EGO/GROOM/JERICO Joint Glider Workshop

Session 1. Review of present/future needs for gliders in Europe
Chair: R. Onken / E. Mauri

P. Testor - Review

1.1 Scientific challenges: key hot topics, long term monitoring
1.2 Environmental challenges: MSFD/ GES, emergency response
1.3 Gliders as a new component of a European Ocean Observing System

Discussion, synthesis, conclusions → Identifying gaps and needs

Session 2: Review of existing glider facilities and technology
Chair: A. Alvarez / L. Merckelbach

2.1 Gliders: existing platforms and sensors
2.2 Workshops: ballasting, repairing, pressure testing
2.3 Ground segments: computer infrastructures (glider communications, data processing,...)
2.4 Calibration facilities
2.5 Coastal Ships

Discussion, synthesis, conclusion across Europe

Session 3. Review best practices in glider operations (one glider/fleet)
Chair: L. Beguery / C. Barrera

3. 1 L. Lucas Merckelbach and others - Glider platforms in the lab

i. Platform maintenance
ii. Sensor maintenance (CTD, optical,...)
iii. Sensor calibration and inter-calibration for glider fleets

EGO/GROOM/JERICO Joint Glider Workshop

Session 3 (follow)

3.2 A. Alvarez and others - Glider Mission

i. Mission preparation: definition and safety.

ii. Mission start/end: launching and recovering

iii. Mission control: piloting (24h/7d monitoring, interactions with scientists)

iv. Procedures used by different teams

Discussion, synthesis, conclusions

Questionnaires

3.3 S. Pouliquen and others - Glider Data Management

i. State of the art in glider data management

ii. Definition of a glider data management strategy

- How to define a glider (metadata, scientific and technical definitions)
- Real-time data (data streams during operations, how to share)
- Delayed-mode (data streams after recovery)

iii. Quality control and validation

3.4 L. Beguery and others - Glider cost analysis

Discussion, synthesis, conclusions

Session 4. Recommendations for glider contributions to a European Coastal Observatories Strategy
Chair: D. Smeed / R. Riethmuller

4.1 D. Smeed - Science: key topics to be addressed using gliders

4.2 P. Testor - Technology: future directions, operations, sensors, platforms and support

4.3 J. Tintoré - Society: contributions to: European Marine Policy, emergency response, etc.

4.4 P. Farcy - Coordination: glider contribution to a European Coastal Observatory Strategy

Discussion, synthesis, conclusions

Session 1:
Review of present/future needs for gliders in Europe

Pierre Testor
LOCEAN-IPSL, CNRS, Paris, France

Joint EGO/GROOM/JERICO Glider Workshop,
22-23 May 2012, Palma de Mallorca, Spain

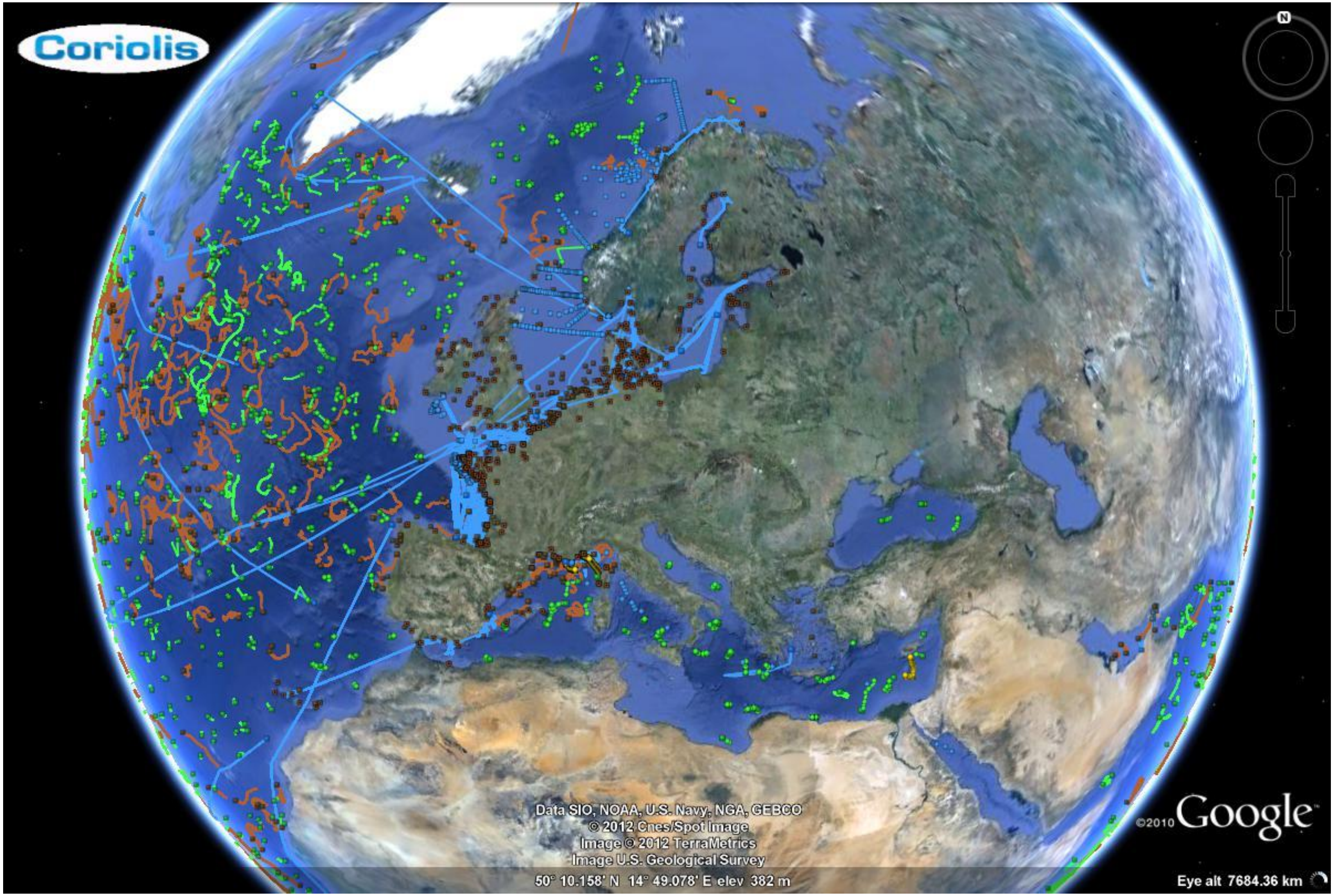
Review of present/future needs for gliders in Europe

1. **Scientific challenges: key hot topics, long term monitoring**

2. **Environmental challenges: MSFD/GES, emergency response**

3. **Gliders as a new component of a European Ocean Observing System**

Altitude 7600km - in-situ data of last month

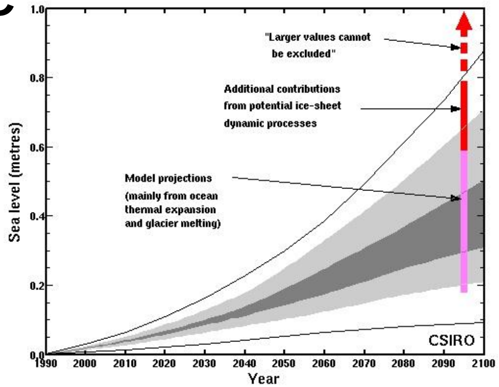


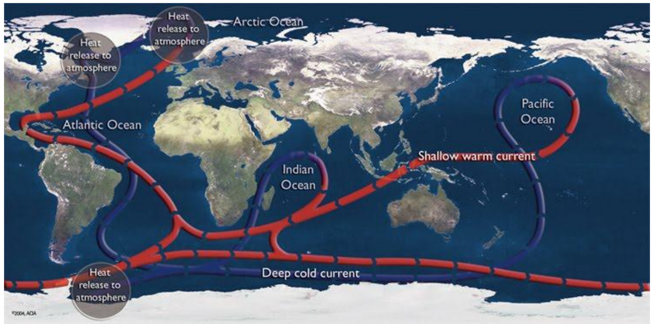
Scientific challenges: key hot topics, long term monitoring

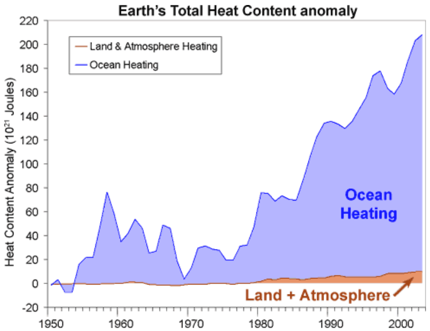
<u>Climate change</u>

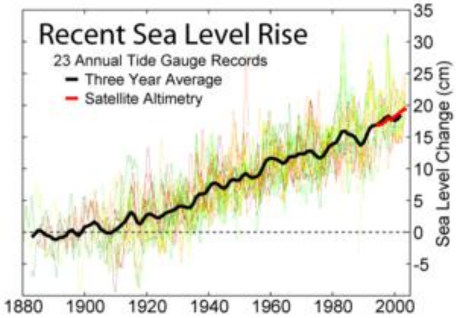
Europe: Increased risk of inland flash floods; more frequent coastal flooding and increased erosion from storms and sea level rise; glacial retreat in mountainous areas; reduced snow cover and winter tourism; extensive species losses; reductions of crop productivity in southern Europe

IPCC







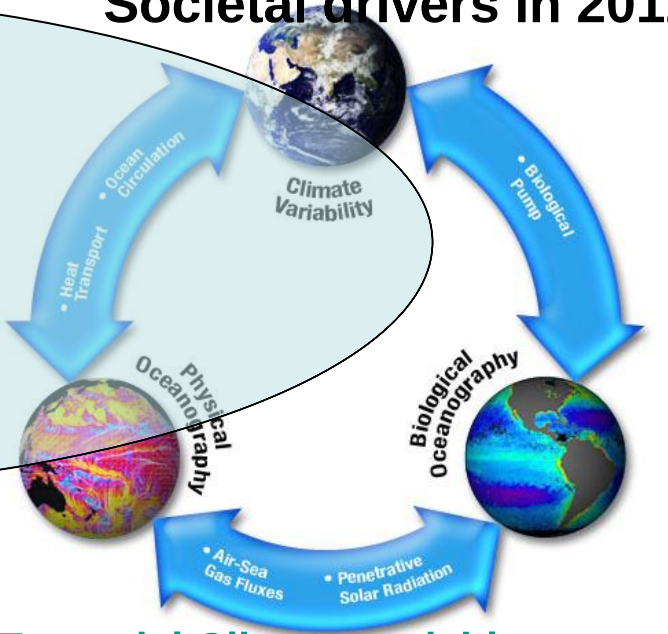


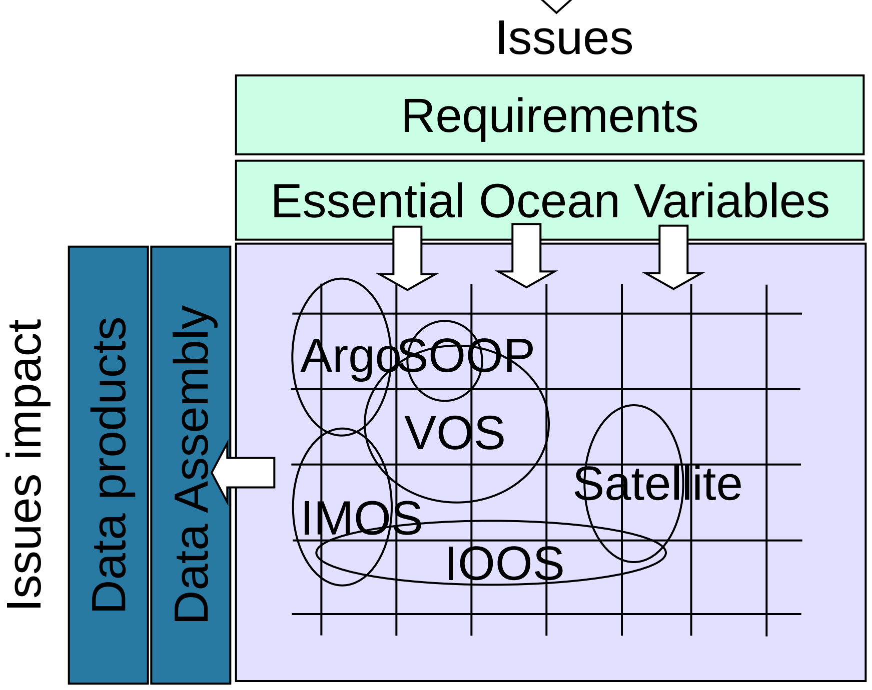
→ In situ temperature and salinity profiles
Measures of PCO2 (physical and biological pumps)

Room for gliders in the ocean observing system ?

