm (µEinstein m^{-2} s^{-1}), f) diffuse attenuation coefficient at 490 nm (m^{-1}), g) fluorescence line height and h) max chlorophyll index at Gulf of Gabes.

Remote Sensing



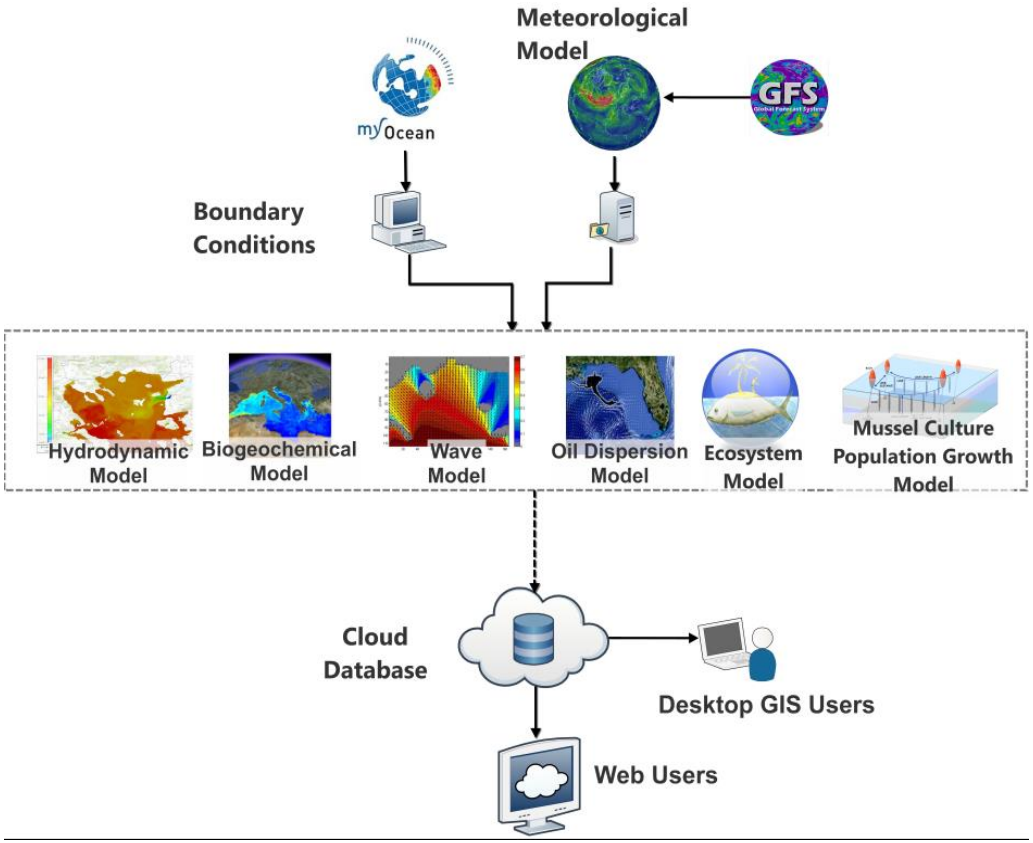
The Models



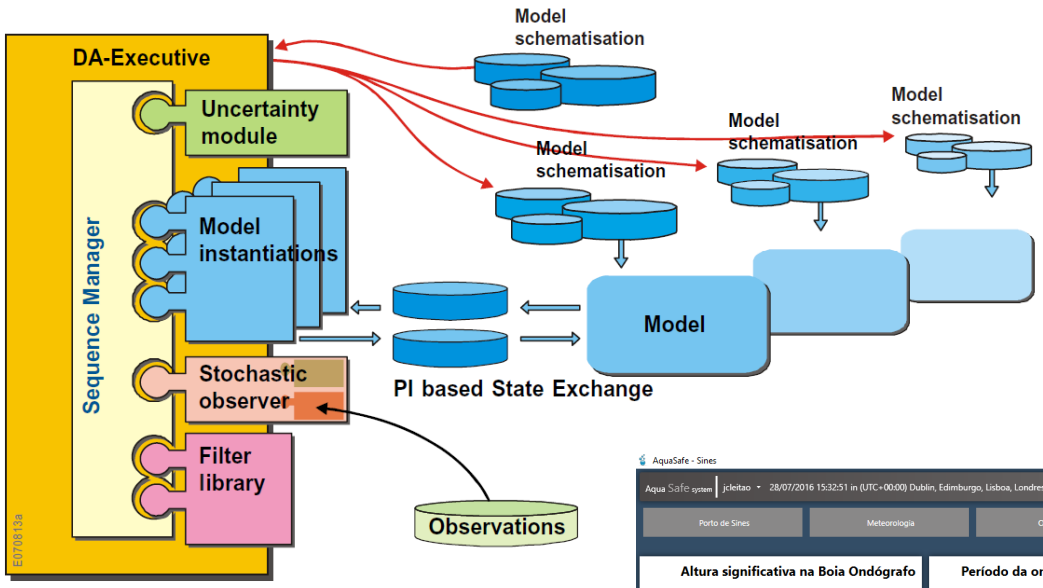
The Models

- ✓ A prototype ‘chain’ of operational models will be developed,
- ✓ Link models to existing databases,
- ✓ Provide short- and long-term prognostic results,
- ✓ Manage risks and emergencies in coastal and offshore areas,
- ✓ Meet the requirements of various end-user groups,
- ✓ Report on parameters never previously reported,

Models: Meteorological (WRF), 3Dhydrodynamic (Delft3D), Wave (SWAN), Oil spill (MEDSLICK-II), Water quality (DELWAQ), Ecosystem models (Ecopath with Ecosim), Fish and Mussel/oyster culture population growth

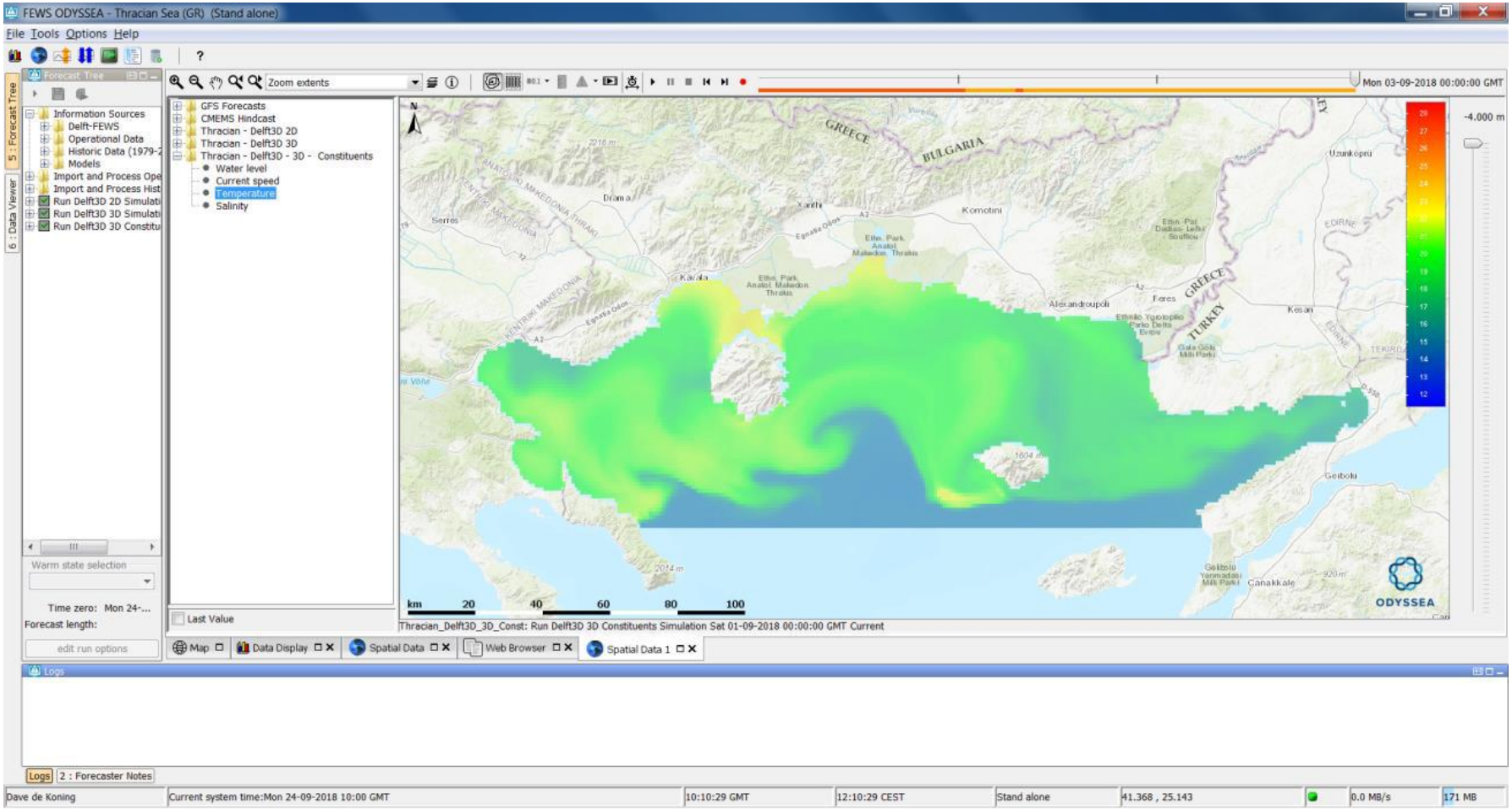


The Models


DA-Executive
Sequence Manager
Uncertainty module
Model instantiations
Stochastic observer
Filter library
E070813a
Model schematisation
Model schematisation
Model schematisation
Model schematisation
Model
PI based State Exchange
Observations

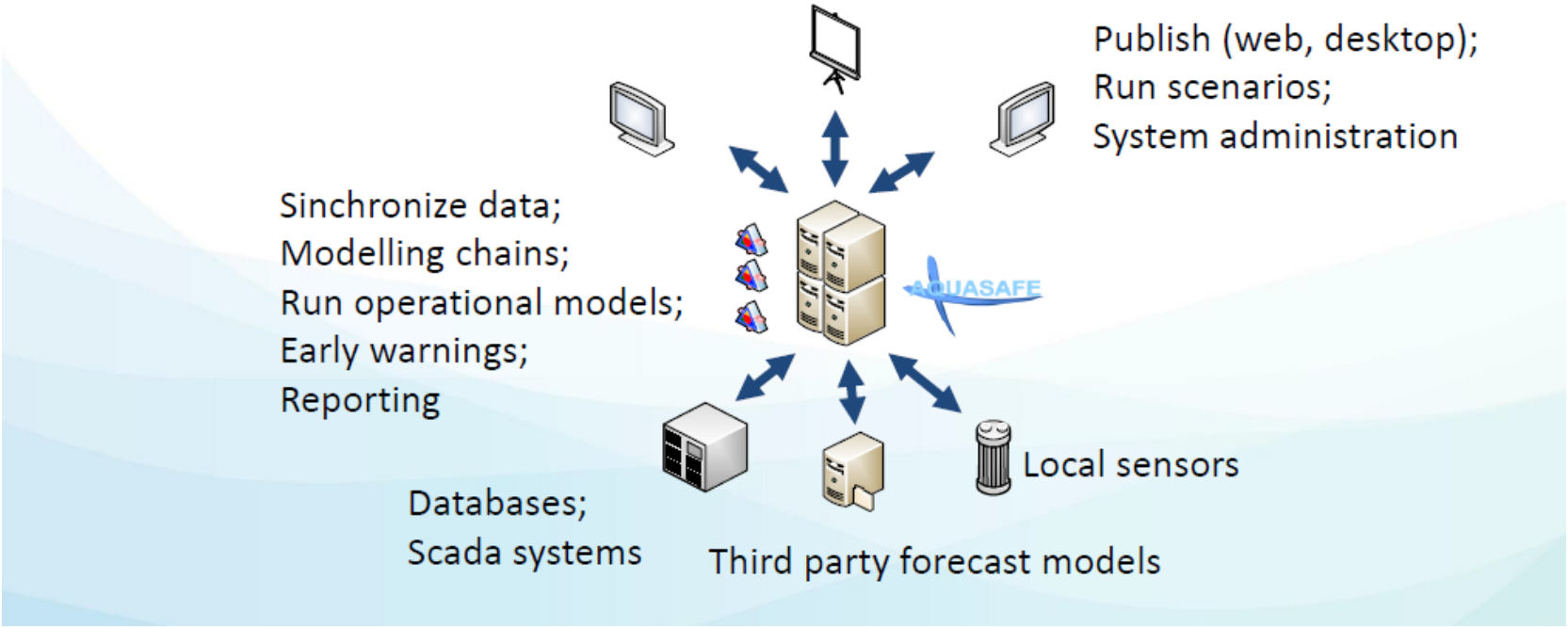
AquaSafe - Sines
Porto de Sines
Meteorologia
Ondulação
Correntes
Maré
Altura significativa na Boia Ondógrafo
Período da ondulação na Boia Ondógrafo
Intensidade do Vento - Entrada da Baía de Sines
Nível de Maré - Marégrafo de Sines
Direção da Ondulação na Boia Ondógrafo
Altura significativa em 3 locais
Direção do vento - Entrada da Baía de Sines
Pressão Atmosférica
Tempo Actual

