

# Digital Ocean Forum#2

June 14-15, 2023

## Key Outcomes



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## Versions of the document

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## EXECUTIVE SUMMARY

The annual Digital Ocean Forum events are an opportunity to showcase how the EU Digital Twin Ocean (henceforth EU DTO) activities are moving forward, getting structured from the initial concept to the present organization. After the April 20-21, 2022, Digital Ocean Forum#1 in Paris which was stressing out the need for co-design and collaboration across the marine and EU research community to build the EU Digital Twin Ocean (EU DTO), the 2<sup>nd</sup> edition of the Digital Ocean Forum#2, that took place in Brussels on June 14-15 2023, is building a step further on the construction of the EU Digital Twin Ocean: it allowed to inform a large number of EU research projects about what the EU DTO core infrastructure is and how they may contribute and use it. It was also a place to define together with all the EU research project attending, the service offer to be provided by the EU DTO core infrastructure.

The development of the EU DTO core infrastructure has been entrusted to the entrusted entity of the Copernicus Marine Service and the central portal operator of the European Marine Observation and Data Network (EMODnet), respectively Mercator Ocean International and the Flanders Marine Institute (VLIZ), through the EDITO-Infra project. Its sister project, EDITO-Model Lab, is also part of this revolutionary endeavor, with the responsibility to develop the next generation of ocean numerical models by combining artificial intelligence and high-performance computing to provide access to focus applications and simulations of different what-if scenarios.

More than 50 projects representing scientists, users, and ocean communities have gathered and worked together on June 14-15, 2023, in Brussels to co-design and co-create the EU DTO, to ensure that it best serves the wider community. They have all engaged in forward looking discussions on progress so far, in understanding the EU DTO core infrastructure offer -through the EXPLORE, CREATE and CONTRIBUTE options- and in the potential evolution and impact of the EU DTO.

Next 2024 Digital Ocean Forum#3 edition that will take place in Brussels in 2024 (date TBC), will allow to take one step further, with a first Proof-Of-Concept of the EU DTO and its demonstration.

## THE DIGITAL OCEAN FORUM#2

After the April 20-21, 2022, Digital Ocean Forum#1 in Paris, the 2<sup>nd</sup> edition of the Digital Ocean Forum#2 took place in Brussels on June 14-15, 2023. Next 2024 Digital Ocean Forum#3 shall take place in Brussels in 2024 (date TBC) I.

For its 2<sup>nd</sup> edition, the European Commission's Directorate-General for Research (DG RTD), Directorate-General for Maritime Affairs and Fisheries (DG MARE), Mercator Ocean International and VLIZ have invited about fifty EU research projects to the 2nd Digital Ocean Forum on June 14-15, 2023.

The first day on June 14 was an in-person workshop under invitation only for EU research projects, while the second day on June 15 was a public and hybrid event. **The present document mainly reports on the first day workshop.**

A main function of the Digital Ocean Fora is the co-design and co-creation of the European Digital Twin of the Ocean (henceforth EU DTO), by defining together its main ground principles, functionalities, assets, and specifications.

As the EU DTO is to be formed by all possible existing and collaborating projects, the 2023 Digital Ocean Forum edition had a particular focus on EU research projects, to get their views on how they see the development of the EU DTO and how they could contribute to it.

About fifty EU research projects (see list below of the EU research projects attending) accepted the invitation and were part of this exercise to participate to the thematic Working Group discussions on 14 June 2023, 13:30 – 18:00 CET in the DG RTD premises in Brussels (CDMA, SDR-1 (DG RTD), Rue du Champ de Mars 21, 1040 Brussels).

All projects were also invited to the June 15 high-level public and hybrid event, taking place from 9:00 – 13:00 CET at the Auditorium Breydel (BREY, DG GROW), Av. d'Auderghem 45, 1040 Brussels (see slides [here](#) for June 14 and [here](#) for June 15).