Societal drivers in 2012

Weather & Climate
•UNFCCC/IPCC
•WCRP



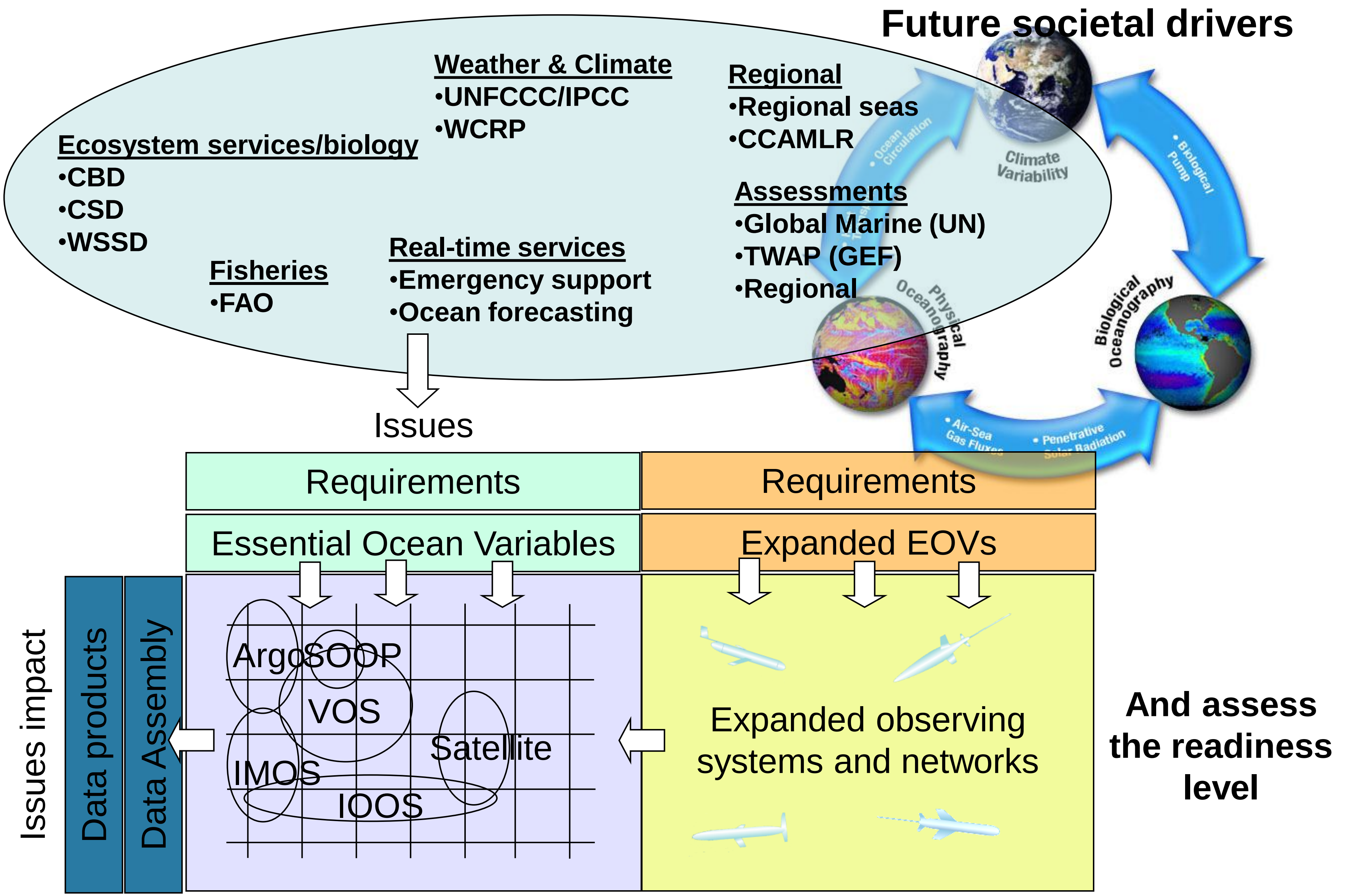


GCOS Essential Climate variables "Oceanic domain"

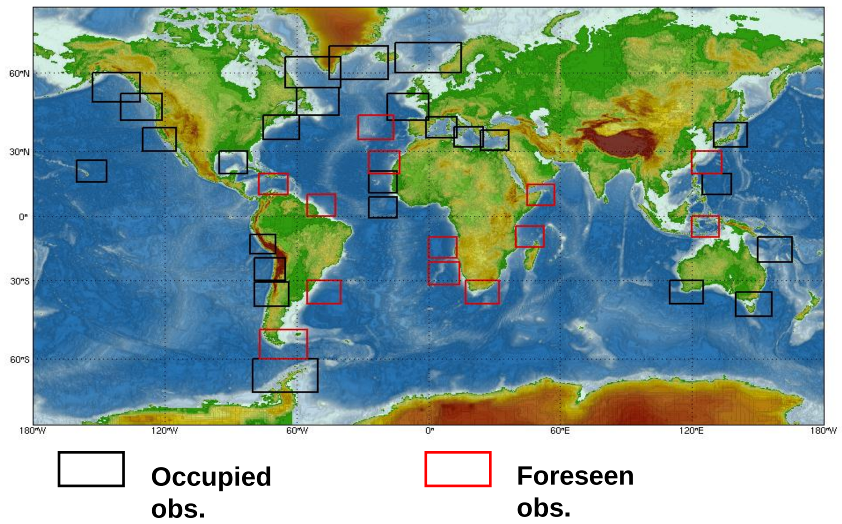
1. **Surface:** **Sea-surface temperature, Sea-surface salinity, Sea level, Sea state, Sea ice, Surface current, Ocean colour, Carbon dioxide partial pressure, Ocean acidity, Phytoplankton.**

2. **Sub-surface:** **Temperature, Salinity, Current, Nutrients, Carbon dioxide partial pressure, Ocean acidity, Oxygen, Tracers.**

Room for gliders in the ocean observing system ?



Gliders can enhance the global in-situ observing system where required



• the sites of deep and intermediate **water formation** (regional/marginal seas), so important for the functioning of the ocean (important **spring blooms**);

• the **straits** with constraints on transports (overflows,...);

• the **boundary circulations** (very energetic).
The **western** boundary region, critical for weather forecast (Cronin et al. 2009, this issue), hurricanes (Goni et al, 2009) and towards better estimates of the global ocean heat content.
The **eastern** boundary currents, very productive (upwelling) areas (Peru, African...) critical for fisheries;

• a number of **biogeochemical provinces**, **frontal areas**, and '**permanent' circulations**, to better characterize the global marine circulation/ecosystem functioning;

• the **coastal area** for cross-slope exchanges (links between the coastal environment and the open sea) and **more societal applications**.

Recommendations

- the formation of the global glider system;

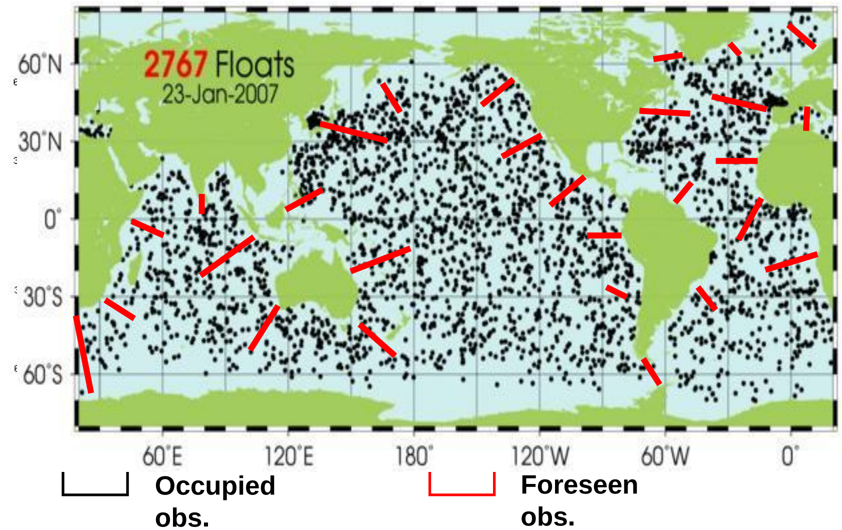
- the adoption of standards and a "ARGO" like data system for gliders;

- the target of >20 standard lines in the next 5 years and then, even more;

- the setup of a network of shared resources and expertise;

- to distinguish between climate and process and NWP objectives;

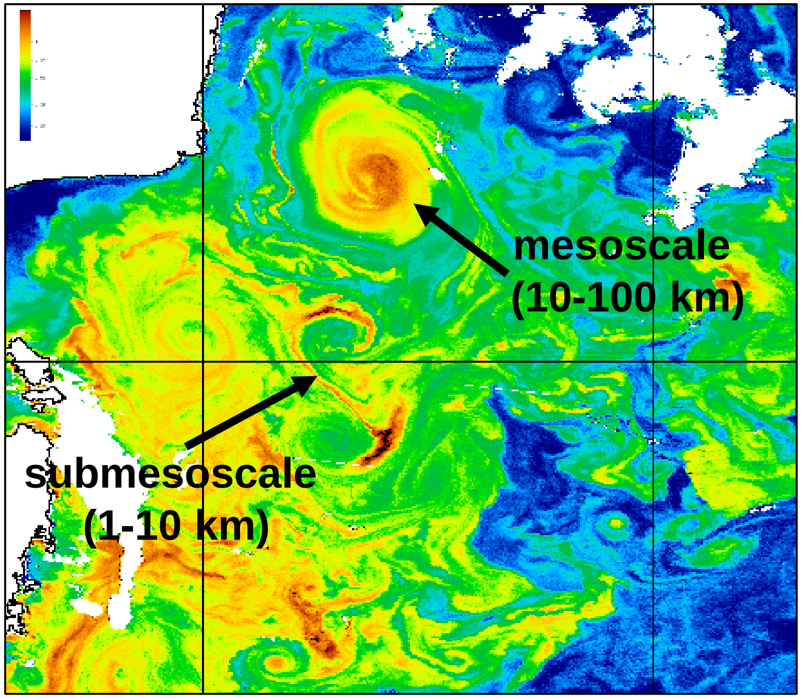
- to establish the adoption of a common and accessible portal for glider data.