Delft-FEWS Interface



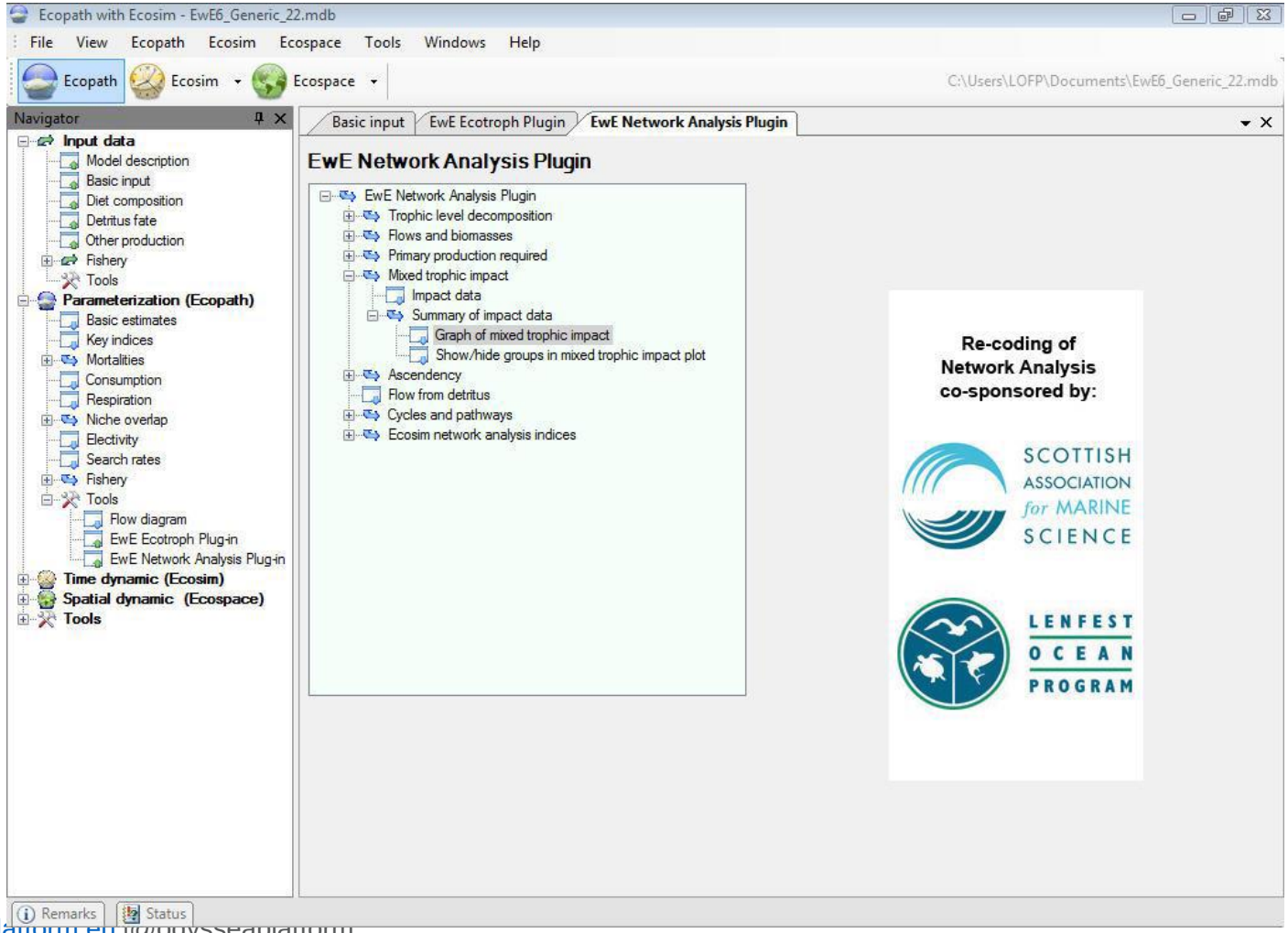
Delft-FEWS Interface

- **AQUASAFE** is a business intelligence platform supported by modelling tools and advanced data analysis systems

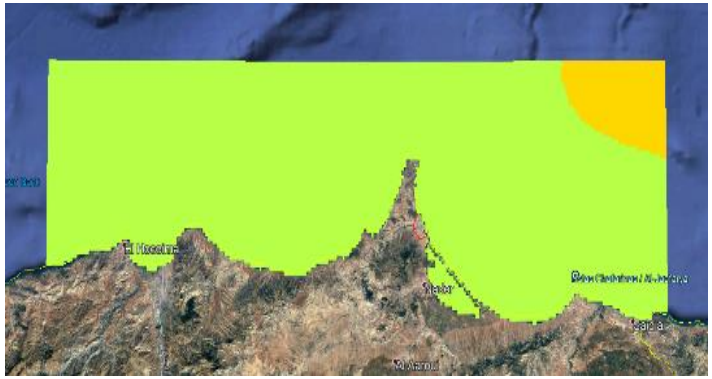


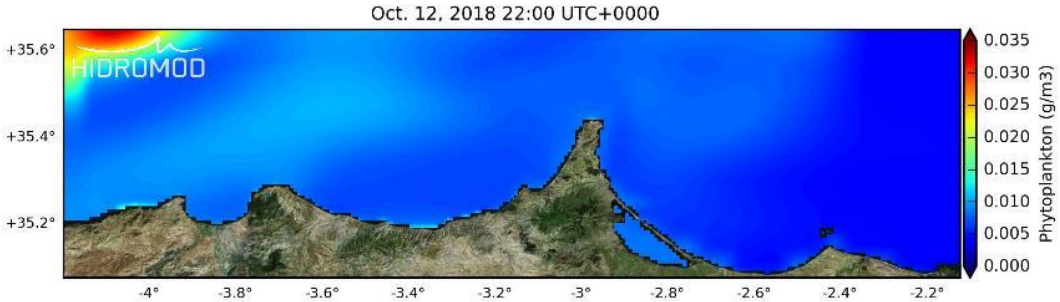
GUI of Ecopath with Ecosim

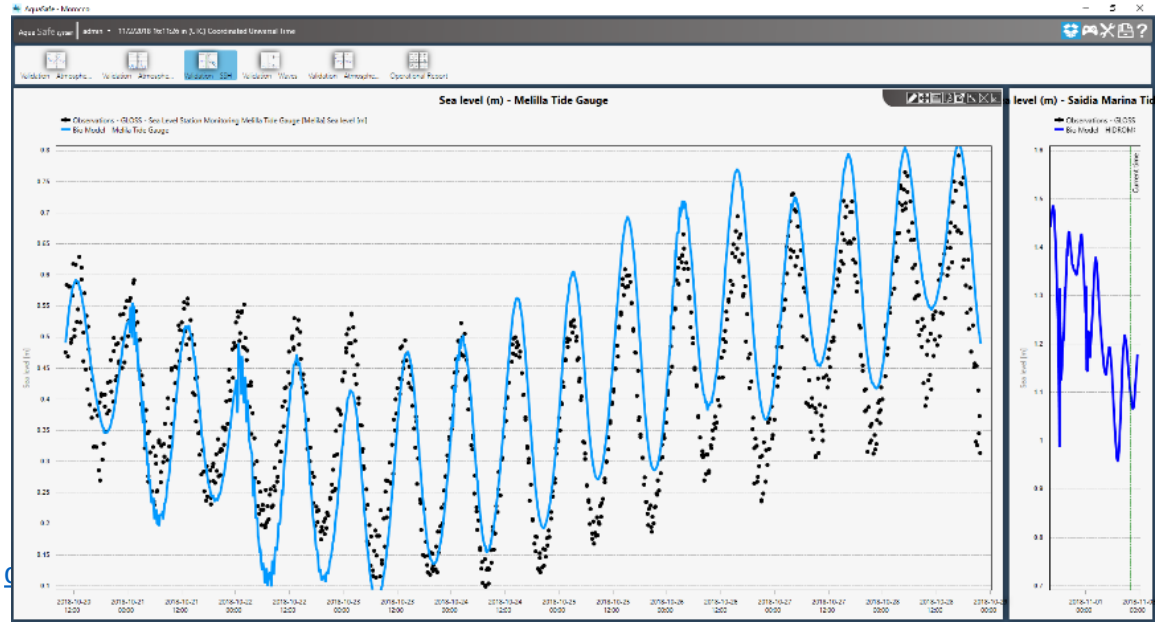
ODYSSEA



The Models in Al Hoceima Observatory

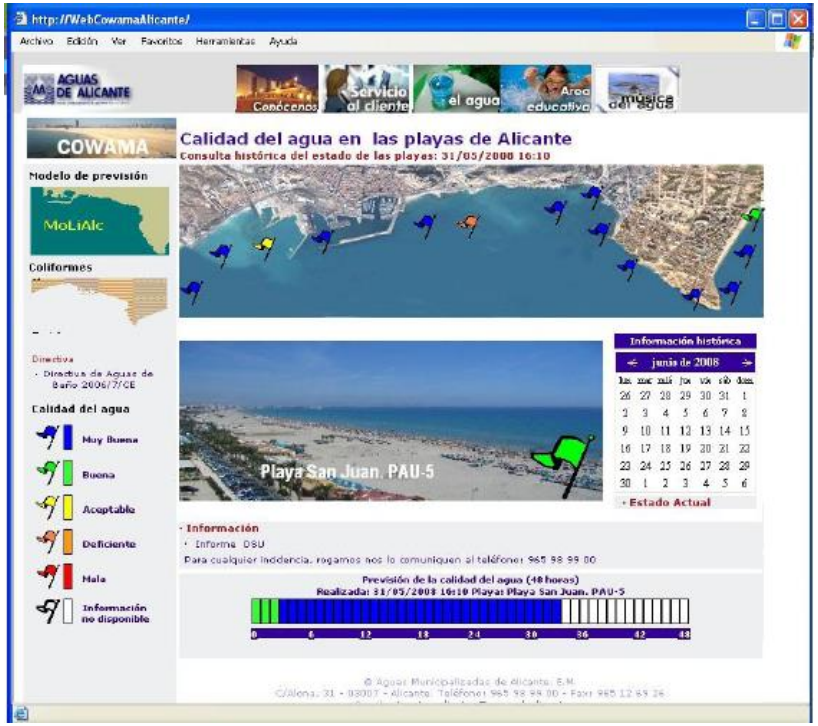






AQUASAFE Morocco. Validation workspace for sea level. Comparison between observations from Gloss (black dots) and numerical model results (blue line).

The Observatories

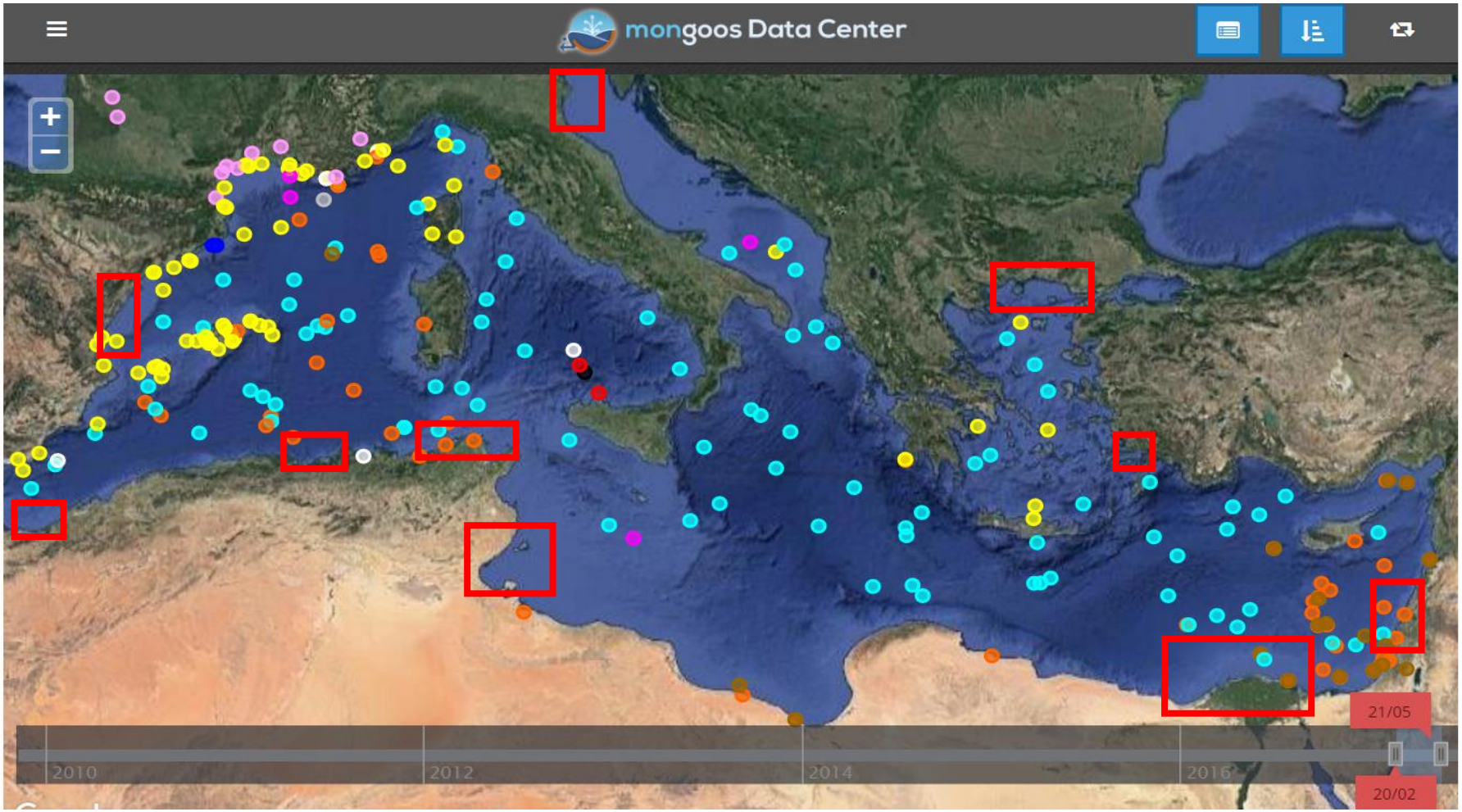


9 ODYSSEA Observatories

Establish ODYSSEA Observatories to fill-in data gaps & increase spatial and temporal resolution

A. North Aegean/Thracian Sea (Greece/Turkey),
B. Gulf of Gökova (Turkey),
C. Valencia's regional coastline (Spain),
D. Northern Adriatic Sea basin,
E. Arzew Bay/Stora Gulf (Algeria)
F. Gulf of Gabes (Tunisia),
G. MPA National Park Al-Hoceima (Morocco),
H. Israel's coastline and
I. Nile River of Freshwater Influence (Egypt).