The agenda of the June 14, 2023, workshop was the following:

| <b>June 14 2023</b>   |  |  |
|---|--|--|
| <b>13:30 – 18:00 CET in the DG RTD premises in Brussels</b>         |  |  |
| <b>CDMA, SDR-1 (DG RTD), Rue du Champ de Mars 21, 1040 Brussels</b> |  |  |
| Time  | Title  | Speaker  |
| 14:00 – 14:10   | Welcome and opening words  | Elisabetta BALZI, Head of Unit, Healthy Seas and Ocean –DG RTD<br><br>Andreea STRACHINESCU, Head of Unit, Maritime Innovation, Marine Knowledge and Investment- DG MARE. |
| 14:10 – 14:30   | The Mission Ocean and the EU DTO Vision<br>Objectives of the meeting<br><i>Questions from the audience</i>               | Nicolas SEGEBARTH, Policy Officer, Healthy Seas and Ocean –DG RTD<br><br>Zoi KONSTANTINOOU, Policy Officer, Maritime Innovation, marine knowledge & investment –DG MARE  |
| 14:30 – 15:25   | DOF 1 Outcomes (15mn)<br><br>The DTO Offer – (30mn)<br><br>Questions from the questionnaire and the audience (10mn)      | Alain ARNAUD (EDITO-Infra project Manager, Mercator Ocean International)   |
| 15:25 – 15:30   | Introduction to the working groups   | Alain ARNAUD (EDITO-Infra project Manager, Mercator Ocean International)   |
| 15:30 – 16:30   | Breakout I: DTO co-construction<br>Data   Model   Ocean Intelligence   Innovation & Digital component                    | All  |
| 16:30 – 17:00   | <i>Break</i>   |  |
| 17:00 – 17:45   | Breakout II: DTO impact<br>Blue Ocean   Biodiversity, Marine Environment & Conservation   Decision-making   Blue Economy | All  |
| 17:45 – 18:00   | Return in plenary<br>Short reporting of the discussion<br>Closing the day followed by reception                          | Nicolas SEGEBARTH, Policy Officer, Healthy Seas and Ocean –DG RTD<br><br>Zoi KONSTANTINOOU, Policy Officer, Maritime Innovation, marine knowledge & investment –DG MARE  |

The June 15 public and hybrid event can be re-watched on the [Digital Ocean Forum webpage](#). [Presentations](#) and a [Q&A](#) are also available. The agenda for the June 15 public event was the following:

|  |
|--|
| <p>Digital Ocean Forum part I<br/>9:00 – 13:00 CET at the Auditorium Breydel (BREY, DG GROW), Av. d'Auderghem 45, 1040 Brussels<br/><b>June 15 2023, 9:00 – 10:25</b></p>  |
| <p><b>09:00 - 09:25</b><br/>Welcome and opening words - The Mission Ocean and the EU DTO Vision</p> <ul style="list-style-type: none"> <li>• <b>Kestutis Sadauskas</b>, Deputy Director General (DG MARE) and Mission Manager</li> <li>• <b>Pascal Lamy</b>, Chair of the Mission Ocean Board (remotely)</li> </ul> <p><b>09:25 - 09:45</b><br/>The EU DTO, a co-creation endeavour, to the service of ocean actors</p> <ul style="list-style-type: none"> <li>• <b>Alain Arnaud</b>, Director of the Digital Ocean Department, EDITO-Infra</li> </ul> <p><b>09:45 – 09:55</b><br/>Interoperability with Destination Earth</p> <ul style="list-style-type: none"> <li>• <b>Charalampos Tsitlakidis</b>, Policy Officer DG CNECT</li> </ul> <p><b>09:55 – 10:15</b><br/>Reporting workshop outcomes</p> <ul style="list-style-type: none"> <li>• <b>Francisco Hernandez</b>, Technical Director Flanders Marine Institute, EDITO-Infra</li> </ul> <p><b>10:15 – 10:30</b><br/>Questions and discussion</p>  |
| <p>Digital Ocean Forum part II<br/>15 June 2023<br/>11:00-12:30</p>  |
| <p><b>11:00 - 11:45</b><br/>Roundtable I - (EU) DTO(s): a game changer but for what, whom, and how?</p> <ul style="list-style-type: none"> <li>• Moderator: <b>Peter Heffernan</b>, Mission Ocean Board Member</li> <li>• Panellists:</li> <li>• <b>Martin Visbeck</b>, GEOMAR Helmholtz-Centre for Ocean Research &amp; lead UN Decade DITTO programme (remotely)</li> <li>• <b>Corine Lochet</b>, French Naval Hydrographic and Oceanographic Service (remotely)</li> <li>• <b>Caroline Bocquel</b>, CEO Irish Sea Fisheries Board</li> <li>• <b>Andrea Taramelli</b>, Senior Scientist Istituto Superiore per la Protezione e la Ricerca (remotely)</li> </ul> <p><b>11:45 - 12:30</b><br/>Roundtable II - EU DTO: Societal aspects, ethics, and responsibility</p> <ul style="list-style-type: none"> <li>• Moderator: <b>Zoi Konstantinou</b>, DG MARE</li> <li>• Panellists:</li> <li>• <b>Alice Vadrot</b>, Mission Ocean Board Member, Associate Professor University of Vienna</li> <li>• <b>Stephen Parkinson</b>, Grant and Innovation Coordinator EarthWatch (remotely)</li> <li>• <b>Nicolas Pade</b>, Executive Director EMBRC-ERIC and Coordinator Marco-Bolo project</li> <li>• <b>Olivia Gambelin</b>, Ethical Intelligence (remotely)</li> <li>• <b>Sheila Heymans</b>, Executive Director European Marine Board (remotely)</li> </ul> <p><b>12:30 - 13:00</b><br/>Conclusions and closing remarks</p> <ul style="list-style-type: none"> <li>• <b>John Bell</b>, Director Dir Healthy Planet (DG RTD) and Deputy Mission Manager</li> </ul> |