International collaboration/coordination

Scientific challenges: key hot topics, long term monitoring

Satellite image sea color - surface Chl



Remote sensing from space OK, but :

- Temperature : “skin” temp. only
- Salinity : Surface only, too coarse (SMOS, AQUARIUS starting)
- Altimetry : Surface, relatively coarse and synoptic. Some models (eSQG) might allow to go deeper (but < 100s of m)
- Color : only ~1/4 of the euphotic layer and “proxy” signal only

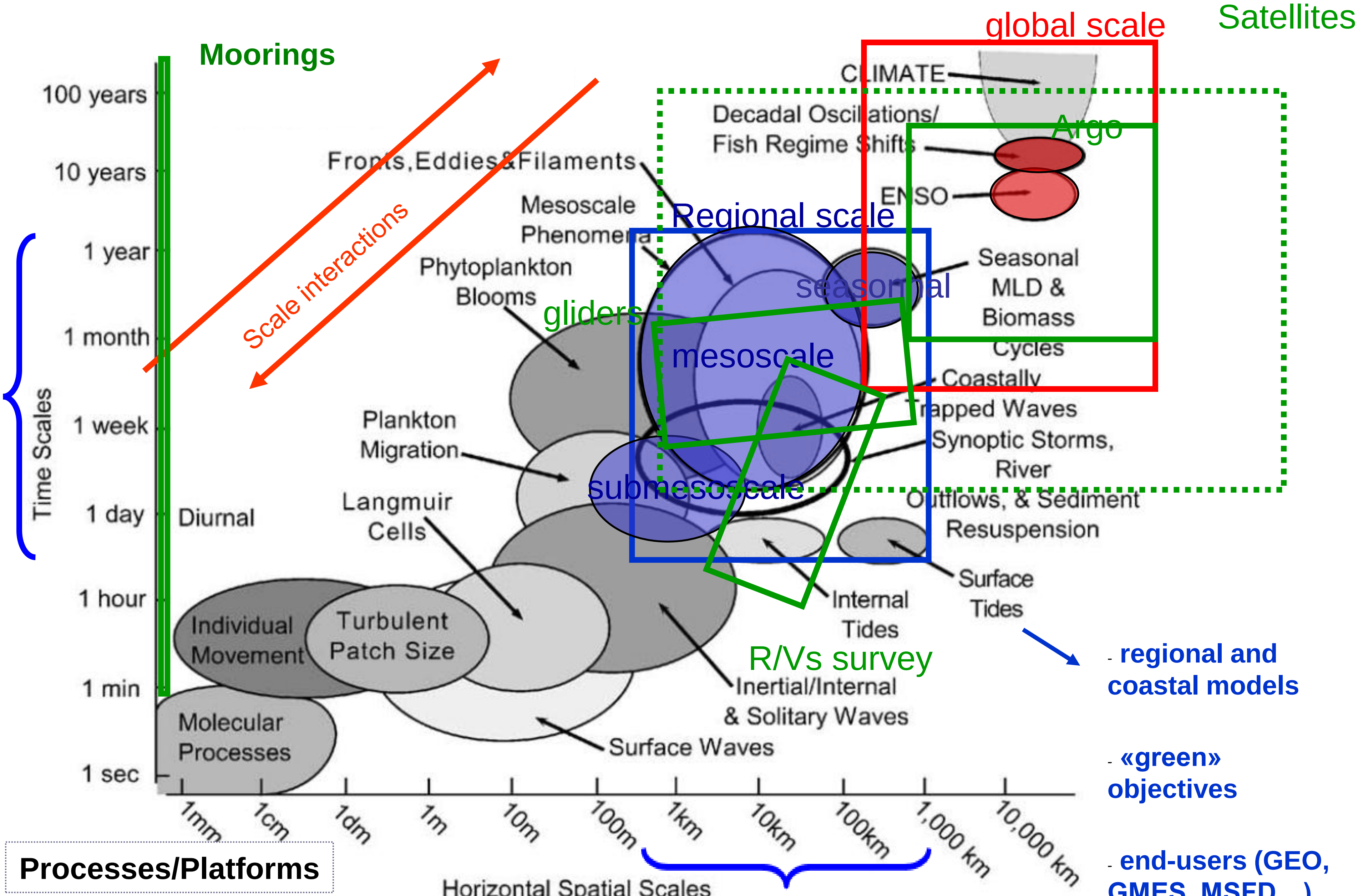
Existing in situ observations

- R/Vs : too coarse time resolution (WOCE like), expensive
- Moorings : too coarse space resolution
- VOS/SOOP : Surface only. Useful but large space/time gaps
- Argo : fine but space (and time) resolution too coarse

Need for better multiparameter characterization of the vertical structure at mesoscale and submesoscale of the ocean for :

- Climate research,
- Process studies (turbulence, ocean convection, overflows, …)
- Coupling with primary production and carbon
- Higher trophic level
- Operational models (global and regional)

A «network» of observation (all platforms) and new sensors



- **regional and coastal models**
- **«green» objectives**
- **end-users (GEO, GMES, MSFD…)**

Processes/Platforms

Marine Strategy Framework Directive (MSFD)

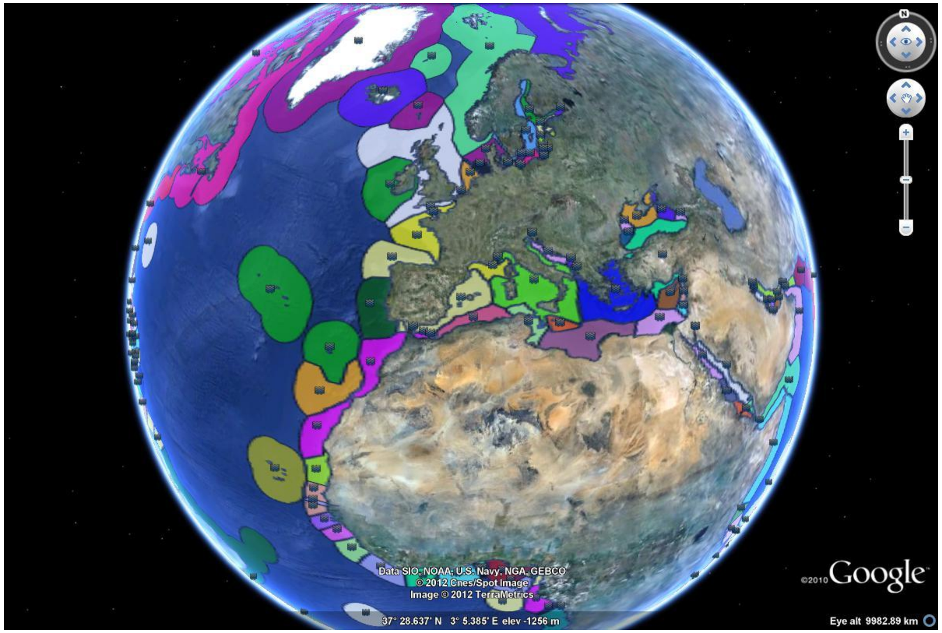
The Marine Strategy Framework Directive (MSFD) adopted in July 2008 aims at achieving or maintaining a <u>good environmental status</u> by 2020 at the latest.

It is the **first legislative instrument in relation to the marine biodiversity policy** in the European Union, as it contains the explicit regulatory objective that "biodiversity is maintained by 2020", as the cornerstone for achieving good environmental status.

It enshrines in a legislative framework the **ecosystem approach to the management of human activities having an impact on the marine environment**, integrating the concepts of environmental protection and sustainable use.

In order to achieve the objective the Member States have to **develop Marine Strategies** which serve as **Action Plans** and which apply an ecosystem-based approach to the management of human activities**.**

An important point is the regional cooperation required at each stage.



Marine Strategy Framework Directive (MSFD)

Qualitative descriptors for determining GES (Annex I)

(1) Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.

(2) Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems.

(3) Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock.

(4) All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.

(5) Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters.

Marine Strategy Framework Directive (MSFD)

Qualitative descriptors for determining GES (Annex I)

(6) Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.

(7) Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems.

(8) Concentrations of contaminants are at levels not giving rise to pollution effects.

(9) Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards.

(10) Properties and quantities of marine litter do not cause harm to the coastal and marine environment.

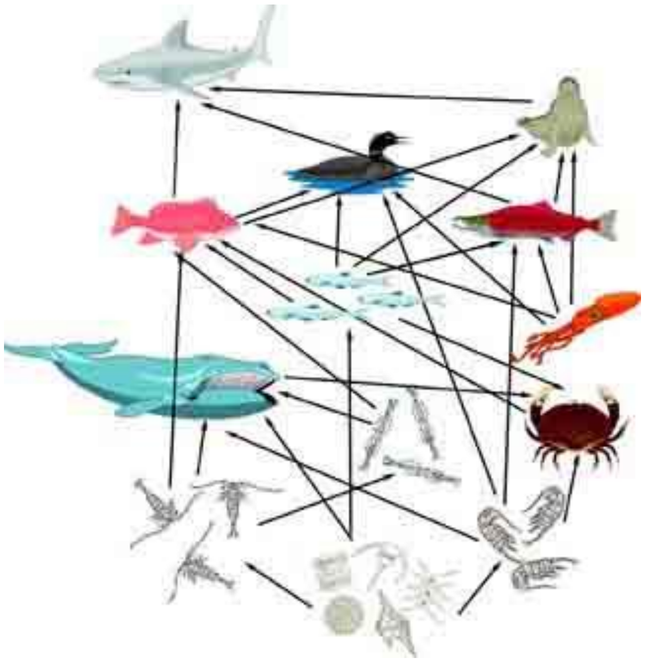
(11) Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.

Marine Strategy Framework Directive (MSFD)

Descriptor 7: **<u>Permanent alteration</u> of hydrographical conditions does not adversely affect marine ecosystems**

Need to monitor the hydrographical conditions 

Compare with marine ecosystems health ? 



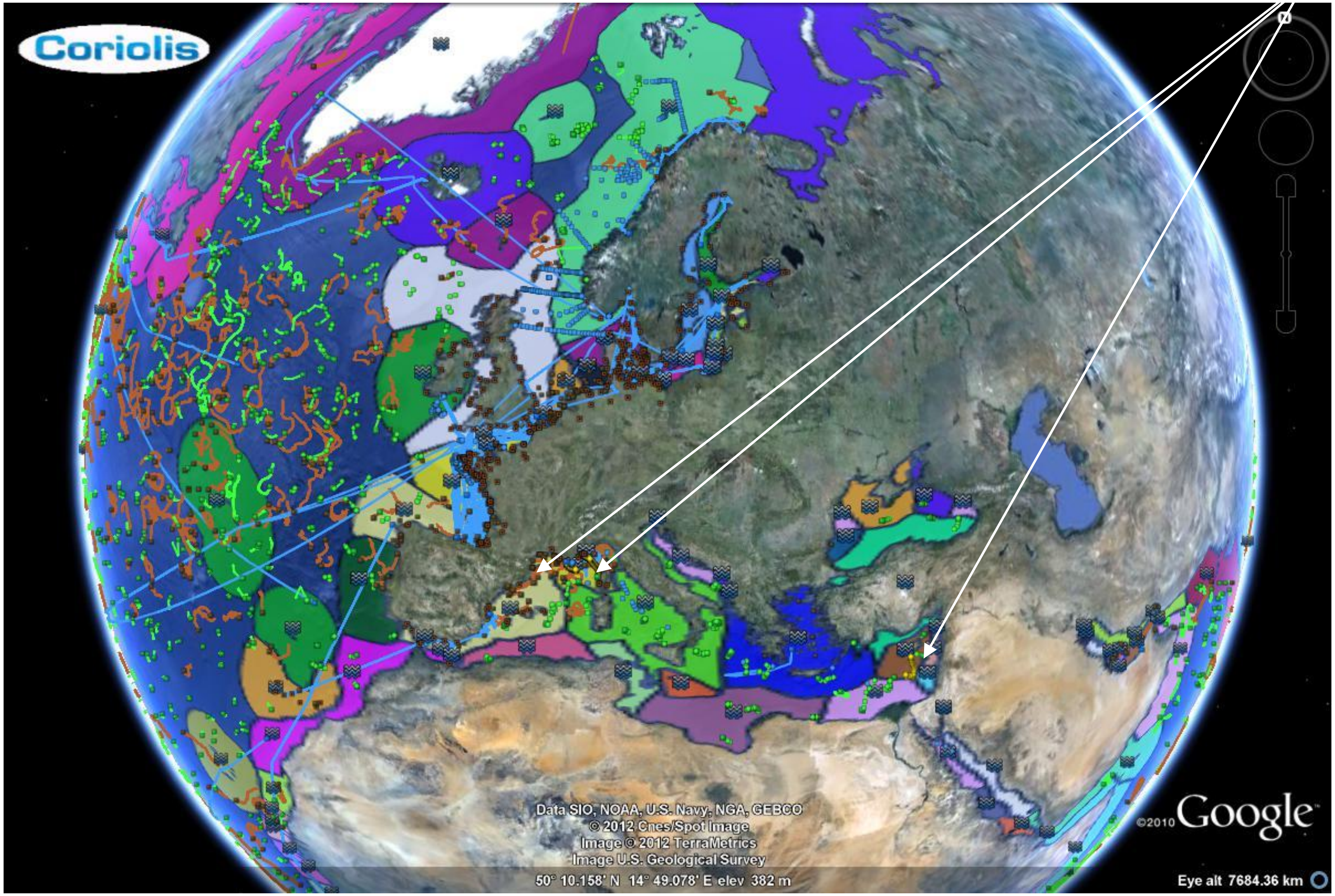
Need to make products useful for biologists who study the food webs!