9 ODYSSEA Observatories



The Observatories

- ✓ Comprise a network of 9 observing and forecasting systems,
- ✓ Cover coastal and shelf zone environments,
- ✓ Cover Ecologically-vulnerable systems (MPAs) / systems with increased human pressure,
- ✓ Combine monitoring and modeling activities,
- ✓ Produce new datasets, store, manipulate, make accessible through the ODYSSEA platform,
- ✓ Data with increased temporal and spatial resolution.

The Scope of ODYSSEA Observatories

ODYSSEA

The establishment and operation of ODYSSEA Observatories, will

(a) Improve the spatial and temporal resolution of existing data;
(b) Enhance existing knowledge along the North African and Middle Eastern coastline;
(c) Develop, test and demonstrate novel monitoring systems for data collection;
(d) Collect new marine parameters in line with EU policies;
(e) Involve directly and train local/regional end-users in data collection and model results assessment; and
(f) Provide operational modelling results to serve multiple end-users needs.

ODYSSEA Observatory Fact Sheets

Observatory Name	National Park of Al-Hoceima (PNAH) Observatory
Country	Morocco
Geographic Area	The National Park of Al Hoceima is located on the Mediterranean Moroccan coast, 150 km east from the Gibraltar Strait, in proximity to the city of Al Hoceima and has a 47 km long coastline.
Oceanographic Interest	The area is affected by the surface Atlantic water jet-like flow through the Strait, moving eastward with strong currents and complex dynamics. Alboran basin topography induces anticyclonic gyres. Al-Hoceima is affected by the western Alboran Gyre (WAG) the combination of strong tidal currents at the entrance of the Strait, noticeable winds, mostly strong regional westerlies and easterlies regimes, and the existence of re-circulations at both margins of the jet.
Ecosystem Importance	The PNAH is an unusual biotope consists of caves, islets and rocks which host one of the most original biodiversity in the Mediterranean, like rare or threatened species from small invertebrates (giant limpet) to large marine mammals monk seal and dolphins. Also, a very rich avifauna Osprey, Bonelli's Eagle, Audouins, and mixed fish abundance atlantics and Mediterranean Sea, and more than 500 types of algae.
Human Activity	The PNAH appears to be exposed to different human pressures that affect rare species survival and threaten local biodiversity. Direct effects of such threats, especially those resulting from illegal fishing practices such as dynamite fishing and poisoning, have strong implications for the entire marine biodiversity of PNAH.
Main Citations	[38-41]
End-User Groups	Port authority, fish farms, mussel farms, marine protected area management body.
Partner responsible	AGIR

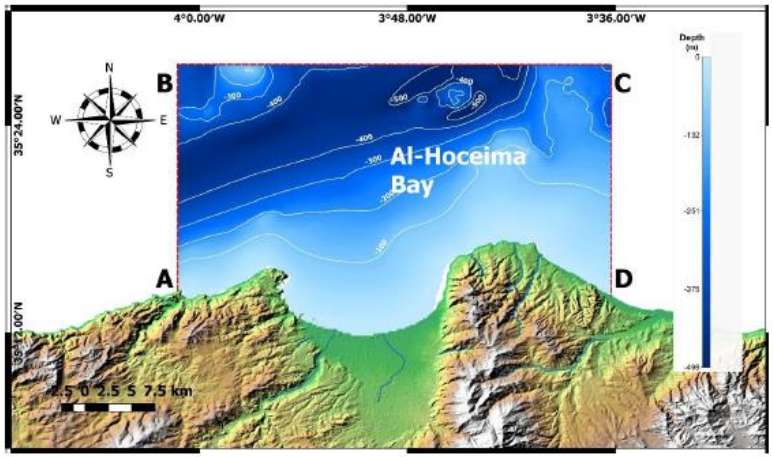
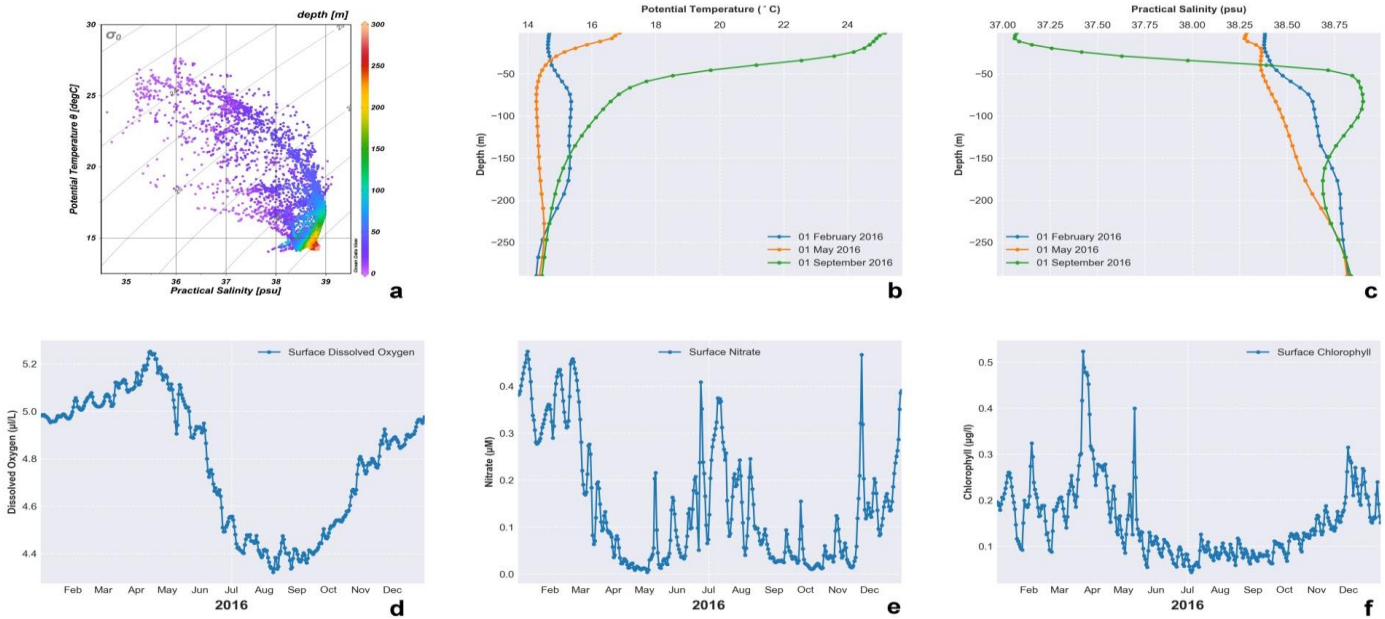
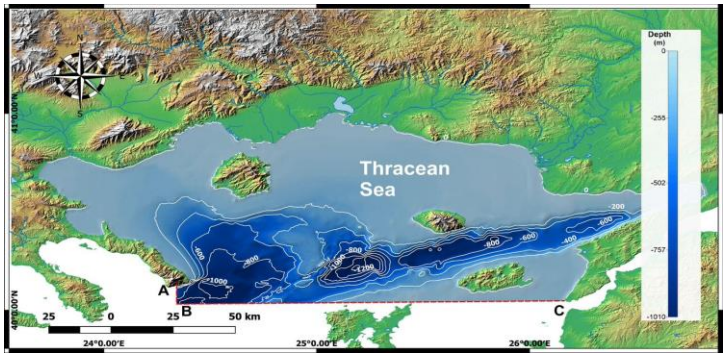


Figure 13. The spatial dimensions of the Al-Hoceima Observatory.

Observatory Case Data





The Services

ODYSSEA

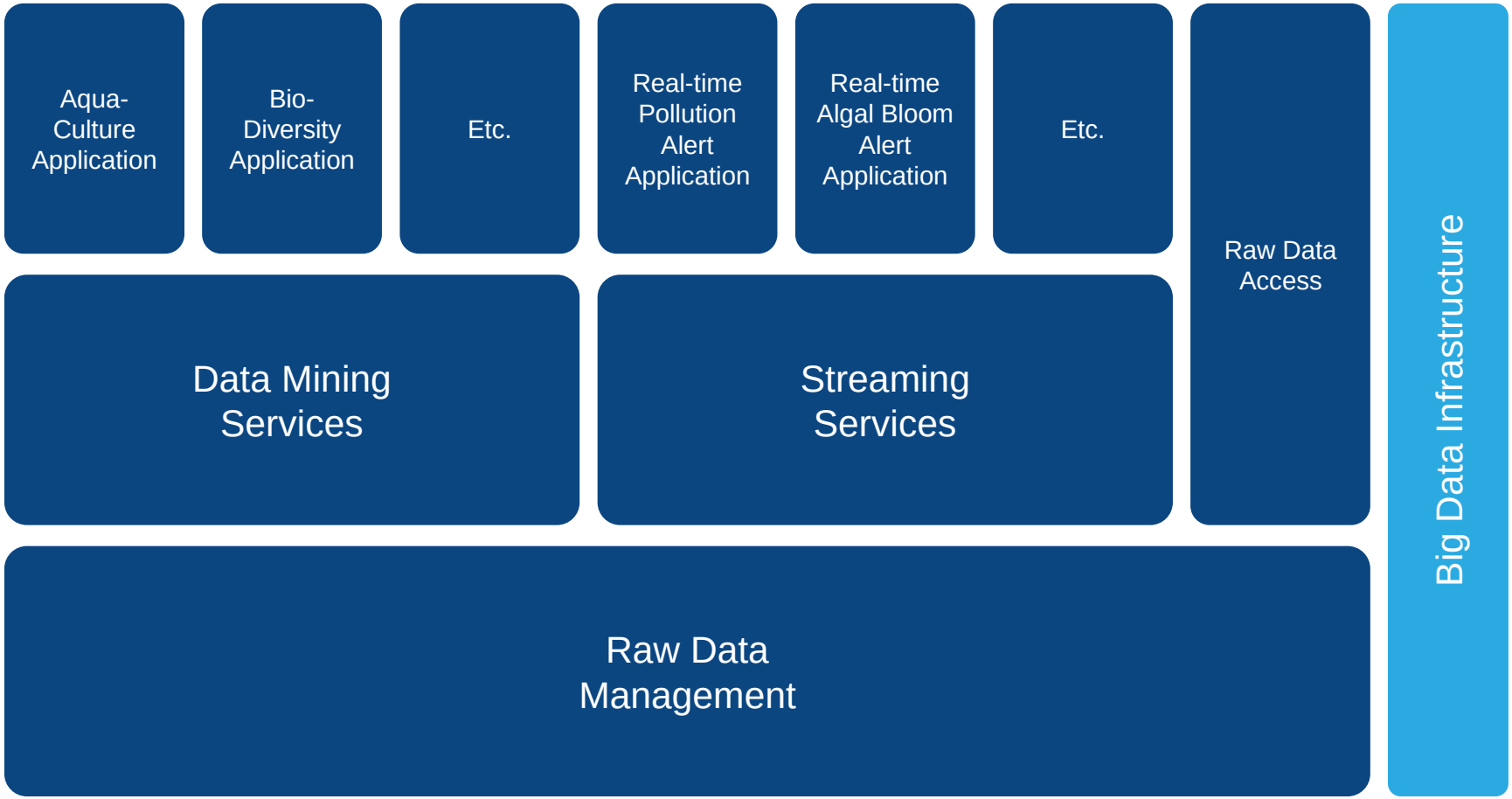
WP6
Platform Development, Operation and Maintenance

WP7
Big Data Management and Tools Development

WP8
ODYSSEA End-user Services

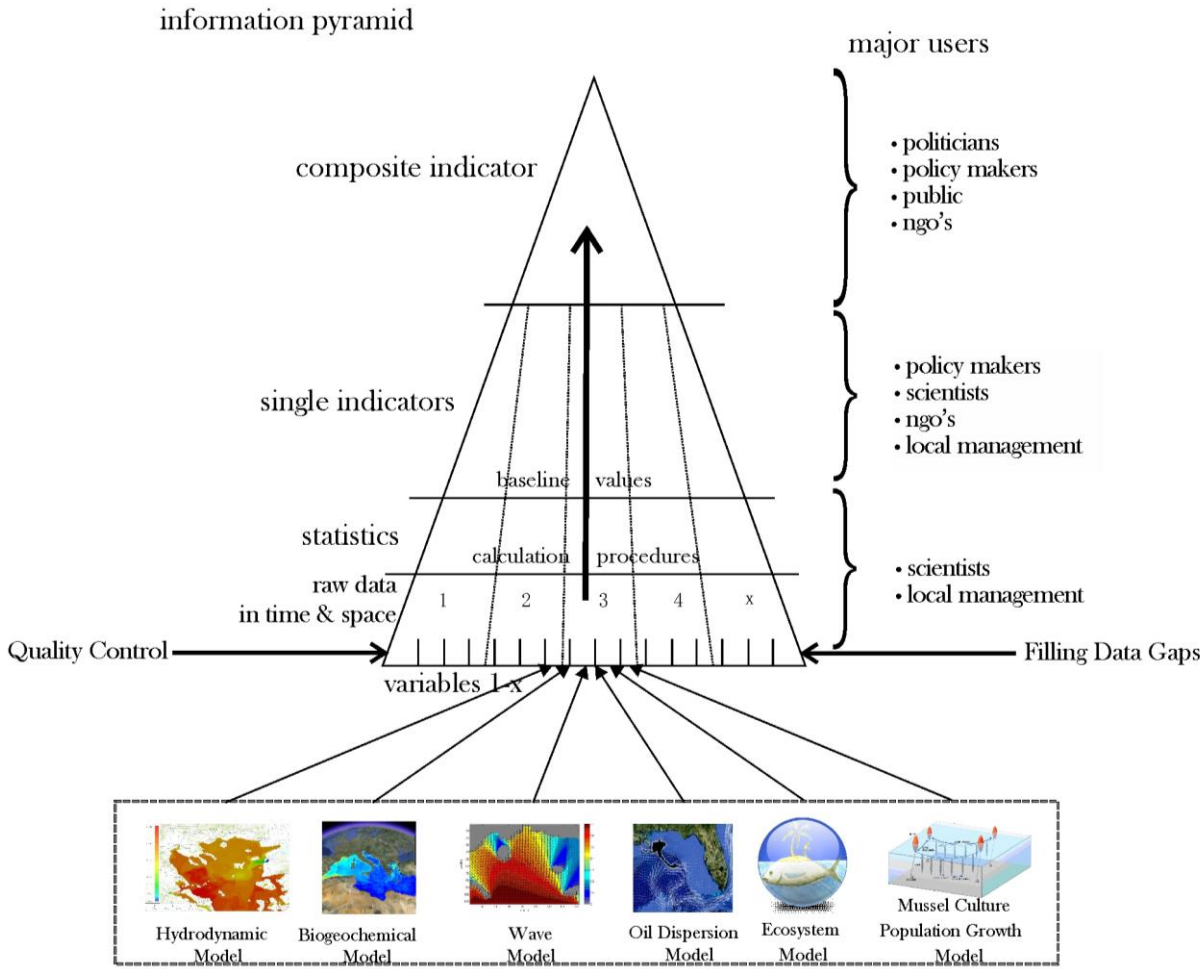
Big data in Action

ODYSSEA



Produce Indicators from Datasets

ODYSSEA



Data Integration for End-Users Services Generation

Services for end-users

ODYSSEA will:

- **Eventually be transformed into a business**
- Develop a **community of data users** who enjoy the benefits of facilitated access to marine data
- Classify end-users into: **primary users, advanced users and higher-level clients**
- Directly involve end-users in **the design and data collection** of Observatories monitoring module through the use existing facilities (onshore and offshore), like oil & gas terminals and rigs, mariculture installations and ports,
- Ensure **increased number/types of end-users** requiring real-time data from the sea
- **Reduce costs for end-users** data assembling from different sources
- Inform end-users on **emergencies and risks**

Potential Users/Clients

Table 1: Potential end-user groups per ODYSSEA Observatory, as identified in Deliverable 2.1	
ODYSSEA observatory name	**Potential end-users**
North Aegean/Thracian Sea Observatory (Greece)	Fish and mussel farms; Port authorities; oil and gas industry; Cruise companies; touristic industry (hotels, yachts).
Gulf of Gökova Observatory (Turkey)	Cruise companies; ferries to Greece; fishing and sponge diving; recreational fishing, tourism (hotels, yachts).
Valencia's regional coastline Observatory (Spain)	Cargo and Cruise companies, ferries, fishery communities, tourism (hotels, yachts), local authorities.
Northern Adriatic Sea (NAS) basin Observatory (Italy)	Industry, wetlands management bodies, fishermen, fish and mussel farmers.
Gulf of Arzew/Stora Bay Observatory (Algeria)	Petrochemical industry, LNG terminal, Chlorine industry, cargo and ferry companies, fisheries, aquaculture.
Gulf of Gabes Observatory (Tunisia)	Dredging activities, fisheries, oil and gas platforms, port authorities, aquaculture, mussel farms.
National Park of Al-Hoceima (PNAH) Observatory (Morocco)	Port authority, fish farms, mussel farms, marine protected area management body.
Israel Coastal Observatory (Israel)	Port authorities, oil and coal terminals, offshore gas extraction, desalination and power plants, sand mining, marine farms, tourism.
Nile River Region of Freshwater Influence Observatory (Egypt)	Port authorities, oil and coal terminals, desalination and power plants, sand mining, marine farms, tourism.

Potential End-User Groups for ODYSSEA

Industrial End-Users

- fishery and mariculture industry (fishing fleet, fish farms, and mussel farms, agriculture on saline soils),
- design and construction of offshore facilities and installations (pipelines, cables), oil and gas exploitation (boreholes and hydrocarbons extraction facilities),
- maritime transport and shipbuilding (deep-sea & short-sea shipping, cargo and passenger ferry services, inland shipping, seaplanes),
- renewable ocean energy facilities (offshore wind energy, ocean renewable energy resources, carbon capture and storage),
- raw materials industry (marine aggregate mining, marine mineral resources, sea-floor dredging activities),
- leisure, working and living (coastline tourism, yachting including marinas, cruise including port cities, working and living),

Potential End-User Groups for ODYSSEA

ODYSSEA

Public authorities

- environmental management agencies (environmental monitoring and reporting, rapid environmental assessment, extreme events such as HABs and bottom anoxia),
- fishery and mariculture authorities (fish stock assessments, ecosystem characterization),
- public health and civil protection authorities (coastal protection against flooding and erosion, prevention of saltwater intrusion, protection of habitats, etc.)
- maritime monitoring and surveillance authorities (traceability and security of goods supply chain, to prevent and protect against illegal movement of goods and people),
- marine safety authorities (prediction of extreme events, monitoring and prediction of the pathways and spread of toxic pollutants).

Potential End-User Groups for ODYSSEA

ODYSSEA

Science and Education

- Marine scientists, physicists, chemists, marine biologists and marine geologists as well as atmospheric scientists, engineers, managers, consultants, etc. are some of the categories of scientific staff requesting data at Observatory level.

- Teachers and students from any educational level may need marine data to understand local ecosystem processes and structure

Civil Society

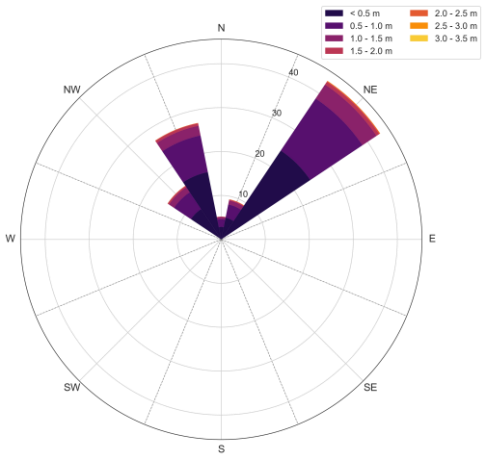
Citizens should be informed on issues that affect their coastal and offshore ecosystem, their livelihoods or their health, including all parameters which impact their well-being as a result of human activity on the marine environment.

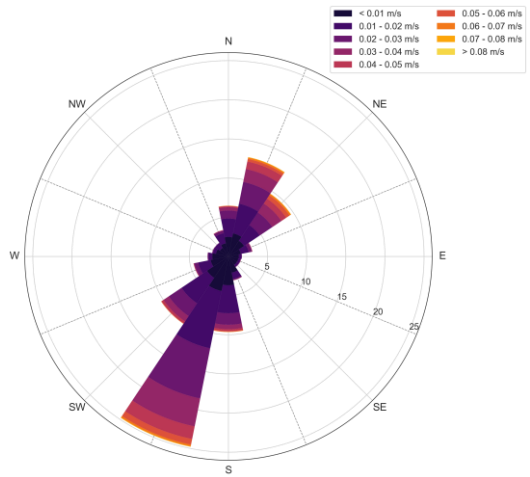
Data Integration for End-User Services

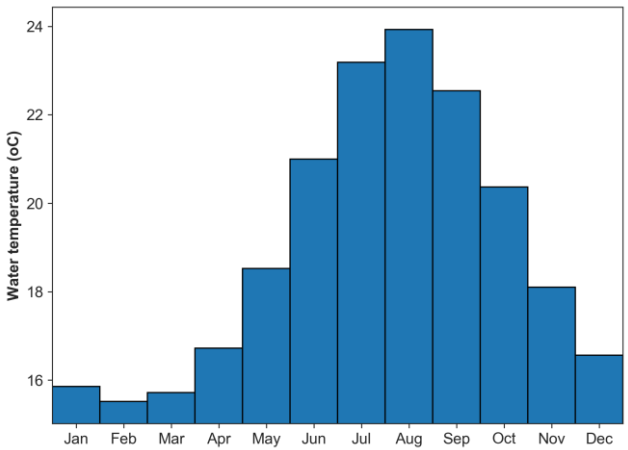
ODYSSEA will:

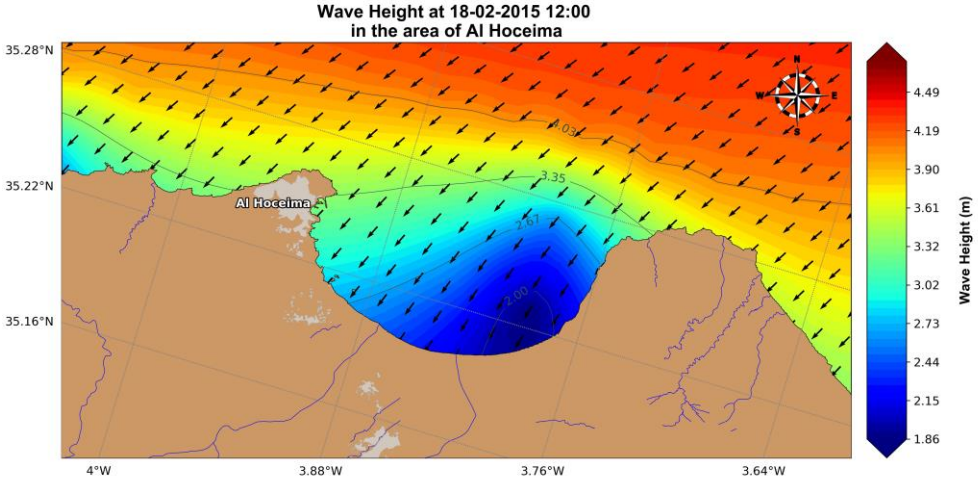
- Provide systematic abiotic and biotic measurements and model results of the marine environment with a predefined spatial and temporal schedule
- Statistical data post-processing (e.g., PCA / EOF analysis, SOM analysis to identify trends, patterns and clusters, perform data mining)
- Produce datasets that could be used for the GES assessment
- Combine physico-chemical data, habitat types, biota to allow the calculation of secondary indicators (e.g., eutrophication indices, pollution indices, MSFD descriptors, etc)
- Export these secondary indicators to the end-users
- Describe the methodology to derive these indicators

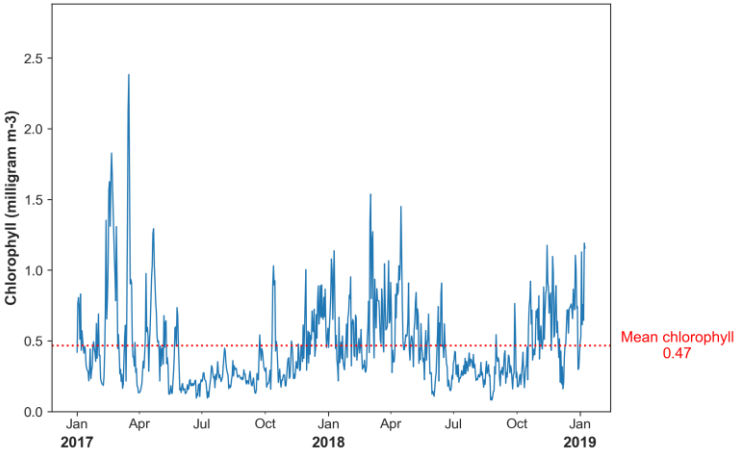
A Dashboard per User







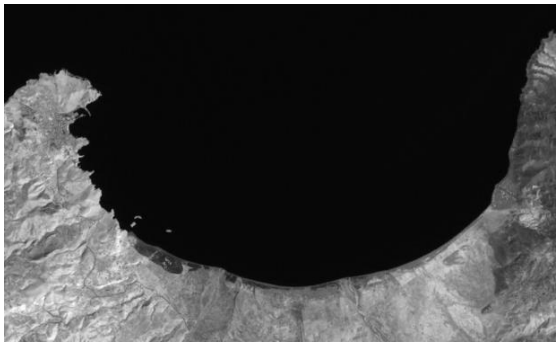




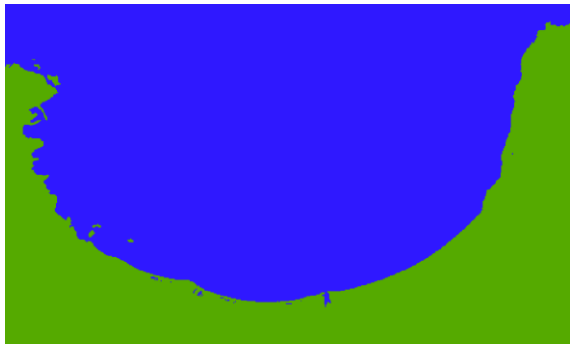
Services for Coastal Erosion

ODYSSEA

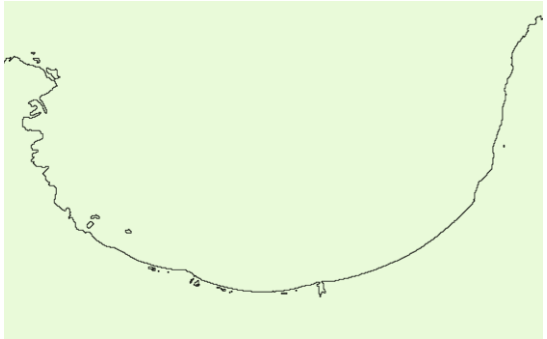
Semi-Automatic Classification Plugin (SCP) for QGIS



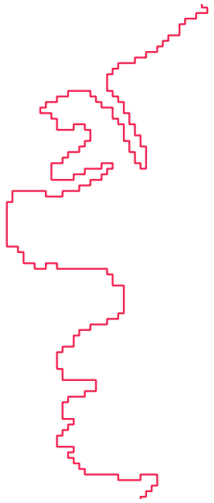
Landsat Image - Band 5



Classified Image (Land - Sea)