**Resources:**

- **Video** <https://www.youtube.com/watch?v=SgnaEoYS8Fo&t=22s>
- **Contact:** [contact@edito.eu](mailto:contact@edito.eu)
- **EU DTO website :** [European Digital Twin of the Ocean \(European DTO\) \(europa.eu\)](http://europa.eu)
- **Digital Ocean Forum#2 slides:** see slides [here](#) for June 14 and [here](#) for June 15
- **Subscribe to the EDITO newsletter** [here](#).



## DAY1- JUNE 14, 2023- PLENARY OUTCOMES

### 2.1 Welcome and Opening Words

Elisabetta Balzi, Head of Unit, Healthy Seas and Ocean - DG RTD and Andreea Strachinescu, Head of Unit, Maritime Innovation, Marine Knowledge and Investment- DG MARE, warmly welcomed the audience.

They recalled the context of the European Digital Twin Ocean that was announced by President von der Leyen at the One Ocean Summit in Brest in February 2022. Its ambition is to make ocean knowledge readily available to citizens, entrepreneurs, scientists and policymakers by providing them with an innovative set of user-driven, interactive and visualization tools. This knowledge will help design the most effective ways to restore marine and coastal habitats, support a sustainable blue economy and mitigate and adapt to climate change.

They also recalled that the Digital Twin of the Ocean is a main element of the Digital Ocean Knowledge System under the EU Mission [Restore our Ocean and Waters](#).

It is also a priority in many different initiatives such as the International Ocean Governance, the UN Decade of Ocean Science for Sustainable Development, the All-Atlantic Ocean Research Alliance and the G7 working group Future of the Seas and Oceans Initiative which the EU contributes to.

The European DTO, also builds on the EU [Digital Agenda](#), will be interoperable with Destination Earth and will benefit from the upcoming initiative to increase transparency in European Ocean Observation.

Ms Balzi and Ms Strachinescu also noted that it is the first time that such a large number of EU research projects meet for the co-design and co-creation of the European Digital Twin of the Ocean to define together its main ground principles, functionalities, assets, and specifications.

### 2.2 The Mission Ocean and the EU DTO Vision

Nicolas Segebarth (DG RTD) presented the European Digital Twin Ocean (EU DTO) vision (see slides [here](#)).

To ensure that the DTO can be valuable to as many different stakeholders as possible, its creation is “by principle, an inclusive and open process,” says Dr Nicolas Segebarth, policy officer at DG Research & Innovation. “The Digital Ocean Forum is one of the platforms where we try to have this happen”.

Leveraging on existing European science and assets, the European DTO will provide consistent high-resolution, multi-dimensional descriptions of the ocean. This includes its physical, chemical, biological, socio-ecological and economical dimensions, with forecasting periods ranging from seasons to multi-decades. It will transform data into knowledge for everyone's benefit.