<u>Essential Ocean Variables:</u>
Currents (U,V,W?)
Temperature
Salinity
(…)

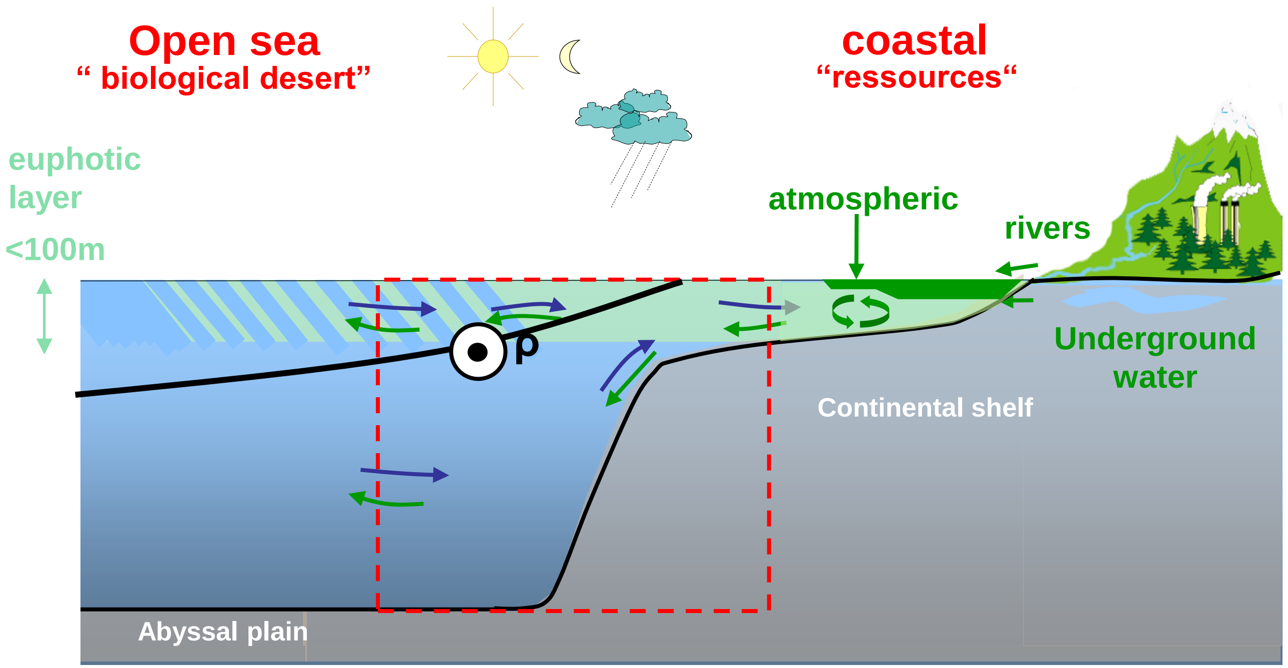
Marine Strategy Framework Directive (MSFD)

WFD (littoral) -> MSFD (eez)

Data collected last month -> not that much in the EU-EEZs except when gliders



Cross-slope exchanges and variability



Exchanges of energy and m atter acoss the continental slope, impacts on ecosystems

physical

open sea ⇄ coastal

[Mariano et al., 2003]

biogeochemical

Open sea→ ressources

coastal→ anthropic impact

- ✓ **up/downwellings** **(local wind)**
- ✓ **atmospheric forcing at large scale** **(wind and buoyancy flux)** **modifications of the open sea circulation**
- ✓ **continental water inputs** **(fresh and nutrient-rich)**
- ✓ **formation of dense waters on the shelf and « cascading »**
- ✓ **Tides, internal waves**

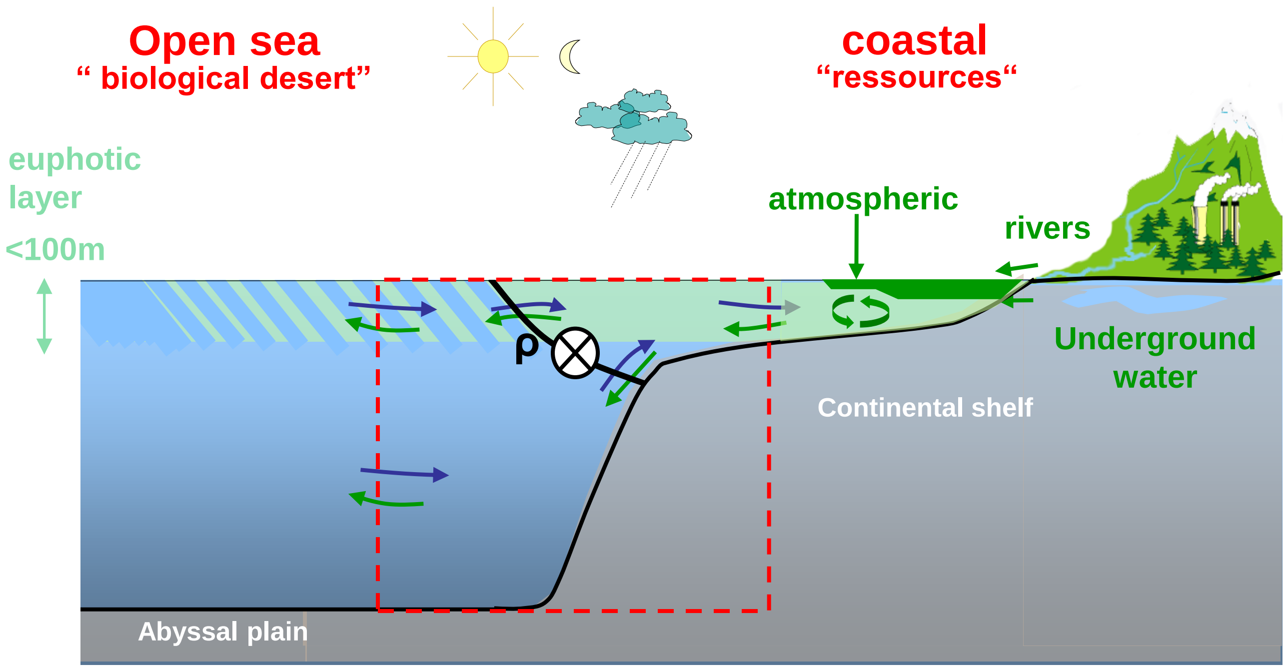
State of the art :

← **displacements of the interface**

+

Oceanic turbulence horiz./vert. mixing

Cross-slope exchanges and variability



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- ✓ continental water inputs (fresh and nutrient-rich)
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- ✓ Tides, internal waves

State of the art :

displacements of the interface

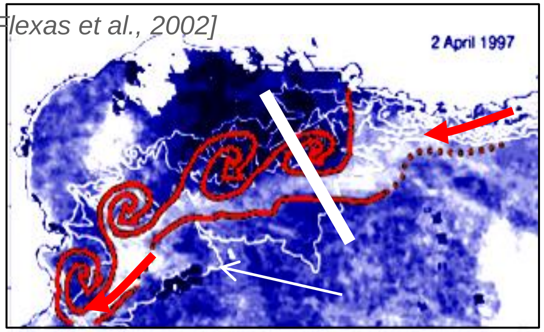
+

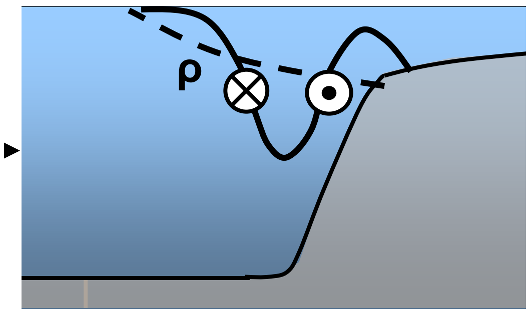
Oceanic turbulence horiz./vert. mixing

Mesoscale on the slope

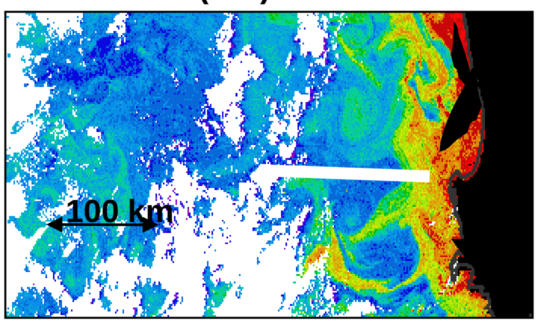
satellite image – SST Gulf of Lion

[Flexas et al., 2002]

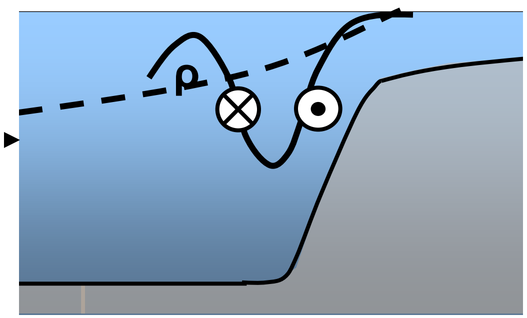




Ocean color (Chl)



3D structure of meanders, eddies, filaments
interactions with topography (canyons)



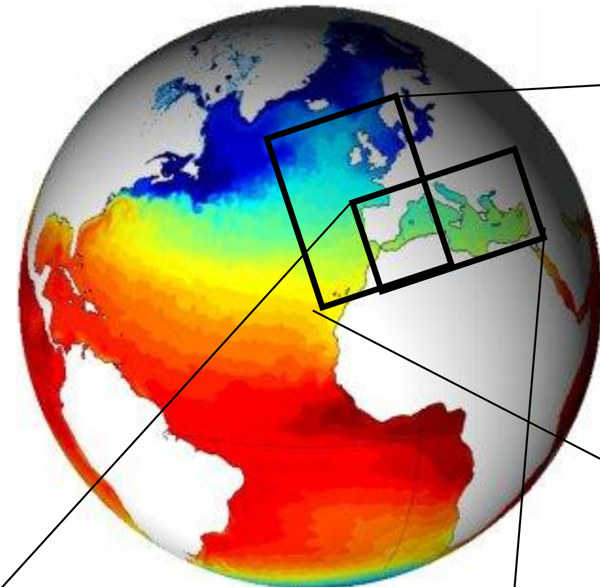
Need to better monitor EOVs over the water column.
At relatively fine scale (time and space) to avoid aliasing.