Raster to Vector

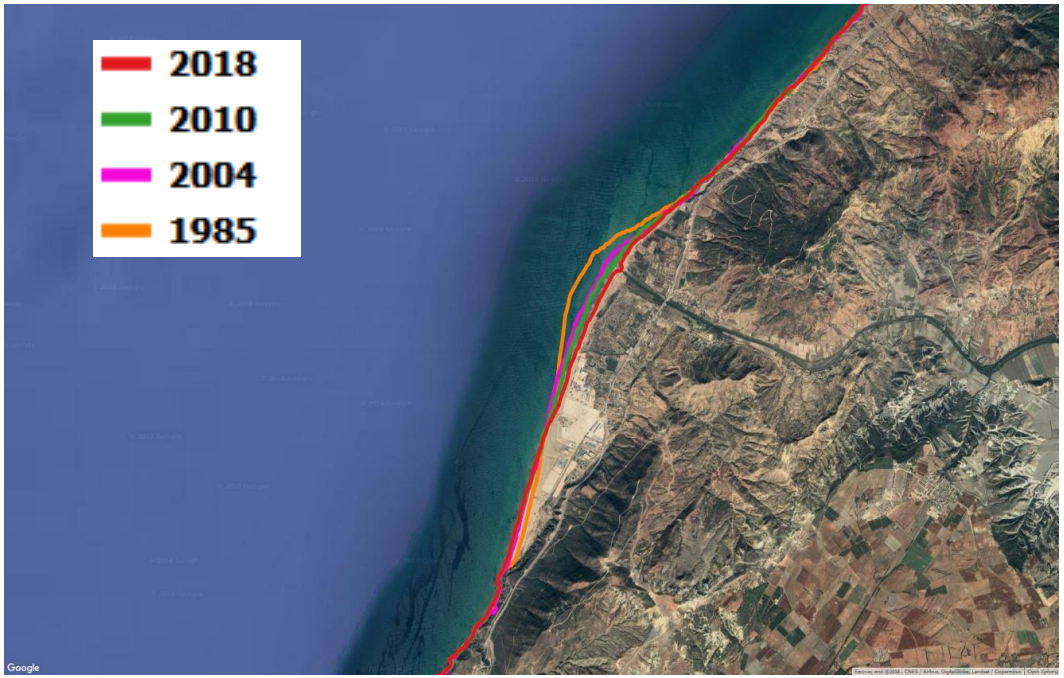


Shoreline Extraction

Smoothed Shoreline

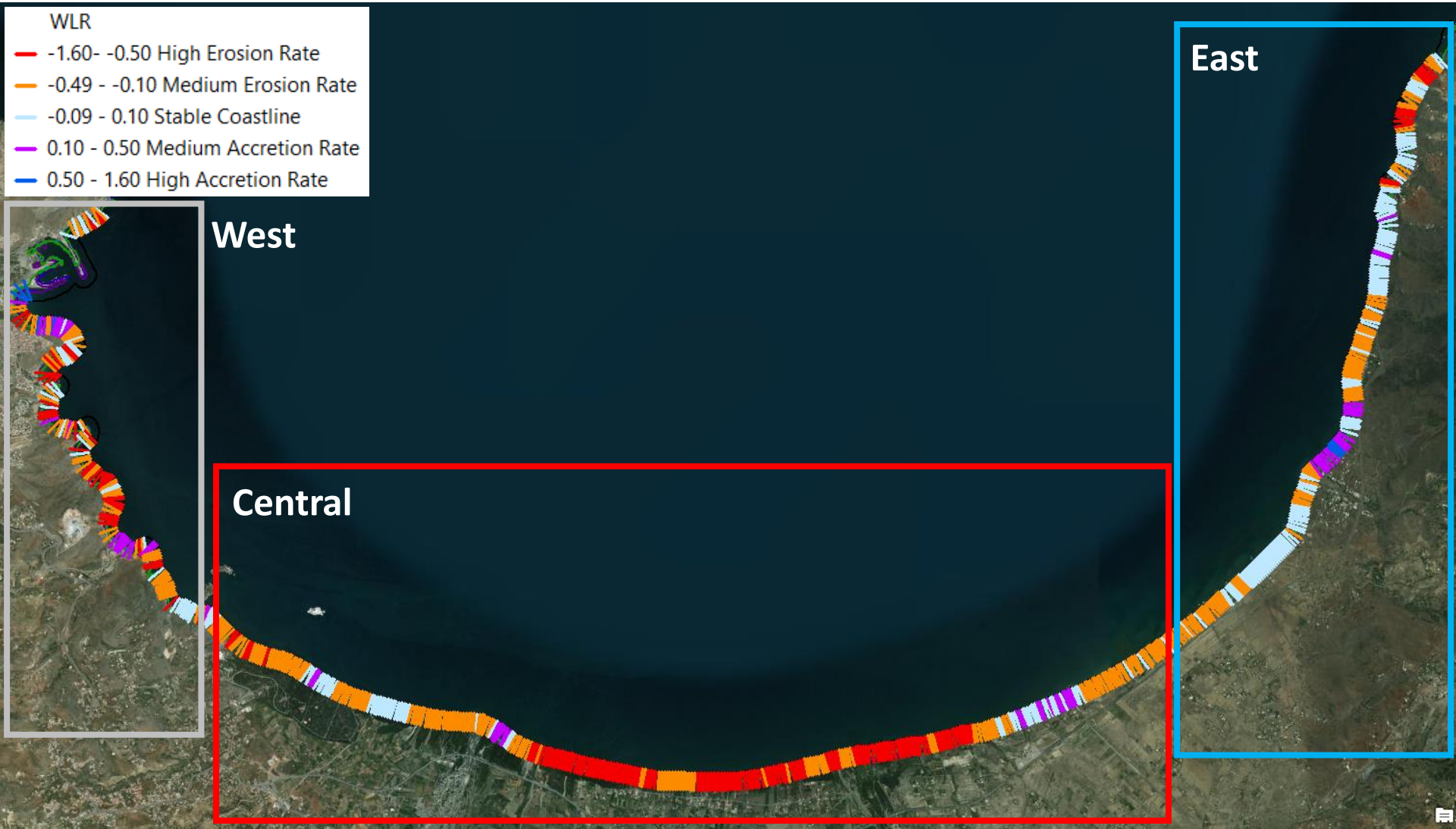
Extracted Shoreline

Services for Coastal Erosion



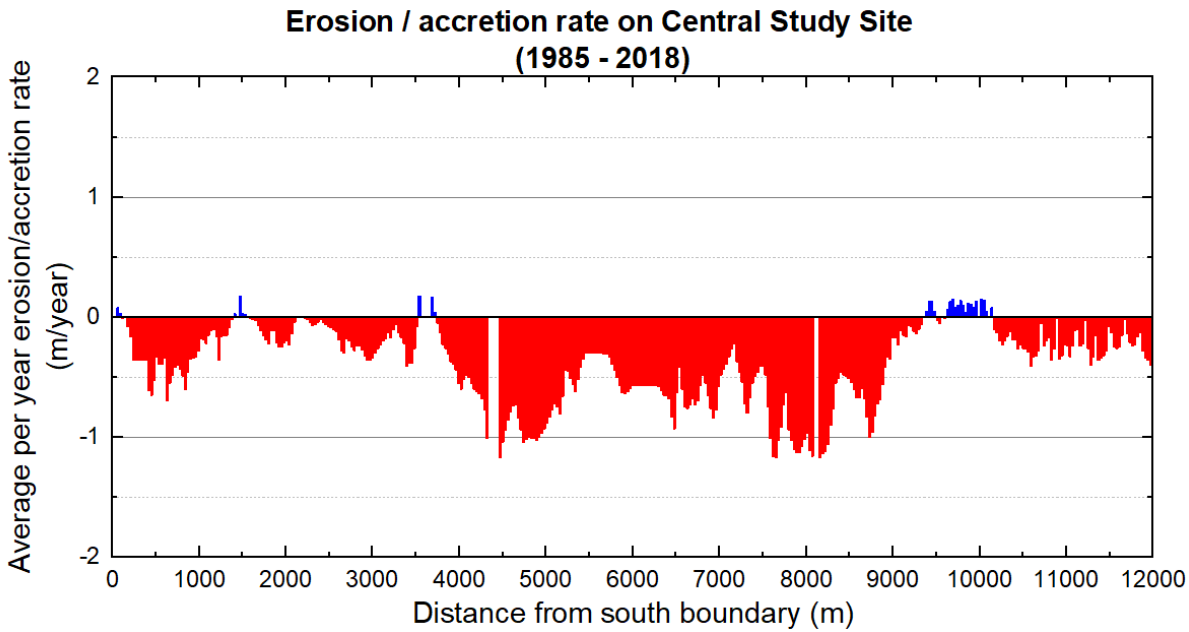
Coastal Erosion in Al Hoceima shoreline

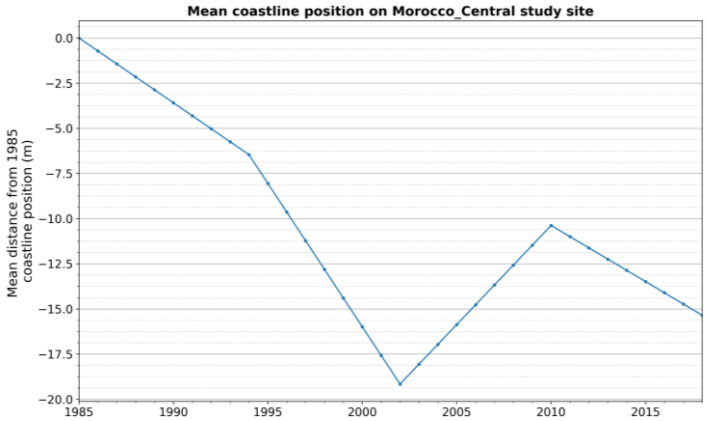
Services for Coastal Erosion



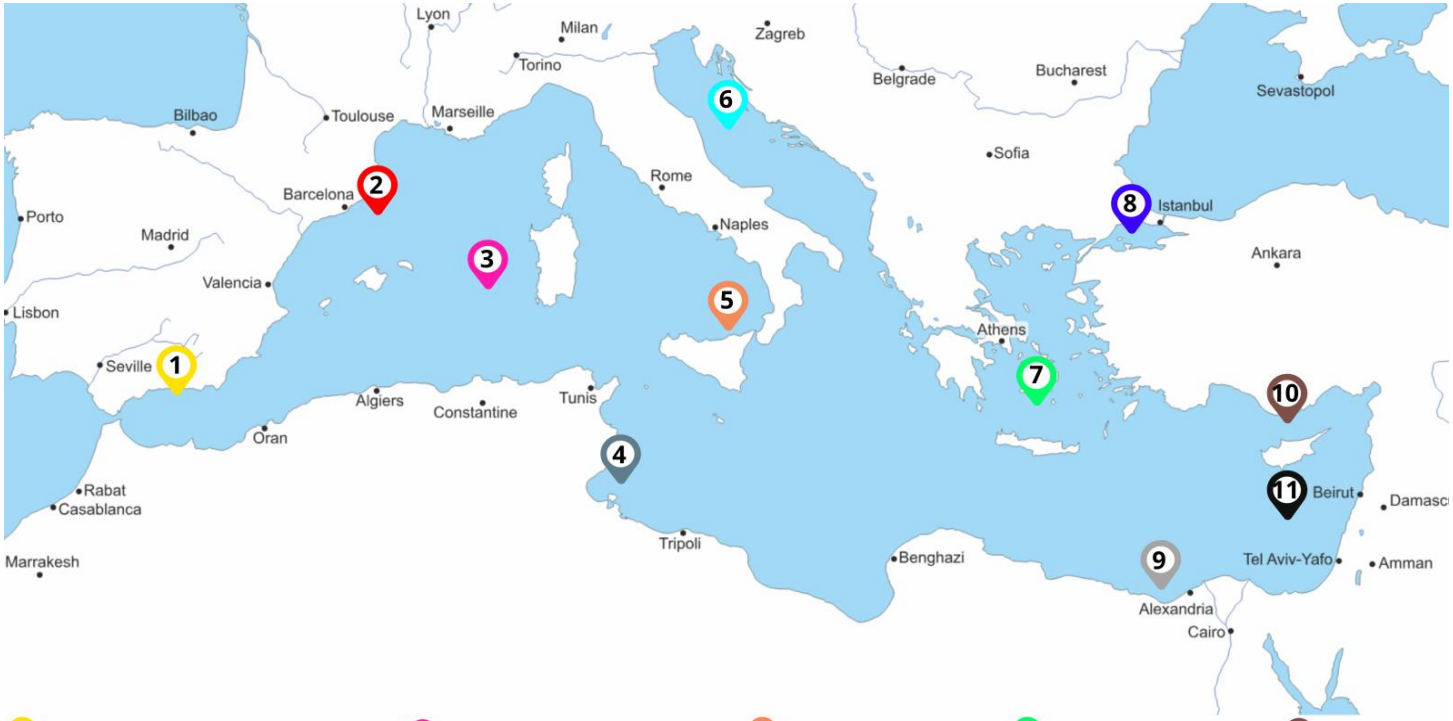
Central coast of Al Hoceima Gulf

Average rate	-0.38	m/year
max accretion rate	0.30	m/year
max erosion rate	-1.26	m/year
Average Error	0.34	m/year





Services for Jelly Fish Blooms



1 Western Spanish Mediterranean waters:

-Portuguese man-of-war (Physalia physalis)

2 Southern Spanish Mediterranean waters:

-Mnemiompsis leidyi
-Carybdea marsupialis
-Phyllorhiza punctata
-Clytia hummelincki
-Aureli aurita
-Aequorea forskalea
-Olindia phosphorica
-Gonionemus vertens
-Pandea conica
-Rhizostoma pulmo

3 Western Mediterrranean waters:

-Pelagia noctiluca (mauve stinger)
-Cotylorhiza tuberculata
-Mnemiopsis Leidyi
-Liriope tetraphylla
-Carybdea marsupialis
-Clytia hummelincki

4 Tunisia - Gulf of Gabes:

-Phyllorhiza punctata

5 Sicily:

-Catostylus tagi

6 Adriatic Sea:

-Pelagia noctiluca (mauve stinger)
-Aurelia aurita (moon jellyfish)
-Beroe ovata
-Carybdea marsupialis
-Clytia hummelincki
-Mnemiopsis Leidyi