The European Commission has been investing about €10 million annually since 2021 to develop a core European Digital Twin Ocean, conceived as a public service and a public good. The European Commission has entrusted 2 main entities behind the [Copernicus Marine Service](#) and [EMODnet](#) programmes, namely [Mercator Ocean International](#) and the [Flanders Marine Institute](#), to develop the core infrastructure of the EU DTO: [EDITO-Infra \(3M€\)](#). The EU DTO also builds on the [EDITO-Model Lab](#) project (7M€) coordinated by Mercator Ocean International.

This complements the €19 million [Iliad](#) project, funded under the Green Deal Call for research proposals to pilot the DTO concept, and the Mission Lighthouse (European seas) projects, as well as a number of research projects developing the background science.

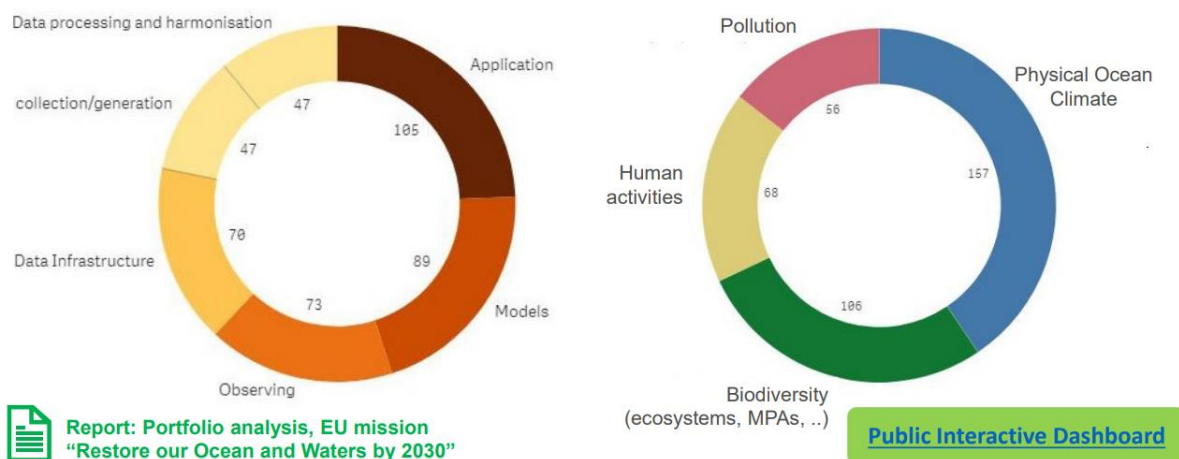
As the EU DTO is to be formed by all possible existing and collaborating projects, the 2023 Digital Ocean Forum edition had a particular focus on EU research projects, to get their views on how they see the development of the EU DTO and how they could contribute to it.

A text mining analysis among the full EU research project database was conducted to identify projects contributing to the EU Mission Restore our Ocean and Waters objectives, and enablers. The top 1500 projects identified by CORTEX as potentially relevant have been then screened and analyzed by independent experts, ending up to with a portfolio analysis of 187 projects. Such analysis is available from a public interactive dashboard [Ocean and Waters mission portfolio \(public version\) | Aperçu de l'application - Qlik Sense \(europa.eu\)](#).

Among this list, a selection of 50 projects (mainly Horizon Europe and Horizon 2020), deemed as the ones more relevant to the EU DTO were invited and participated in the June 14, 2023, Digital Ocean Forum workshop, as a first engagement effort. Further engagement with a wider spectrum of projects will take place as the development of the EU DTO core infrastructure progresses.

## Portfolio analysis – Digital Ocean Knowledge system

187 projects, validated and analysed



### 2.3 Outcomes from Digital Ocean Forum#1

Alain Arnaud (Mercator Ocean International) presented the outcomes of the Digital Ocean Forum#1 that took place in April 2022 in Paris and highlighted the needs for fundamental design and collaboration.

Digital Ocean Forum#1 stressed out the need for co-design of the digital ocean knowledge systems with users (policy, science, industry, citizens). Regular engagement with representatives of user groups is necessary to ensure that the ocean knowledge service generated by new digital ocean systems is fit-for-

purpose. Users also include representatives from Member States, the EU Mission Ocean (Restore Our Ocean and Waters by 2030), and the European Green Deal actors.