cross-slope exchanges and their impact on ecosystems

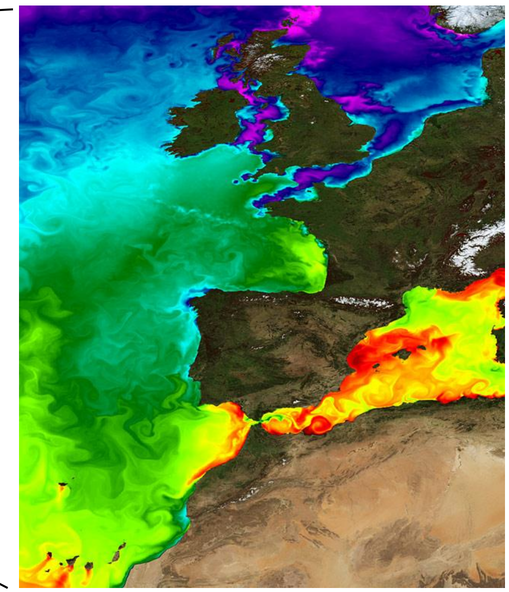
Numerical analysis and forecast

Nested models for regional aspects
More societal applications

Development of “green” models

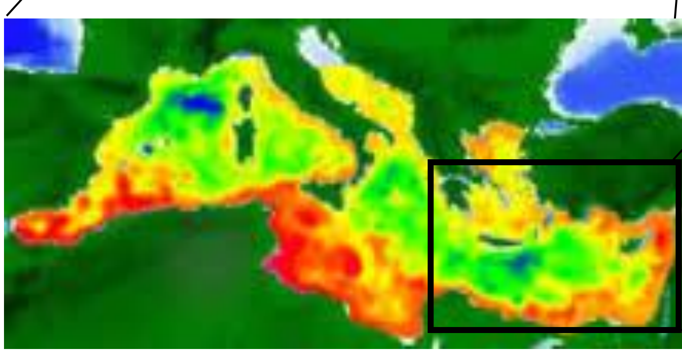


MERCATOR

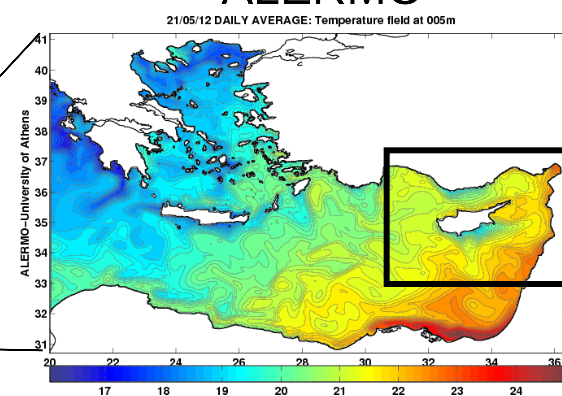


examples

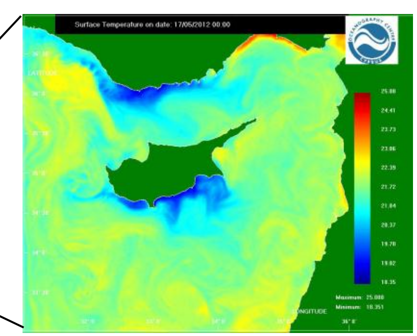
MFS



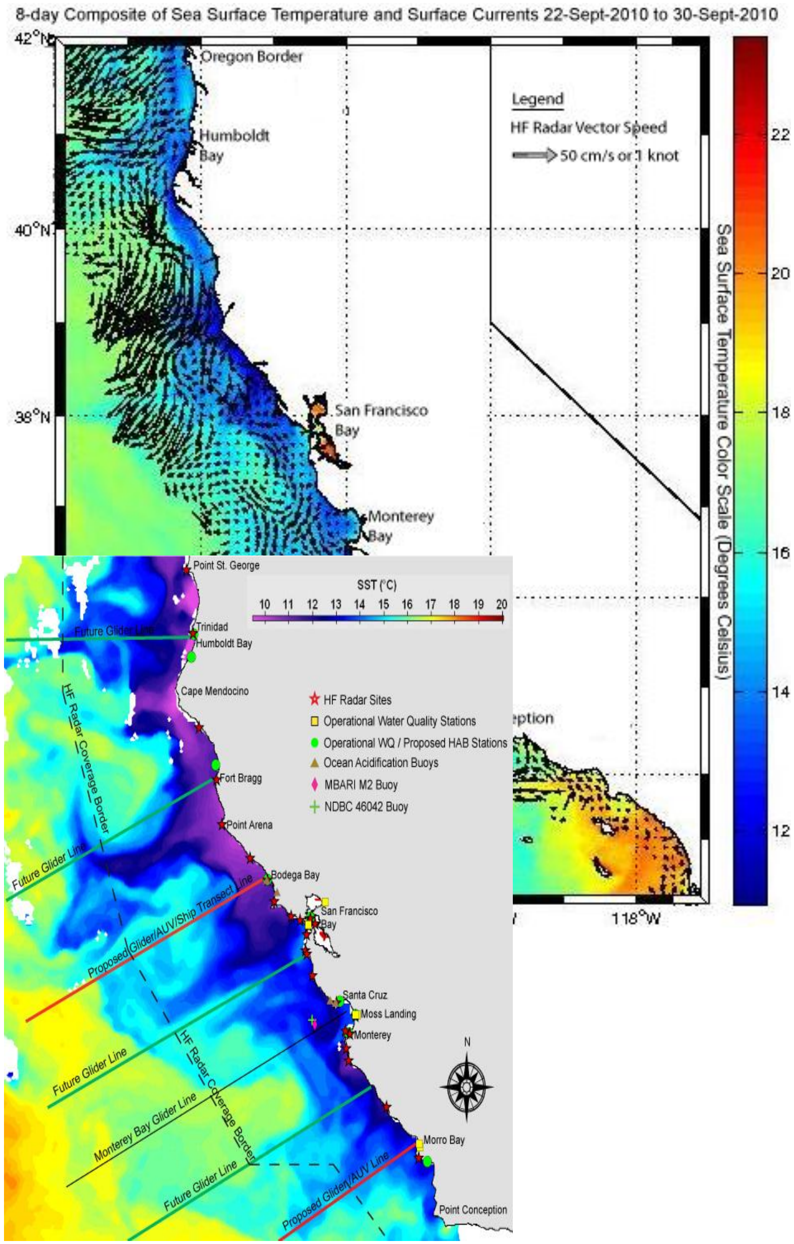
ALERMO



CYCOFOS

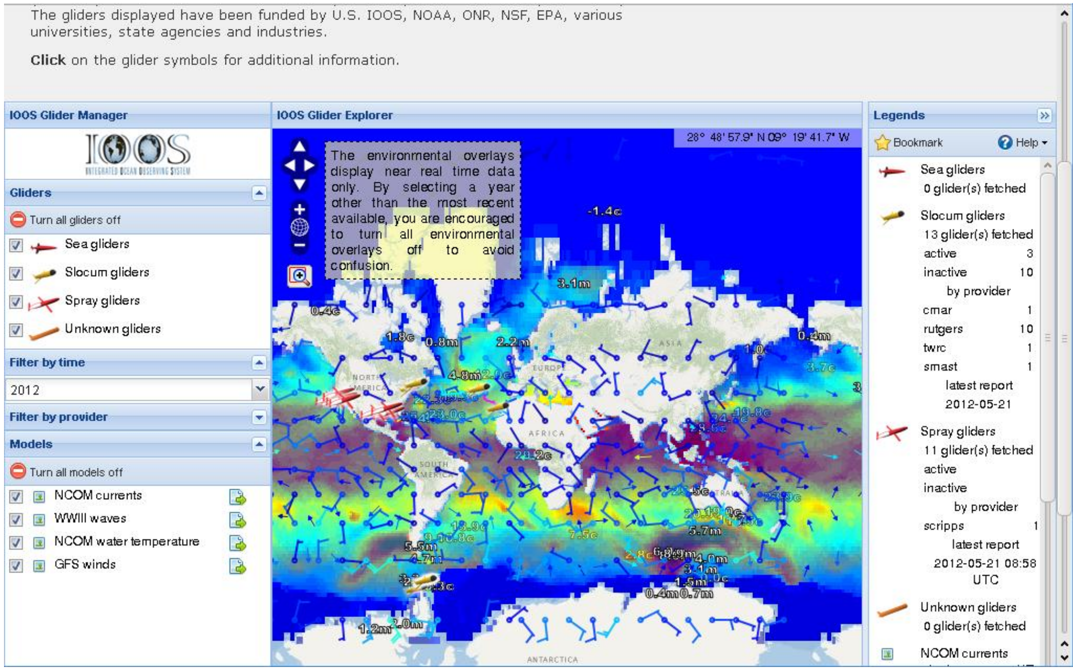


IOOS example



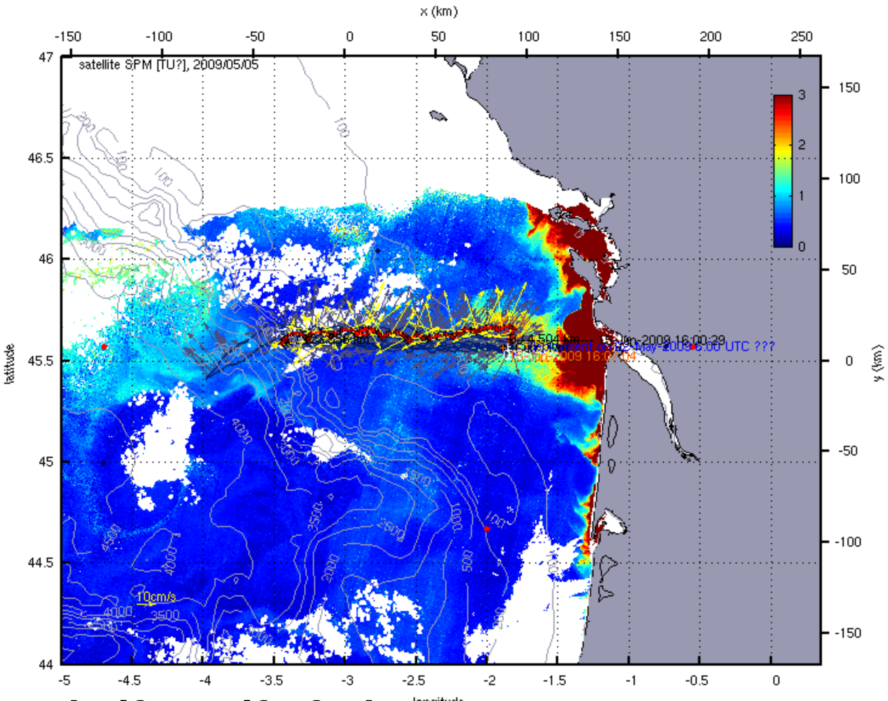
Integrated Ocean Observing System (USA)