7 Aegea Sea:

-Pelagia noctiluca (mauve stinger)
-Mnemiopsis Leidyi
-Beroe ovata
-Rhopilema nomadica

8 Sea of Marmara:

-Mnemiopsis Leidyi

9 Egyptian Coasts:

-Rhopilema nomadica
-Clytia C. linearis

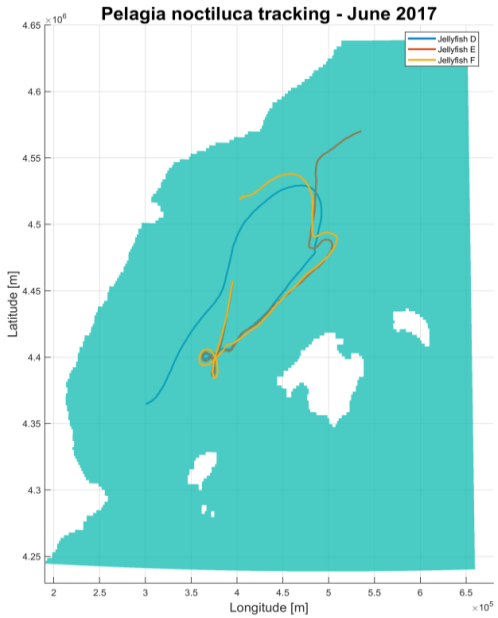
10 Turkish Coasts:

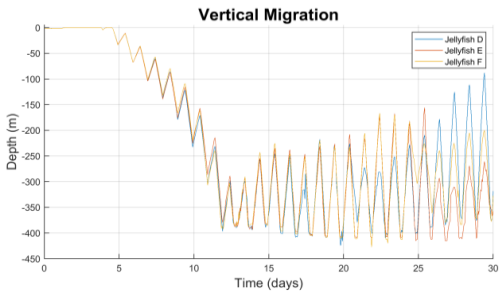
-Mnemiopsis Leidyi
-Rhopilema nomadica
-Aequorea globosa

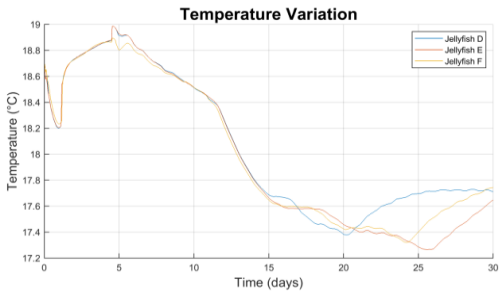
11 Levantine Basin:

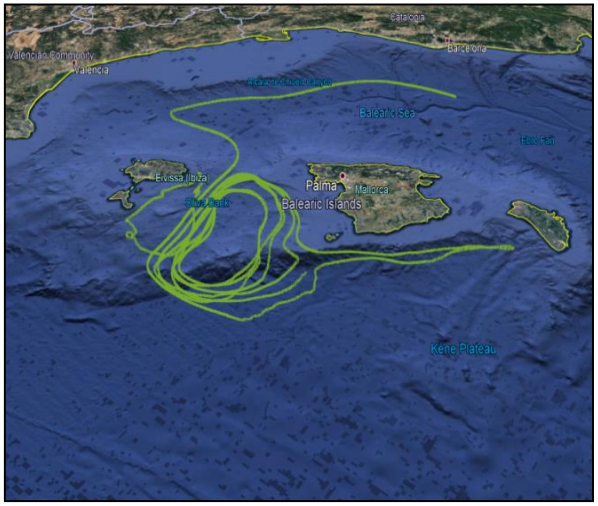
-Mnemiopsis Leidyi
-Beroe ovata
-Phyllorhiza punctata
-Salpa maxima
-Rhopilema nomadica

Services for Jelly Fish Blooms



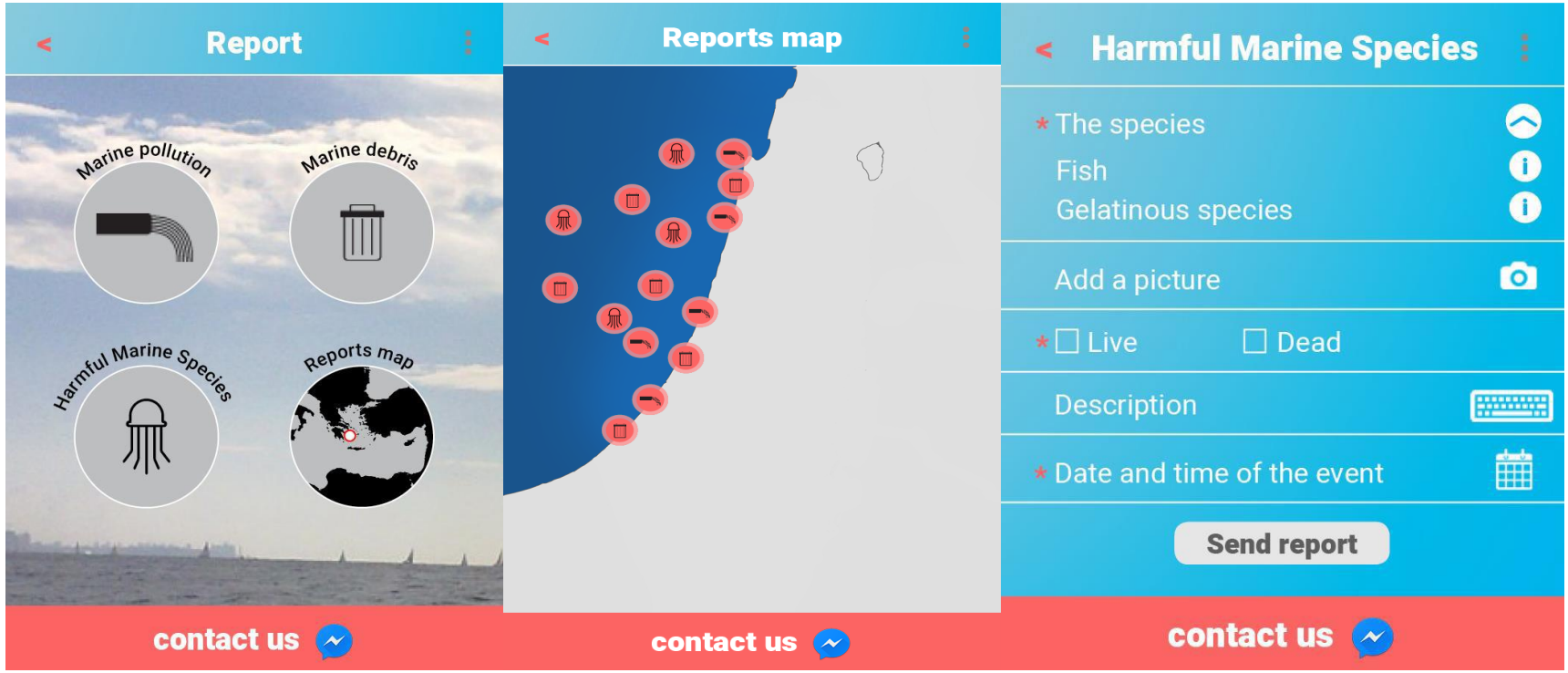






Tracking of Pelagia Noctiluca in June 2017.

ODYSSEA Jelly Fish App



Mock-up of SeaWatch App

Biological Datasets Integration

ODYSSEA

ODYSSEA focuses on biological data integration

- Connect to existing platforms with open, reliable biological data at Mediterranean scale
- Develop new biological datasets at ODYSSEA Observatories
- Integrate biological dimension on the Monitoring module of ODYSSEA Observatories
- Develop/use existing marine biological models (e.g., Ecopath and Ecomap)
- Include the human impact (e.g., fisheries)
- Provide stock assessment recommendations per stock and per area
- Foster the ecosystem assessments, forecasts, scenarios and a deeper understanding of vulnerability, risks and interventions at local and regional levels

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Seagrass detection in the mediterranean: A supervised learning approach

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Keywords:
Seagrass classification
Dataset integration and fusion
Machine learning
Data mining
Mediterranean Sea

ABSTRACT

We deal with the problem of detecting seagrass presence/absence and distinguishing seagrass families in the Mediterranean via supervised learning methods. By merging datasets about seagrass presence and other external environmental variables, we develop suitable training data, enhanced by seagrass absence data algorithmically produced based on certain hypotheses. Experiments comparing several popular classification algorithms yield up to 93.4% accuracy in detecting seagrass presence. In a feature strength analysis, the most important variables determining presence–absence are found to be Chlorophyll-α levels and Distance-to-Coast. For determining family, variables cannot be easily singled out; several different variables seem to be of importance, with Chlorophyll-α surpassing all others. In both problems, tree-based classification algorithms perform better than others, with Random Forest being the most effective. Hidden preferences reveal that *Cymodocea* and *Posidonia* favor the low, limited-range chlorophyll-α levels ($< 0.5\,mg/m^3$), *Halophila* tolerates higher salinities (> 39), while *Ruppia* prefers euryhaline conditions (37.5–39).

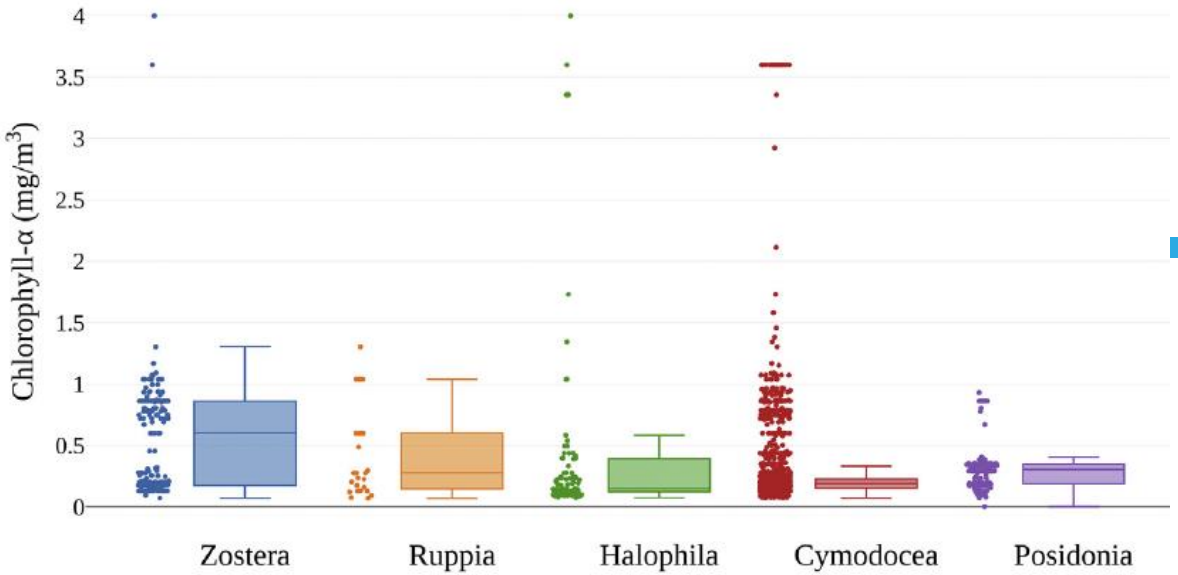


Fig. 9. Distribution of Chlorophyll-α-December values per seagrass family.