Digital Ocean Forum#1 also requested the possibility for European projects to enter data from their projects into EU data systems for use by all (EMODnet, Copernicus Marine Service, etc.) hence creating an unrestricted infrastructure that will provide access to ocean data.

Digital Ocean Forum#1 also stressed the need to ensure alignment and enable integration of European DTO activities and outputs with other digital initiatives including the international DTO programme of the UN Decade of Ocean Science for Sustainable Development and Destination Earth.

There is also a need to establish agreed standards and taxonomy. Accessibility of data requires using and/or developing accepted European or international standards. Standards should be considered on all levels, from taxonomy to vocabularies to formats.

Finally, the DTO ocean knowledge system needs to be based not only on scientific and technical aspects but also 'ethics by design', integrating concerns for social well-being and human rights in projects based on AI.

## 2.4 Presentation of the EU Digital Twin Ocean Core Infrastructure Offer

Alain Arnaud (Mercator Ocean International) presented the EU DTO core infrastructure Offer.

To ensure an operational Digital Twin Ocean core infrastructure by 2024, the building blocks of the initiative are underway through the European-funded EDITO projects, namely EDITO-Infra and EDITO-Model Lab.

Together, these two projects will build the Digital Twin Ocean platform, incorporating:

- a data lake,
- a processing engine
- and virtual simulation environment.



Fostering innovation through co-creation and collaboration, EDITO connects the European marine community, leveraging all observing, monitoring and data programs, expertise, and cutting-edge technology across the European ocean science landscape.

EDITO will construct a thriving digital ecosystem for the further development of the European Digital Twin of the Ocean, hosting the deployment of multiple sectoral and local digital twins, from other related initiatives, including Horizon Europe project Iliad (pilot applications) and the Mission Lighthouses (European seas) projects.

There are 3 possible options for a project on how to use the DTO core infrastructure, from, or a combination of the 3. Here is a summary of each of the EXPLORE, CREATE, CONTRIBUTE offer.



**With the EXPLORE option, users will be able to:**

- Use the digital twin ocean platform;
- Browse and access ocean data seamlessly with adaptative resolution/downscaling, from:
  - CMEMS and EMODnet;
  - New high-resolution reference model simulations, analysis, and forecasts;
  - Forcing fields used for model runs (atmosphere, rivers, etc.).
- Extract data on-the-fly from the browsing data;
- Launch pre-defined ocean processes and what-if-scenarios on various topics, such as:
  - Marine plastic pollution;
  - Coastal hazards;
  - Aquaculture;
  - Carbon sequestration;
  - Marine heat waves detection and forecast;
  - Eddy tracking.
- Access ocean-oriented services hosted the platform, with dedicated user experience on:
  - Marine species and biodiversity;
  - Marine pollution;
  - Ship routing.

**With the CREATE option, users will be able to:**

- Create their own ocean data catalog;
- Add data & processes to their local space on the digital twin ocean platform;
- Embrace the Virtual Ocean Model Lab:
  - Access model software and code;
  - Derive new model output data;
  - Derive pre-defined on-demand processes, what-if-scenarios, and define new ones.
- Use their preferred tools:
  - Upload their data and add it to the own catalog;
  - Launch virtual near-data R&D environments (Jupyter, RStudio, IDE, Python, R, etc.) or other pre-defined services in the virtual place;

- Exploit cloud computing clusters (Dask, Spark);
- Launch and configure automation systems to industrialize their data pipeline;
- Integrate their contributions (data, environments, processes, pipelines, etc.) with HPC.
- Create their own front office to share their contributions with their communities.