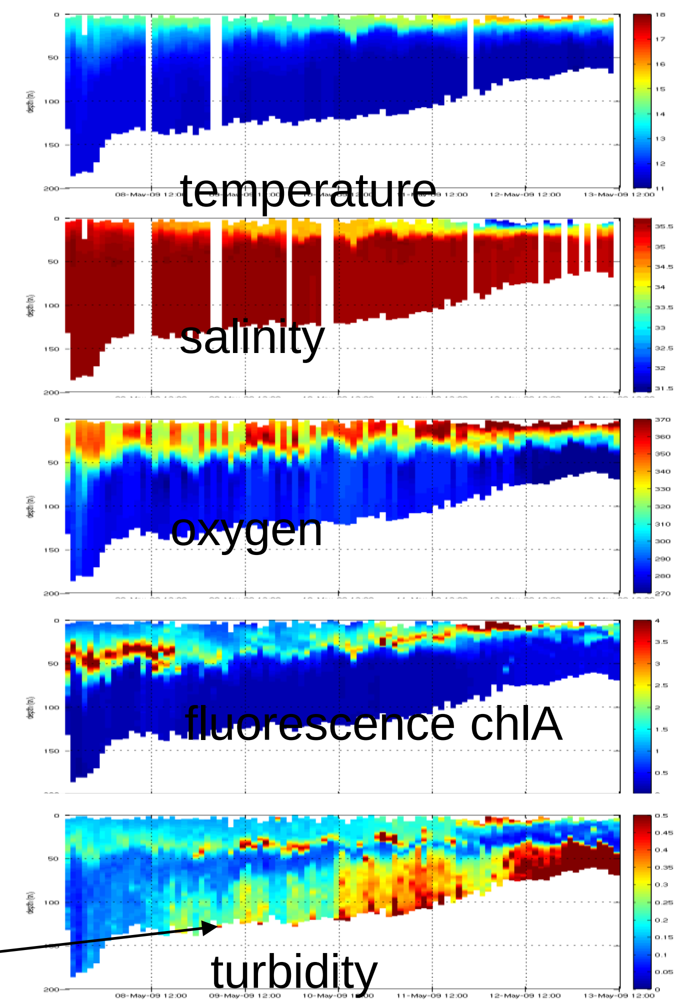
Important glider component



Gliders equipped with bio-sensors

Descriptor 5: **Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters.**



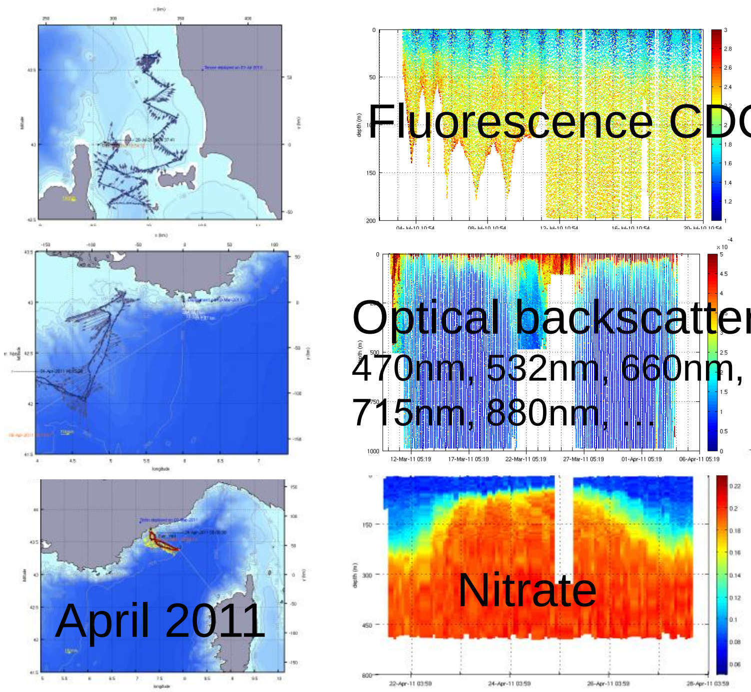


shelf - Gulf of Biscaye
River Gironde (very) fresh waters dispersal
Strong tides

CAROLS/GOGASMOS experiment 2009/05
8 sections of ~150km (5-6 days)
~1.5 month

Tidal front

Gliders equipped with bio-optical sensors



ISUS/Suna :

1. **Parameter not measured enough while crucial for biogeochemical studies (input for primary production + light -> photosynthesis).**

2. **integration on gliders: submesoscale, physique-biological coupling, increase of data collection**

pH ?

PCO2 ?

Phosphates ?

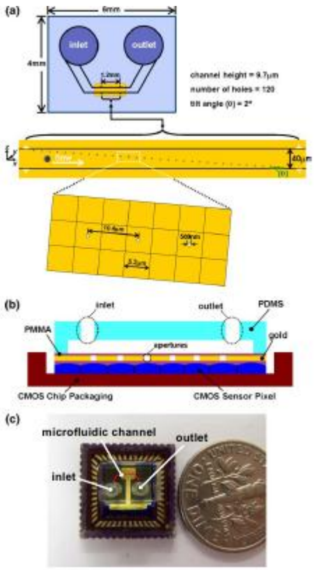
…

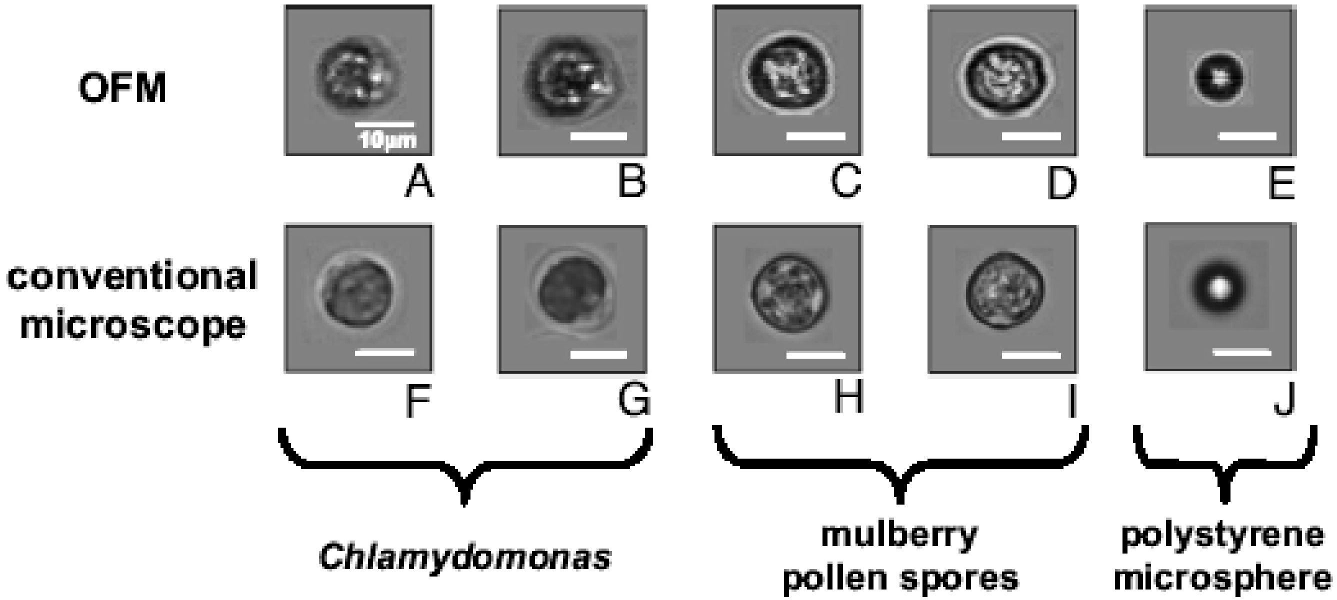
Gliders equipped with video

imagery

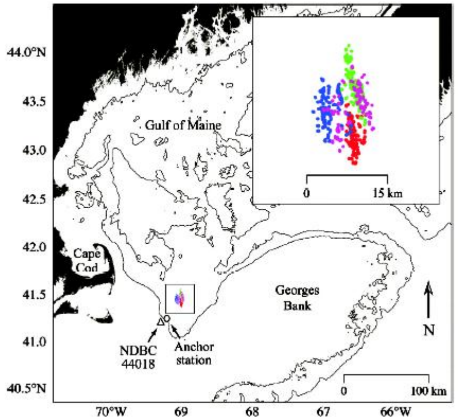
<u>camera</u>
based on the PVM developed at LOV.
→ jelly fishes watch

<u>Microscope 0.01 mm</u>
→ counts, populations descriptions





Gliders equipped with passive/active acoustics



Baumgartner & Fratantoni (2008)

hydrophones

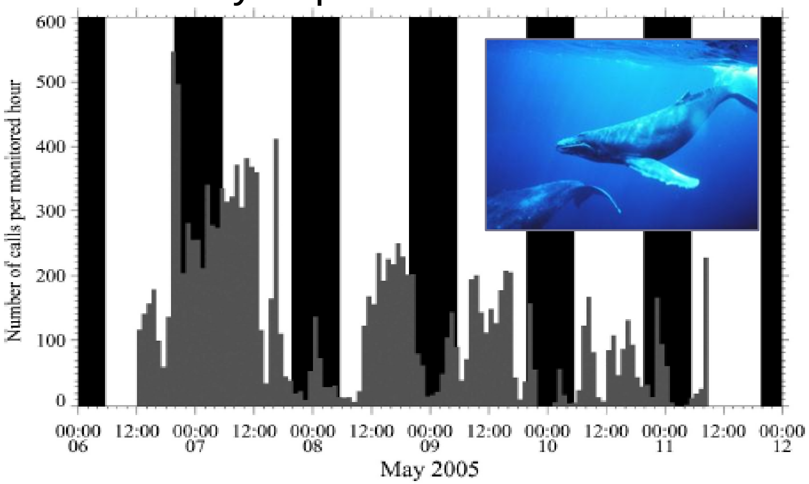
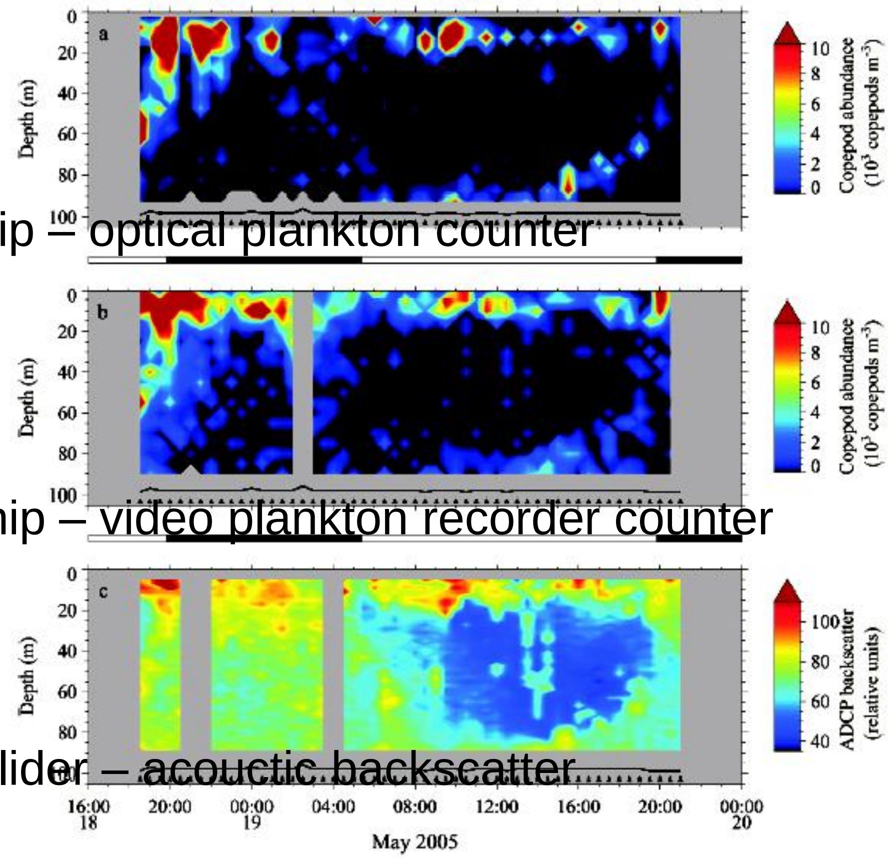


Fig. 6. Hourly sei whale call rates observed by the gliders. Times on the abscissa are local, and dark background bands indicate nighttime.