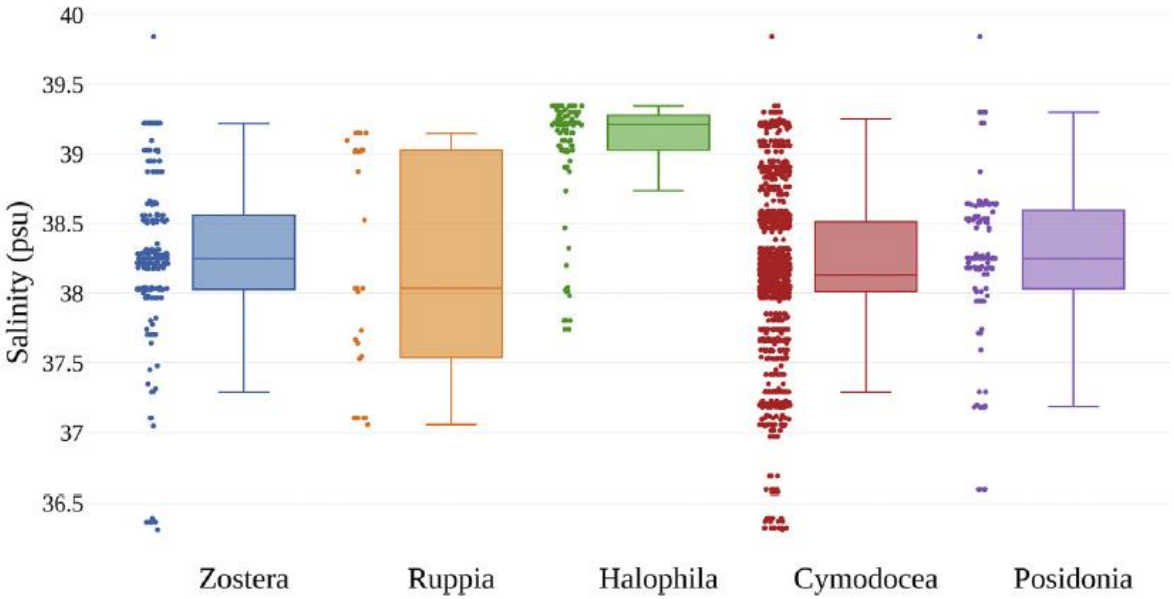
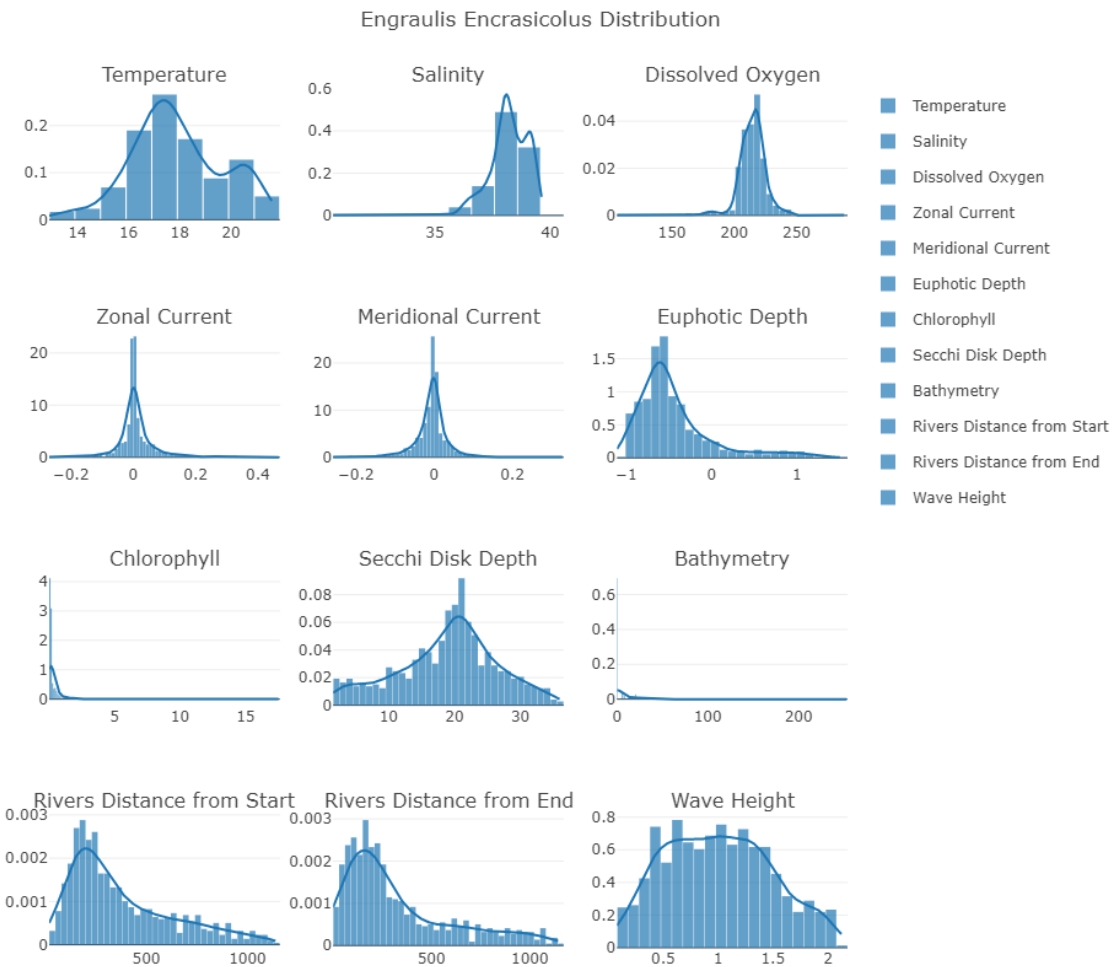
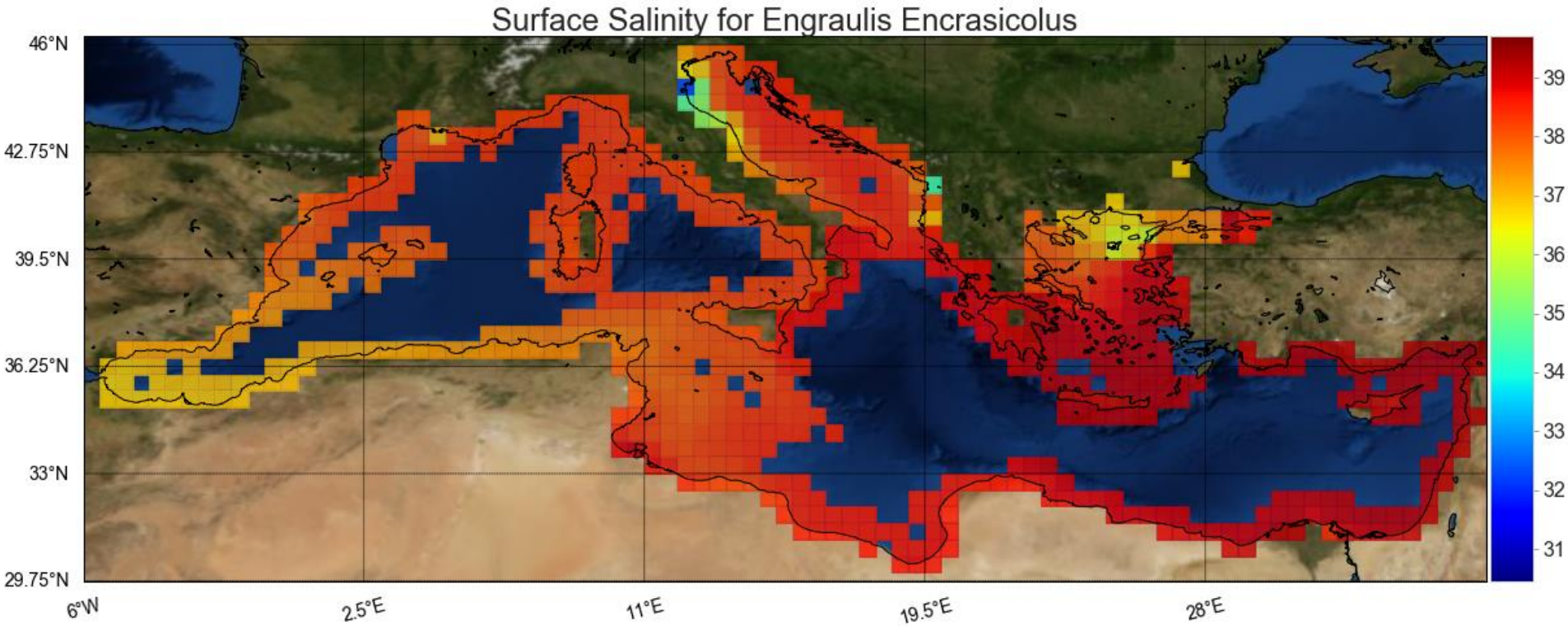


Fig. 10. Distribution of Salinity-December values per seagrass family.

Biological Datasets Integration



Biological Datasets Integration

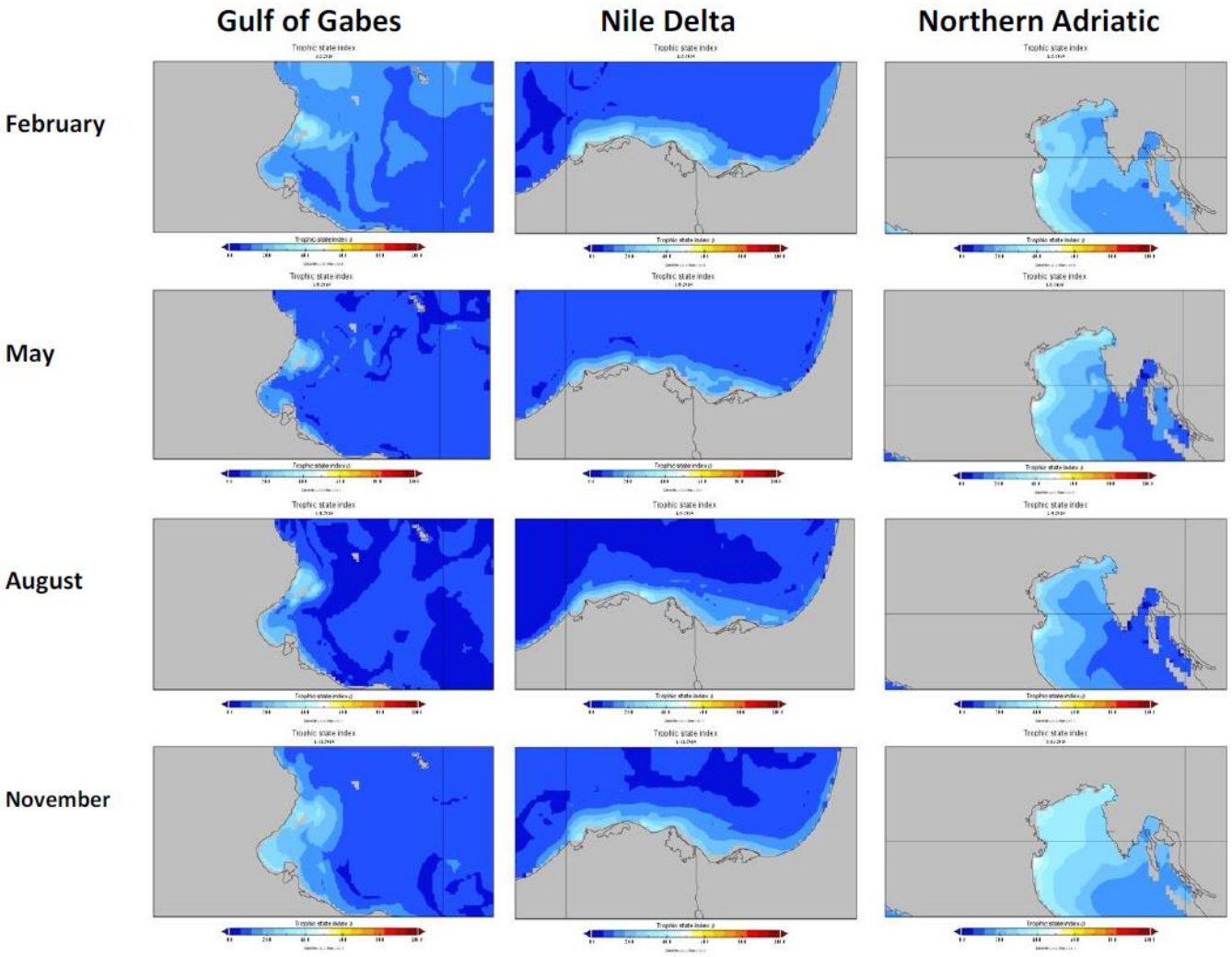


Indicators to EU Policies

ODYSSEA will:

- Use same datasets for different descriptors and indices of EU legislation (Water Framework Directive, Environmental Quality Standards Directive, Habitats Directive, Birds Directive, CFP, Barcelona Convention – MAP)
- Provide less applied monitoring approaches to fulfill EU directives requirements,
- Produce data of high quality, with wide spatial coverage focusing on areas not easily covered by traditional technologies and tools

Indicators to EU Policies



odysseaplat

A Community of Users

ODYSSEA

Involve end-users on ODYSSEA platform design, data collection and day-to-day operations

ODYSSEA will:

- Develop a **community of data users** who enjoy the benefits of facilitated access to marine data
- Classify end-users into: **primary users, advanced users and higher-level clients**
- Directly involve end-users in **the design and data collection** of Observatories monitoring module through the use existing facilities (onshore and offshore), like oil & gas terminals and rigs, mariculture installations and ports,
- Ensure **increased number/types of end-users** requiring real-time data from the sea
- **Reduce costs for end-users** data assembling from different sources
- Inform end-users on **emergencies and risks**