**With the CONTRIBUTE option, users will be able to:**

- Upload their own data or results and share them with the DTO community
- Build their external digital twin services using the digital twin ocean API
- Build new web services on top of the platform content and resources:
  - Implement their own services
  - Integrate external services
  - Integrate HPC
- Host their live services on the platform:
  - For their communities
  - For their external users
- Propose their services to the marketplace
  - Let anyone launch their services in their names
- Share their contributions with the entire DTO community

## THE EU DTO OFFER

|   | EXPLORE<br>USE THE DIGITAL TWIN OCEAN PLATFORM <b>1</b>   | CREATE<br>BUILD YOUR EXTERNAL THIRD-PARTY SERVICES <b>2</b>  | CONTRIBUTE<br>ADD DATA & SERVICES TO THE DIGITAL TWIN OCEAN PLATFORM <b>3</b>          |
|---|---|--|--|
|  DATA                                  | Access the largest EU Marine Portfolio across many Topics including data from the Copernicus Marine Service and EMODnet services. Import external data and benefit from the platform functionalities. | Interface your project to our data lake to build your project fast data access.  | Share your data so that it will be added and referenced in the data lake.              |
|  CLOUD AND HPC COMPUTING RESOURCES     | Benefits from EU DTO own cloud capabilities and HPC computing provided through EuroHPC infrastructures. Optimize your performances thanks to near-data computing.                                     |  |  |
|  OCEAN MODELS                          | Launch pre-defined ocean analysis and model forecasts on the platform. Derive all our ocean models, create and launch your own models on the platform.  | Integrate your project into the platform ecosystem to validate your models.  | Share your ocean models and results so that it will be added to the Digital Twin Ocean |
|  SERVICE MARKETPLACE                   | The platform comes with numbers of out of the box services including, a smart viewer and tools for development, processing and analysis. Use any of the marketplace services for your own needs.      | Automatize and test your workflow thanks to the shared out of the box tools. Integrate to your project other services available on the marketplace. Host and make your project services accessible through the platform. | Propose your services in the service marketplace.                                      |
|  ON-DEMAND PROCESSES WHAT-IF-SCENARIOS | Remotely call pre-defined on-demand processes and run what-if-scenarios. Create and run your own processes and what-if-scenarios.   | Integrate on-demand processes and what-if-scenarios results to your project. Schedule or program their runs.   | Reference your on-demand processes and what-if-scenarios to the process registry.      |







### 2.5 Breakout session overview

Two successive breakout sessions were organised with 4 working groups each, splitting the 50 invited projects in smaller teams (see tables below).

The thematic and methodology for the breakout sessions were presented to the audience during the plenary session, before splitting into the breakout sessions.

Thematic discussed during the first four breakout were about “Data, Model, Ocean Intelligence and Innovation & Digital Component”.

For the second breakout session, thematic discussed were about the “Blue Ocean, Biodiversity, Marine environment & conservation, Decision Making and Blue Economy”. More information on the discussion topics and outputs can be found below.

Everyone has been assigned to a breakout session according to their answers to the registration questionnaire, send in advance of the meeting, or depending on the focus on their project. All breakout session were recorded.

Each one-hour Breakout session had the following structure:

- Short introduction of the breakout thematic (5mn max)
- Paperboard discussion with 2 or 3 questions asked to the audience.
- Each participant receives post-it to answer 3 guiding questions on the paperboard.
- Paperboard review and discussion for each questions
- Final conclusion & sum-up for the short reporting in plenary
- Reminder:
  - Before your interventions, please state your name and the name of your project.
  - Be mindful of the limited time and kindly ensure your interventions are concise and of interest and concern to all