Ship – optical plankton counter

Ship – video plankton recorder counter

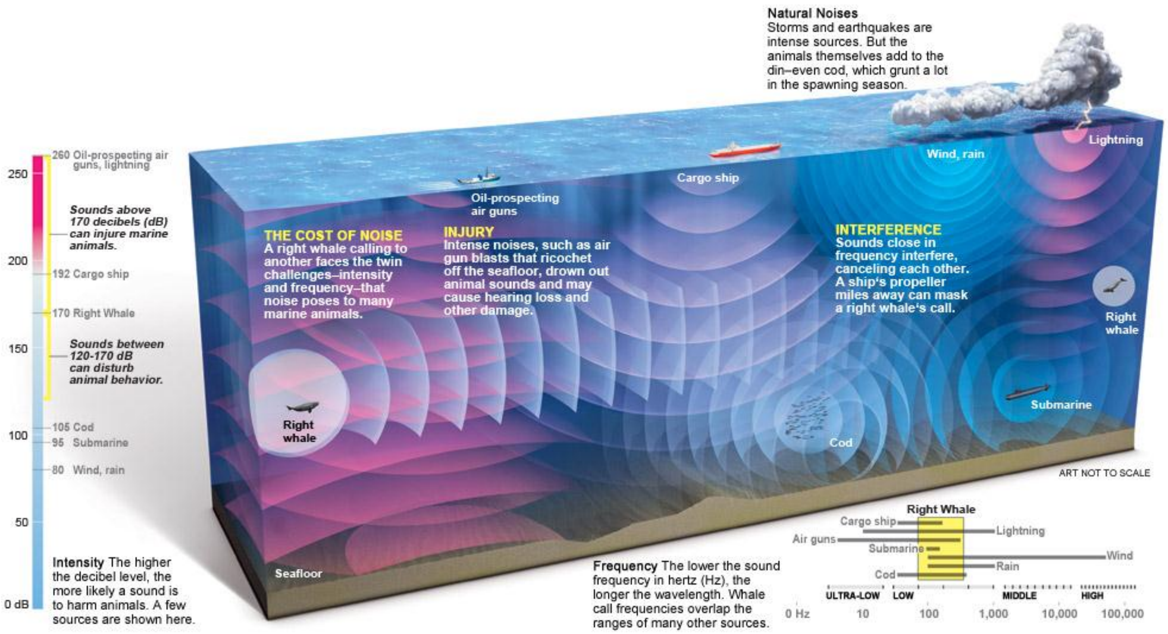
Glider – acouctic backscatter

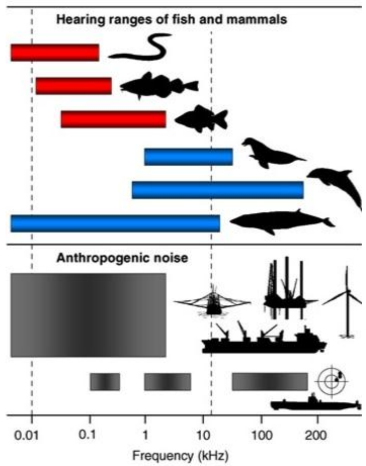
Fig. 7. Collocated observations of copepod abundance and acoustic backscatter at an anchor station in the Great South Channel during the corroborating study conducted aboard the NOAA ship *Albatross IV*. (a) Late-stage *Calanus finmarchicus* abundance estimated with an optical plankton counter using the calibration equation of Baumgartner (2003). (b) Large copepod abundance estimated with a video plankton recorder. (c) Acoustic backscatter from an identical 1-MHz acoustic Doppler current profiler to that deployed on glider WE04. Triangles denote profile times, and the dark black line at the bottom of each plot indicates the seafloor. Times on the abscissa are local. The bars between each panel indicate day (white) and night (black). Missing data attributable to instrument malfunction.

Zooplancton
Distributions, vertical migration

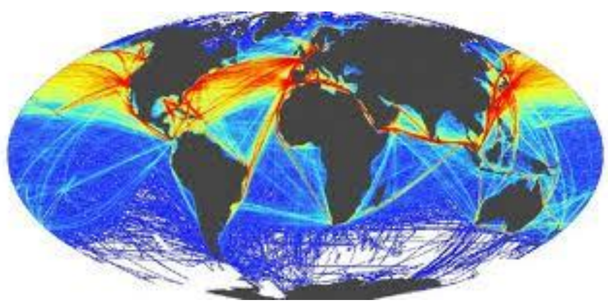
Gliders equipped with hydrophones?

Descriptor 11: **Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.**



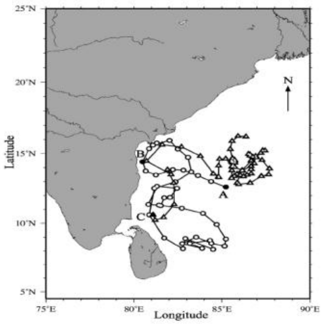


anthropogenic noise



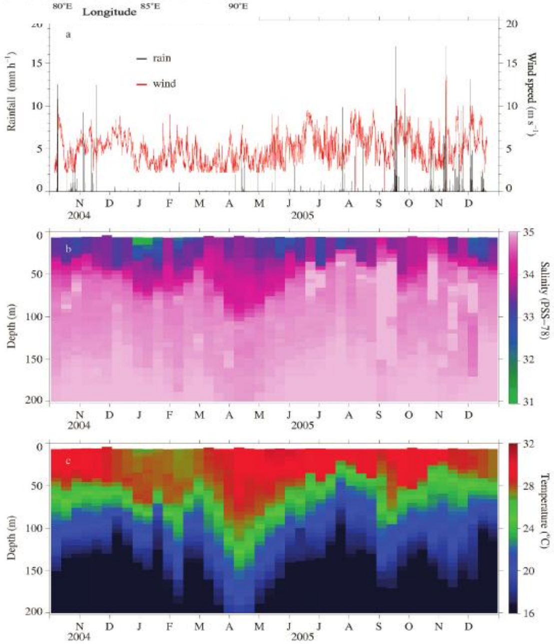
Gliders equipped with hydrophones?

+ applications in meterology:



hydrophones WOTAN (Weather Observation Through Acoustic Nois

Riser et al. (2008)



- demonstrated on profiling floats
- intensity of the surface wind and précipitations

Colocated with vertical profiles (mixed layer, air-sea fluxes …)

Project NOISE (CNES) started to equip gliders

+ applications in sismology?

Gliders = scalpels for oceanographers

- Diagnostic only ! Non-intrusive
- Vertical sections in the upper (0-1000m) ocean
- Measurements of various parameters (physical, biogeochemical)

Environmental challenges to meet:
Maritime Strategy Framework Directive
Emergency response

Context of Global change

To better understand/predict:

1) the role of the ocean in the Climate
2) the marine ecosystem (marine resources management)

To address:

3) security issues related with marine activities (search and rescue, oil spills,…)

CH4, PAH (polycyclic aromatic hydrocarbons) sensors ?

The European glider fleet -> EU Ocean Observing system

Today
European fleet of gliders today
~ 60 gliders

- OC-UCY (cy), AWI (de), IFM-GEOMAR (de), IMEDEA (es), PLOCAN (es), LOCEAN, LOV, LPO (Fr), OGS (It), UIB (no), NOC (uk),…
- "Gliderports" all around

More than 300 in total in the world
but only < 20-30 gliders
at the same time at sea

Everyone's (European) Gliding Observatories - historic

USA, Canada, Australia, EU,…
Global glider community: scientific/technical, academics + manufacturers

Europe

- **2004 first glider deployments in Europe**
- **5 EGO meetings and Glider Schools**

  Series of workshops and training with increasing audience
- **International experiments with fleets (6-10)**

  EGO2007, EGO2008, EYE, TROP-ATL
- **First sustained observatories with gliders**

  SOCIB, MOOSE, YPOKINOYMODA, (RAPID), …
- **OceanObs'09 White Paper**

  the role of gliders in the global ocean observing system (next decade)
- **COST Action ES0904 "EGO"**

  Network to coordinate scientific and technical activities and to help new comers
- **FP7 GROOM Design study**
- **FP7 JERICO**
- **FP7 PERSEUS, ACOBAR**

USA, Australia, Canada, …

- **The Pioneers : WRC (RU/WHOI), SIO, UW**

  3 gliders commercially available since 2002-2003
- **IMOS : Australian National Facility for Ocean Gliders (ANFOG)**

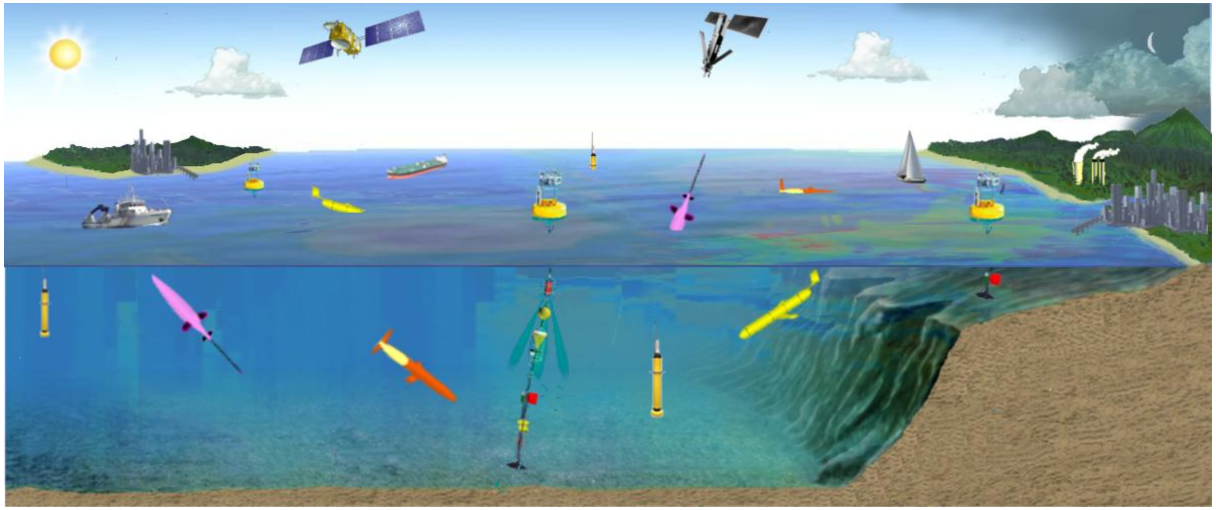
  Strong integration with other systems. Contribute to the Australian marine climate research needs
- **Canadian Centre for Ocean Gliders (CCOG)**
- **NOAA et al. : IOOS**

  Operationally-focused
- **NSF : Ocean Observing Initiative**

  Research-focused, to be merged to IOOS

GROOM: "Gliders for Research, Ocean Observation and Management"

demonstrate and design



- a distributed architecture of "gliderports" around the European seas and overseas is **the required and cost effective way to operate fleets gliders** in the combination with existing observing systems,
- this infrastructure is suitable to deploy, maintain and operate fleets of gliders continuously for **operational monitoring and research**,
- such an infrastructure can provide a world-class service to the research and environment monitoring communities

→ Done in **the framework of existing/future RIs** : EuroARGO, JERICO, EuroFleet, EuroSITES, …
→ Link with IMOS (**ANFOG, Aus.**), IOOS (**USA**), …

GROOM

WP1: scientific coordination – WP6: management

WP coordinator UPMC

WP2: Integration in the GOOS

WP coordinator GEOMAR

- assessment of a glider component in the GOOS
- Legal framework
- Financial framework

WP3: Scientific Innovation

WP coordinator OGS

- New contributions of gliders to marine research
- Data flow and processing
- capacity building and training, outreach