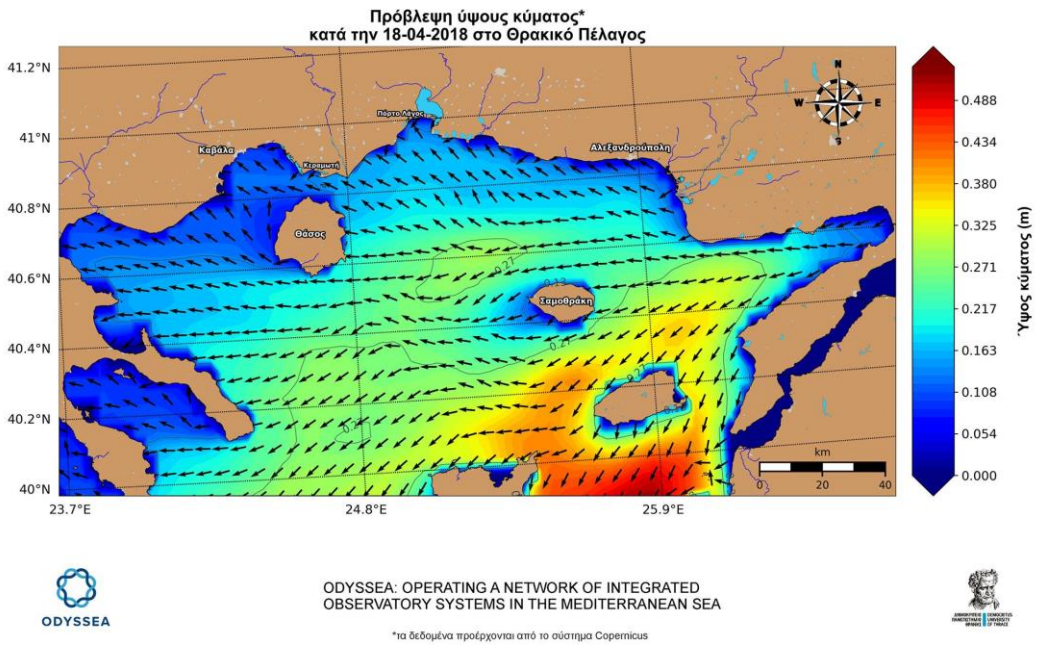
Information box example

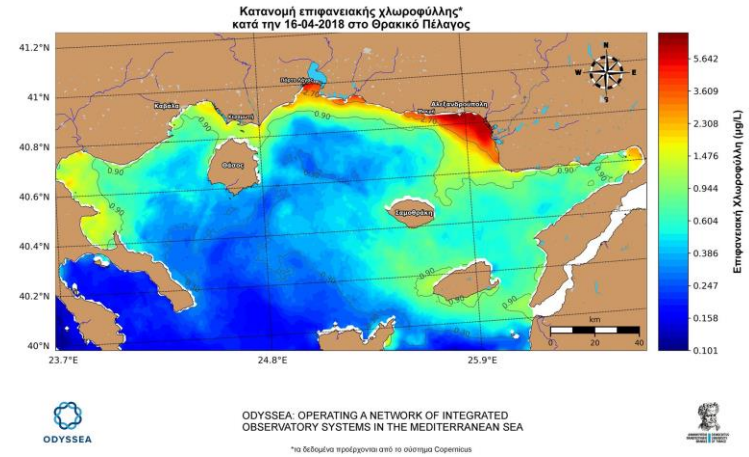
ODYSSEA

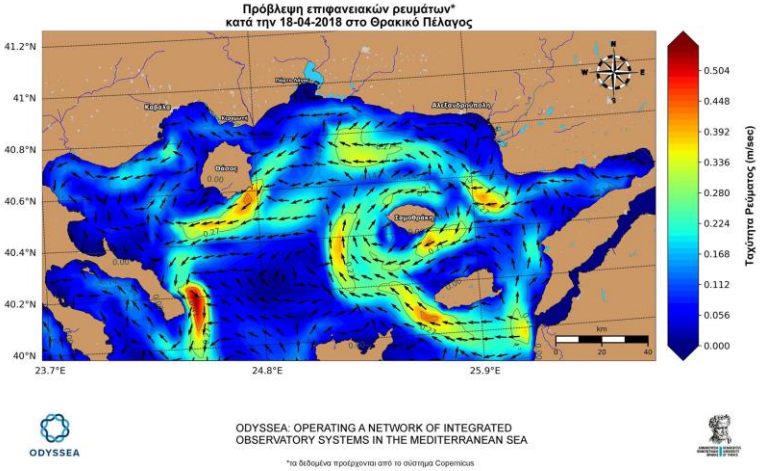
ODYSSEA will apply a **user-centred** approach, in which end-users and stakeholders, internal and external to the Consortium, will be involved from **Day 1** of the project in the design, development and operation of the platform as well in the data collection and operations of the Observatories. Furthermore, databases will be organized, homogenized and fused to provide data in common standard type and format as well as other types and formats according to end-user requirements in order to fulfil their needs for specialized and accurate information.

1. The **end-user** will be able to search, retrieve and visualize data for each specific parameter within a certain time and space window using **one single command, wherever the data are stored (ODYSSEA Novelty 1)**
2. User will be able to download archived/forecasted information and receive services for any part of the Mediterranean Sea **through a single system (ODYSSEA Novelty 2)**
3. A **set of interactive web tools** will be developed for the front-end of the platform to allow the user to visualise both the location of data points (using maps) and the data values (using plots / data visualisation layers) **(ODYSSEA Novelty 3)**
4. Data from **more observational platforms, systems and networks** will be readily available to end-users through the newly developed platform. Emphasis will be placed on **enriching the system i.e., with meteorological, hydrological and citizen's science data (ODYSSEA Novelty 4)**
5. Databases will be re-organized, homogenized and fused to provide data retrieved in a common standard type and format, as well as other types and formats **according to end-user requirements (ODYSSEA Novelty 5)**

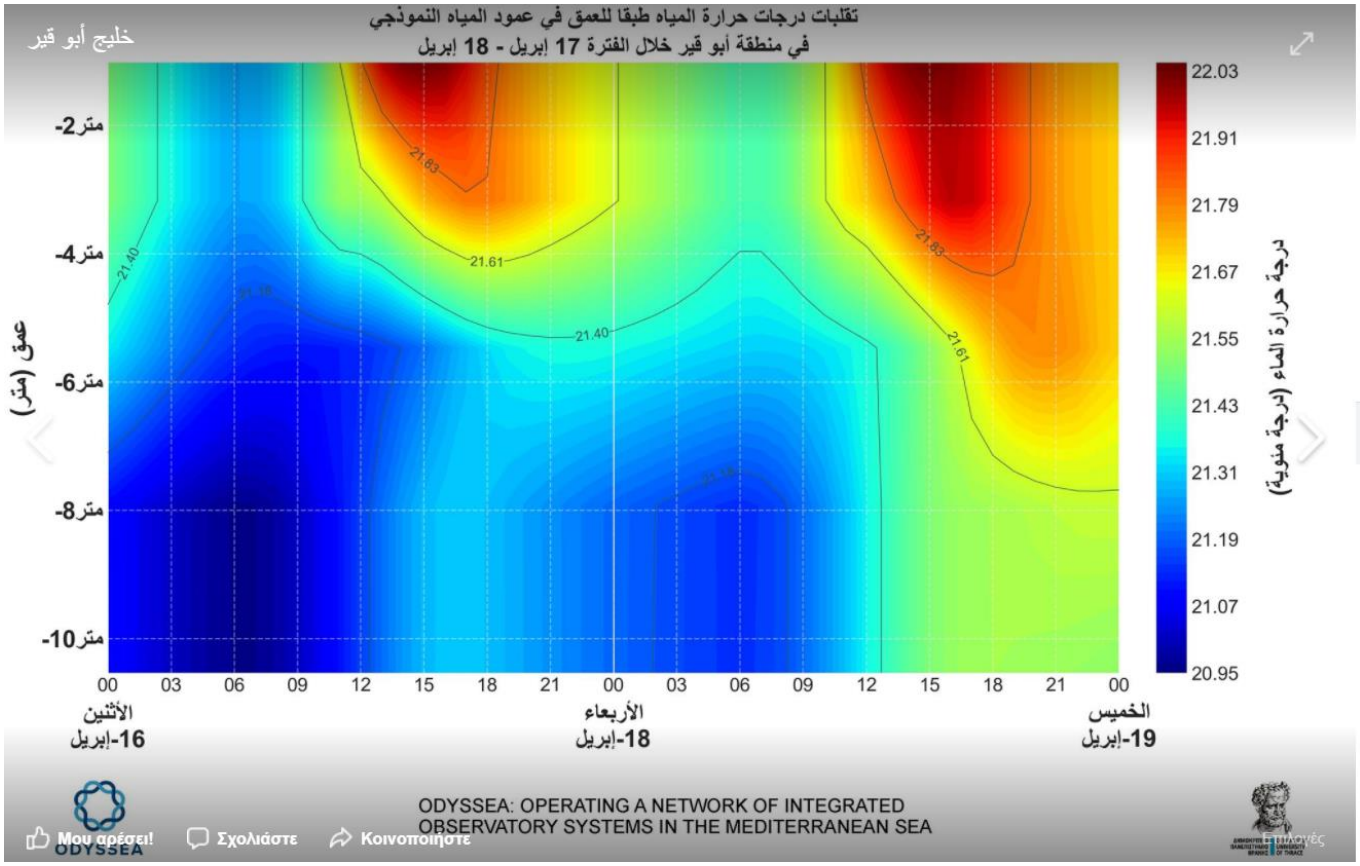
ODYSSEA - Greece







ODYSSEA - Egypt



ODYSSEA Training Actions

Train and educate policy-makers and end-users on platform usage

ODYSSEA will:

- Develop a series of training materials for the **education of young scientists, engineers and entrepreneurs** working within the blue economy within the Mediterranean region
- **Train regional and national environmental managers** on the use of the platform
- Organize **seminars on environmental hazards and emergencies** forecasting
- Present the complex ecological and economic drivers occurring within each Observatory area
- **Demonstrate new technologies** (sensors and systems) developed within ODYSSEA

ODYSSEA and Young Scientists

Improve professional skills and competences - focus on Northern Africa capacity building

ODYSSEA will:

- Improve professional skills on environmental modeling,
- Link environmental technologies to marine policies and legislation
- Support tertiary education, transfer of technologies and knowledge for new and qualified **“jobs of the sea”**

ODYSSEA Training

ODYSSEA Workshops

PARTICIPANTS GROUP PHOTO TAKEN DURING THE WORKSHOP OF HERAKLION (MARCH 2018).

ODYSSEA Summer Schools

Contribution to Europe 2020 Strategy

ODYSSEA

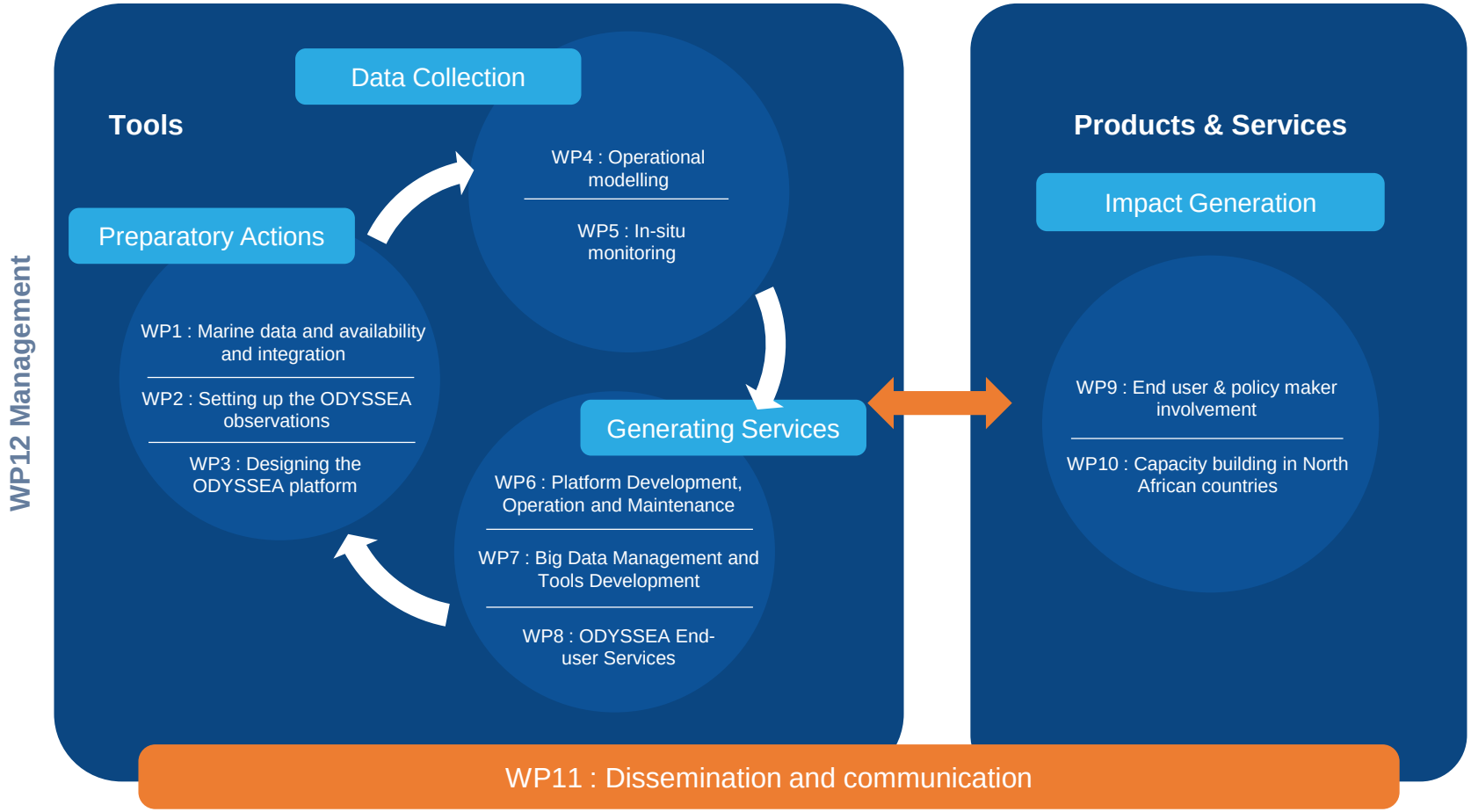
- Reducing operational costs and delays for those who use marine data
  - helping private industry compete in the global economy and meet the challenge of sustainability;
  - improving the quality of public decision-making at all levels;
  - strengthening marine scientific research
- Increasing competition & innovation amongst (re-)users of marine data by providing wider access to quality-checked, rapidly-available & coherent marine data
- Reducing uncertainty in knowledge of the Med Sea and so providing a sounder basis for managing future changes

Contribution to BLUEMED

ODYSSEA

- Provide a Med Sea Integrated Observing system as a component for GEOSS
- Contribute to increasing the temporal and geographic coverage of observational data in the Mediterranean Sea and identify observational gaps
- Provide qualified data to improve the predictive capacity of model products and improve the cost effectiveness of data collection
- Improve the knowledge base that is needed in order to cope with global challenges to make better-informed decisions within key sectors
- Improve the implementation of European maritime and environmental policies and international agreements
- Improve the professional skills and competences of those working and being trained to work within the blue economy

The ODYSSEA Work Plan



ODYSSEA Consortium

- **Knowledge developers**

DUTH (GR), FORTH (GR), Technion (IS), Sapienza (IT), Deltares (NL), IU (TR), HCMR (GR), UNIBO (IT), AUTH (GR)

- **Technology providers**

Alseamar (FR), Leitat (SP), Hidromod (PT), Develogic (GER), GTD (SP), CLS (FR), Thales (FR), Edisoft (PT), Blue Lobster (UK)

- **Policy makers**

UNEP-WCMC (UK), UNEP RAC-SPA (TUN)

- **Service Providers**

VPF (SP), AGIR (MOR), NSV (ALG), ANDDCVS (TUN), RAED (EG), EcoOcean (IS), SPNI (IS), Agora (IS)

ODYSSEA in Numbers

- 28 partners from 14 countries (6 non-EU)
- 8.398 M € budget
- 54 months duration
- Starting date 1st June 2017
- Ending date 30th November 2021
- 932 PMs in total
- 128 Researchers participating
- 7 Advisory Board members

ODYSSEA

Creating products and knowledge for the Mediterranean

ΔΗΜΟΚΡΙΤΕΙΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΘΡΑΚΗΣ | DEMOCRITUS UNIVERSITY OF THRACE

THANK-YOU

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