| <b>Breakout I - DTO co-construction (15:30 – 16:30)</b>   |  |  |  |
|---|--|--|--|
| <p><b>Data</b></p> <p>Co-Chairs: Marina Tonani (MOI), Klaas Deneudt (VLIZ)</p> <p>Secretary: Carlota Muñiz (VLIZ) Fabrice Messal (MOI)<br/>RTD ROOM CDMA -1/SDR1</p> <p><b>Participants:</b></p> <ul style="list-style-type: none"> <li>• BIOcean5D</li> <li>• Blue-Cloud 2026; ENVRI-FAIR</li> <li>• EO4EU</li> <li>• EPOC</li> <li>• GEORGE</li> <li>• iAtlantic</li> <li>• ICES</li> <li>• ILIAD</li> <li>• MARCO-BOLO</li> <li>• OBAMA-NEXT &amp; GES4SEAS</li> <li>• OTTERS</li> <li>• SMARTLAGOON</li> <li>• GREAT</li> </ul> | <p><b>Model</b></p> <p>Co-Chairs:Yann Drillet (MOI), Francisco Hernandez (VLIZ)</p> <p>Secretary: Mary Malicet (MOI)<br/>RTD ROOM CDMA -1/SDR2</p> <p><b>Participants:</b></p> <ul style="list-style-type: none"> <li>• ActNOW</li> <li>• BRIDGE-BS</li> <li>• EERIE</li> <li>• ELISE</li> <li>• EPOC</li> <li>• ESIWACE3</li> <li>• MaCoBioS</li> <li>• NECCTON</li> <li>• NextGEMS</li> <li>• OCEAN ICE</li> <li>• OceanICU</li> </ul> | <p><b>Ocean intelligence</b></p> <p>Co-Chairs: Laurence Crosnier (MOI), Salvador Fernandez (VLIZ)</p> <p>Secretary: Romane Zufic (MOI)<br/>RTD ROOM CDMA -1/044</p> <p><b>Participants:</b></p> <ul style="list-style-type: none"> <li>• B-USEFUL</li> <li>• CLIMAREST</li> <li>• CoCliCo</li> <li>• DOORS</li> <li>• EcoScope</li> <li>• EuroSea</li> <li>• FAO-Blue Cloud-fisheries and aquaculture demos</li> <li>• FutureMARES</li> <li>• MARBEFES</li> <li>• MARCO-BOLO</li> <li>• MSP4BIO</li> <li>• REST-COAST</li> <li>• SusTunTech</li> <li>• ULTfarms</li> </ul> | <p><b>Innovation &amp; Digital component</b></p> <p>Co-Chairs: Alain Arnaud (MOI), Frederic Leclercq (VLIZ)</p> <p>Secretary: Quentin Gaudel (MOI), Chloé Delpont-Ramat (MOI)<br/>RTD ROOM CDMA -1/109<br/>VIDEOCONF</p> <p><b>Participants:</b></p> <ul style="list-style-type: none"> <li>• A-AAGORA</li> <li>• AD4GD, AquaINFRA</li> <li>• BlueRemediomics</li> <li>• EMODnet</li> <li>• iAtlantic</li> <li>• iNest - DT upper Adriatic</li> <li>• MISSION ATLANTIC</li> <li>• SBEP</li> <li>• SEAMLESS</li> <li>• STRAITS</li> <li>• SusTunTech</li> </ul> |

| <b>Breakout II - DTO impact (17:00 – 17:45)</b> |  |                        |                     |
|---|--|------------------------|---------------------|
| <b>Blue Ocean</b>                               | <b>Biodiversity, Marine environment &amp; conservation</b> | <b>Decision-making</b> | <b>Blue Economy</b> |

|  |   |  |   |
|--|---|--|---|
| <p>Co-Chairs: Yann Drillet (MOI), Leandro Ponsoni (VLIZ)</p> <p>Secretary: Romane Zufic (MOI)<br/>RTD ROOM CDMA -1/SDR1</p> <p><b>Participants:</b></p> <ul style="list-style-type: none"> <li>• Blue-Cloud 2026; ENVRI-FAIR</li> <li>• Bridge-bs</li> <li>• EcoScope</li> <li>• EERIE</li> <li>• ELISE</li> <li>• EPOC</li> <li>• ESIWACE3</li> <li>• GEORGE</li> <li>• iAtlantic</li> <li>• NextGEMS</li> <li>• OCEAN ICE</li> <li>• SEAMLESS</li> </ul> | <p>Co-Chairs: Marina Tonani (MOI), Francisco Hernandez (VLIZ)</p> <p>Secretary: Mary Malicet (MOI)<br/>RTD ROOM CDMA -1/SDR2</p> <p><b>Participants:</b></p> <ul style="list-style-type: none"> <li>• A-AAGORA</li> <li>• ActNOW</li> <li>• AD4GD,</li> <li>• AqualNFRA</li> <li>• BIOcean5D</li> <li>• B-USEFUL</li> <li>• CLIMAREST</li> <li>• MARBEFES</li> <li>• MARCO-BOLO</li> <li>• MISSION</li> <li>• ATLANTIC</li> <li>• NECCTON</li> <li>• REST-COAST</li> <li>• STRAITS</li> <li>• SusTunTech</li> </ul> | <p>Co-Chairs: Laurence Crosnier (MOI), Ann-Katrien Lescrauwaet (VLIZ)</p> <p>Secretary: Fabrice Messal (MOI), Chloé Delpont-Ramat (MOI)<br/>RTD ROOM CDMA -1/044</p> <p><b>Participants:</b></p> <ul style="list-style-type: none"> <li>• CoCliCo</li> <li>• EPOC</li> <li>• FAO-Blue Cloud-fisheries and aquaculture demos</li> <li>• iAtlantic</li> <li>• ILIAD</li> <li>• MaCoBioS</li> <li>• MARCO-BOLO</li> <li>• MSP4BIO</li> <li>• OBAMA-NEXT &amp; GES4SEAS</li> <li>• OceanICU</li> <li>• OTTERS</li> <li>• SMARTLAGOON</li> <li>• GREAT</li> </ul> | <p>Co-Chairs: Alain Arnaud (MOI), Chantal Martens (VLIZ)</p> <p>Secretary: Quentin Gaudel (MOI)<br/>RTD ROOM CDMA -1/109<br/>VIDEOCONF</p> <p><b>Participants:</b></p> <ul style="list-style-type: none"> <li>• BlueRemediomics</li> <li>• BRIDGE-BS</li> <li>• DOORS</li> <li>• EMODnet</li> <li>• EO4EU</li> <li>• EuroSea</li> <li>• FutureMARES</li> <li>• ICES</li> <li>• iNest - DT upper Adriatic</li> <li>• SBEP</li> <li>• SusTunTech</li> <li>• ULTFARMS; UNITED</li> </ul> |
|--|---|--|---|