WP4: Targeted Experiments

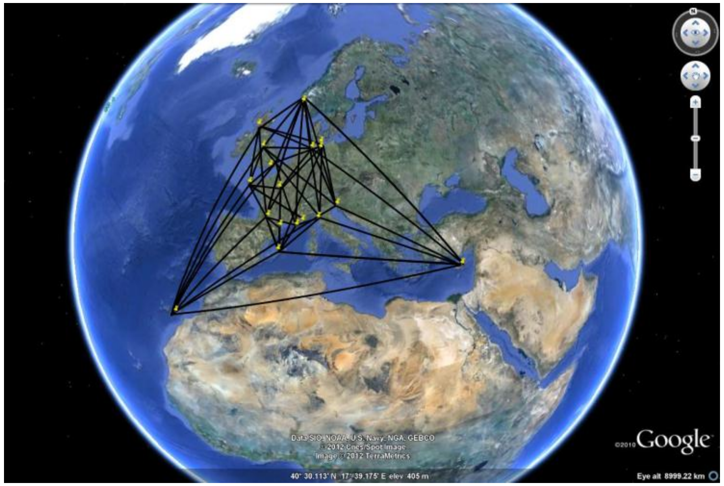
WP coordinator UEA

- Endurance lines
- Fleet missions
- Synergies with other platforms

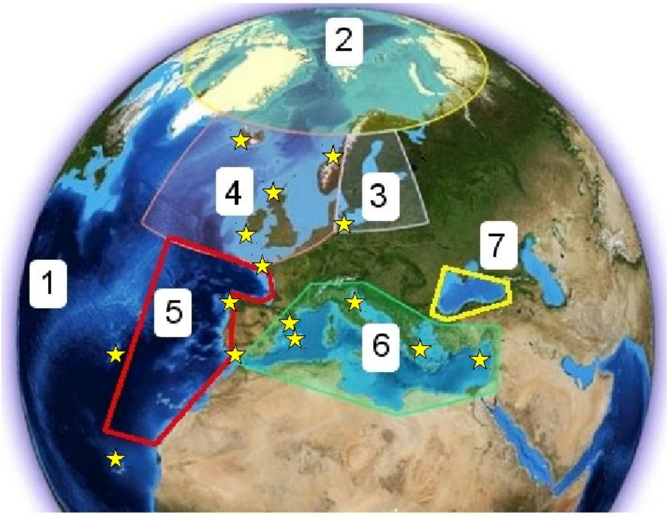
WP5: Observatory Infrastructure

WP coordinator UCY

- Ground segment description
- Glider payload assessment
- Mission planning and analysis
- Estimated setup and running costs



GROOM



ROOSes considered by MyOcean :

- Global ocean
- Arctic Sea (Arctic ROOS)
- Baltic Sea (BOOS)
- Atlantic European North West Shelf Ocean (NOOS)
- Atlantic Iberian Biscay Irish Ocean (IBI-ROOS)
- Mediterranean Sea (MOON and Med-GOOS)
- Black Sea (Black Sea-GOOS)
- European possible “gliderports” are indicated yellow stars.

GROOM will bring solutions for :

- **Integration within the existing observing systems in the ROOSes**
- **Support for (and from) MyOcean operational models, global and regional and National/local Operational services** → WP2

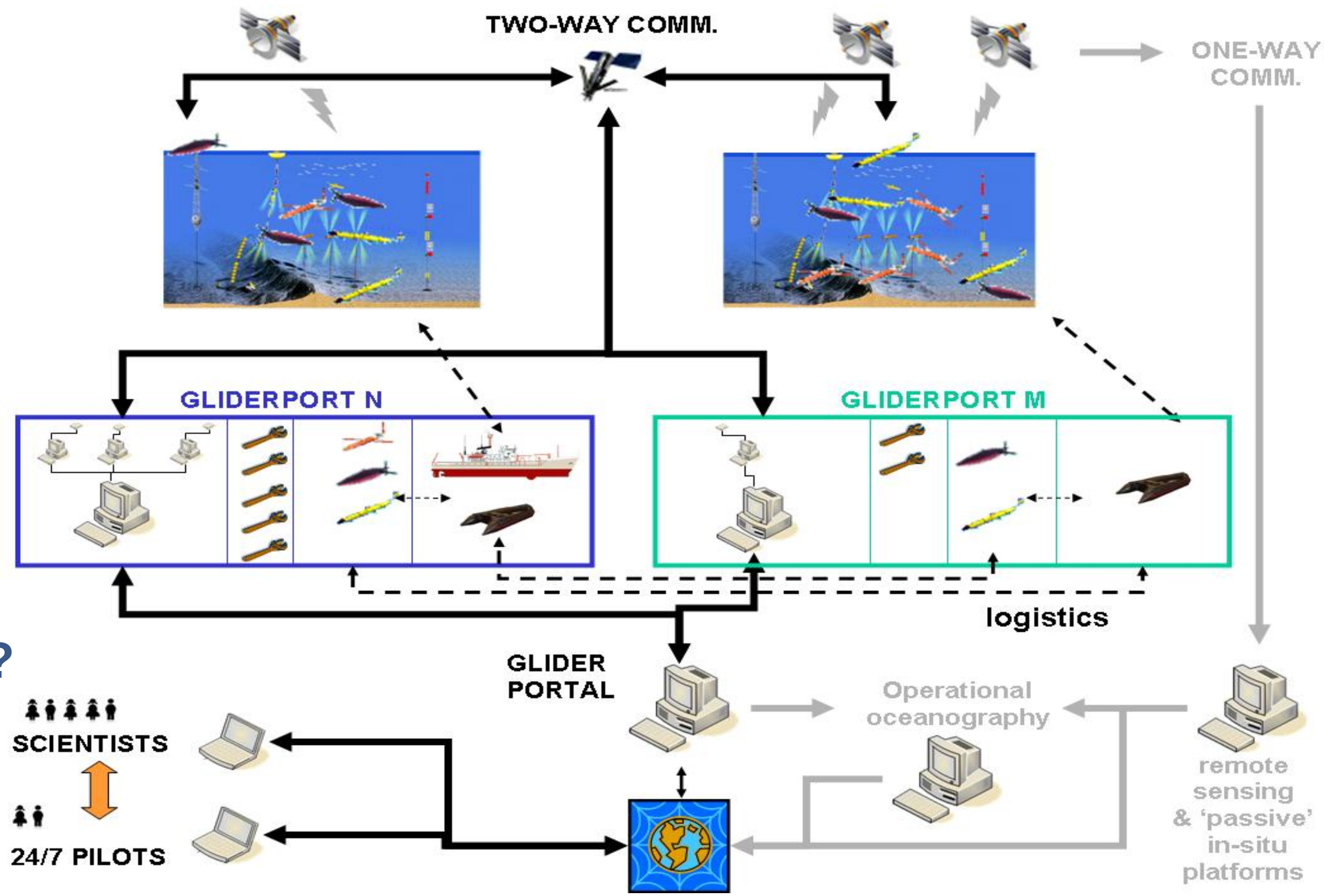
• Such an infrastructure will have to stimulate and not stifle all the creative applications of the glider technology !!! → WP3

• Perform/analyze targeted experiments - demonstration → WP4

• Inventory of existing and design of the required infrastructure → WP5

GROOM: design of "gliderports"

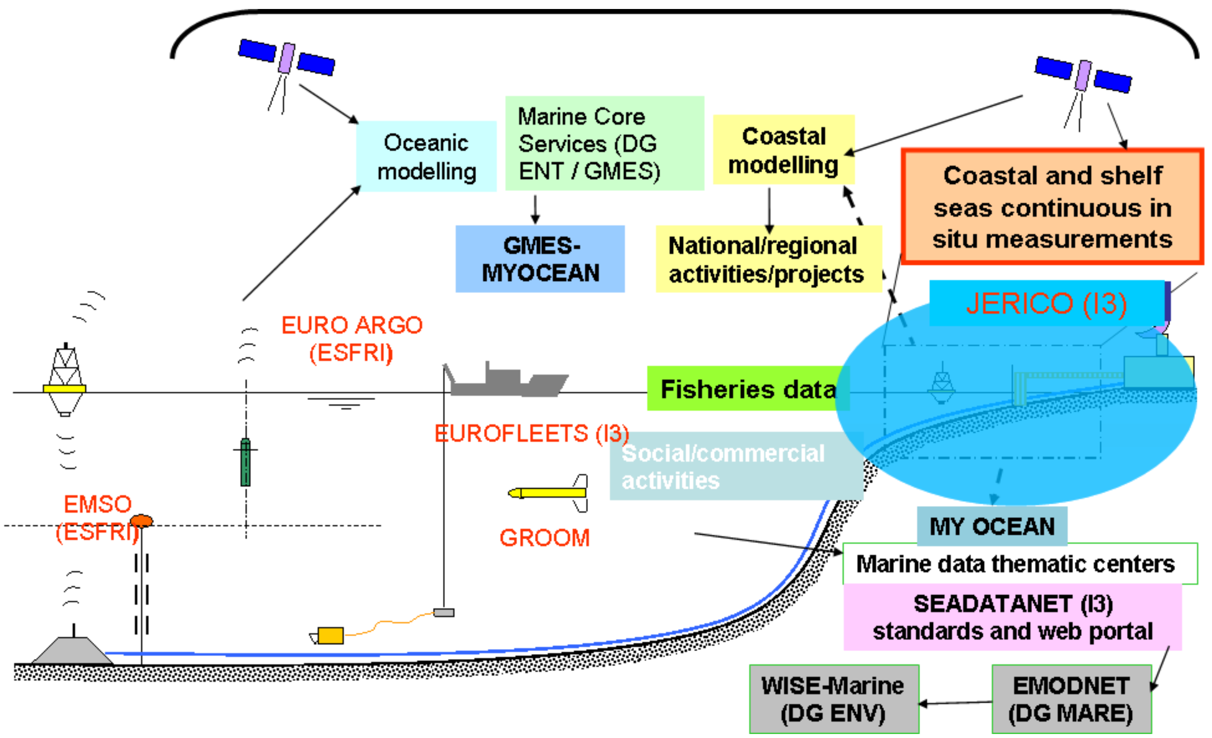
How to organize and manage the flow of platforms and of information ??



- Infrastructure of several "gliderports" (communication and computer resources, workshops for maintenance and development, pools of gliders, sea-access)
- Integration of the two-way communication capabilities
- 24/7 pilot organization and methods to steer the glider fleets

JERICO: "Joint European Infrasctructure network for Coastal Observations"

EC umbrella (directives, policies, communications)



- Enhanced the coordination between existing coastal observatories
- Propose common procedure from the sensor to the data quality assessment
- Enlarge the network with new partners
- Prepare for the future European Network of operational coastal observatories

JERICO

Networking activities (NA)

- **WP1 : A common strategy, including definition and implementation aspects**
  - WP coordinator INSU + Ifremer & NIVA
- **WP2 : Strengthening regional aspects**
  - ROOS aspects and inter regional interfaces (IMR – BOOS)
- **WP3 : Harmonizing technological aspects**
  - Observing systems : fixed station, ferrybox, gliders (HZG)
- **WP4 : Harmonization operation and maintenance methods**
  - Fouling, calibration, maintenance and costs (HCMR)
- **WP5 : Data distribution (Seadatanet and MyOcean)**
- **WP6 : Public outreach and education (CEFAS)**

TNA & JRA

- **WP7 : Service Access (SA) to the data**
- **WP8 : Trans National Access**
- **WP9 : OBSERVING SYSTEM DESIGN**
  - How to optimize the network : OSE, OSSE
- **WP10 : IMPROVE THE SYSTEM COMPONENTS**
  - monitoring of key biological compartments and processes .
  - Developments and implementation on new platforms of physico-chemical sensors
  - Emerging technology : profiler, ship of opportunity (Recopesca, CANOE)

JERICO: WP3 - Harmonizing technological aspects

- To provide a common base for the operational use of FerryBox, **glider**, fixed platforms along European coasts
- To review the current status of existing systems in operational use in European seas
- To define the best technical practices for compatible, robust and cost-effective systems
- To define procedures for harmonizing and merging quality assessed Platform data at regional (ROOS) level
- To define procedures and technological solutions for integration and testing of new sensors on these systems.

:

3.2 Gliders (CSIC – IMEDEA)

- Review on current status of glider operations in Europe with EGO network → GROOM
- Define the best practices for gliders operation, in coastal areas (close to GROOM 5.4 <u>but QA not QC</u>)
  . Mission preparation, energy supply
  . Sensor housing and characteristics
  . Quality control
- Strategy for operation in shallow water …

JERICO: WP8 - transnational infrastructure network

Review of present/future needs for gliders in Europe

Discussion, synthesis, conclusions → Identifying gaps and needs

Coffee break!

Joint EGO/GROOM/JERICO Glider Workshop,
22-23 May 2012, Palma de Mallorca, Spain