## 2.6 Invited EU research projects

A total of 50 EU research projects accepted the invitation and attended in-person the Digital Ocean Forum#2 with at least one representant. Here the list of those EU research projects:

1. BIOcean5D [MARINE BIODIVERSITY ASSESSMENT AND PREDICTION ACROSS SPATIAL, TEMPORAL AND HUMAN SCALES | BIOcean5D Project | Fact Sheet | HORIZON | CORDIS | European Commission \(europa.eu\)](#)
2. Blue-Cloud 2026 [A federated European FAIR and Open Research Ecosystem for oceans, seas, coastal and inland waters | Blue-Cloud 2026 Project | Fact Sheet | HORIZON | CORDIS | European Commission \(europa.eu\)](#)
3. ENVRI-FAIR [ENVIRONMENTAL RESEARCH INFRASTRUCTURES BUILDING FAIR SERVICES ACCESSIBLE FOR SOCIETY, INNOVATION AND RESEARCH | ENVRI-FAIR Project | Fact Sheet | H2020 | CORDIS | European Commission \(europa.eu\)](#)
4. EO4EU [AI-augmented ecosystem for Earth Observation data accessibility with Extended reality User Interfaces for Service and data exploitation. | EO4EU Project | Fact Sheet | HORIZON | CORDIS | European Commission \(europa.eu\)](#)
5. EPOC [Explaining and Predicting the Ocean Conveyor | EPOC Project | Fact Sheet | HORIZON | CORDIS | European Commission \(europa.eu\)](#)
6. GEORGE [Next generation multiplatform Ocean observing technologies for research infrastructures | GEORGE Project | Fact Sheet | HORIZON | CORDIS | European Commission \(europa.eu\)](#)
7. iAtlantic [Integrated Assessment of Atlantic Marine Ecosystems in Space and Time | iAtlantic Project | Fact Sheet | H2020 | CORDIS | European Commission \(europa.eu\)](#)
8. ICES <http://ecosystemdata.ices.dk/>

9. ILIAD [INTEGRATED Digital Framework FOR Comprehensive MARITIME DATA AND INFORMATION SERVICES | ILIAD Project | Fact Sheet | H2020 | CORDIS | European Commission \(europa.eu\)](#)
10. MARCO-BOLO [MARine COastal BiODiversity Long-term Observations | MARCO-BOLO Project | Fact Sheet | HORIZON | CORDIS | European Commission \(europa.eu\)](#)
11. OBAMA-NEXT [OBSERVING AND MAPPING MARINE ECOSYSTEMS – NEXT GENERATION TOOLS | OBAMA-NEXT Project | Fact Sheet | HORIZON | CORDIS | European Commission \(europa.eu\)](#)
12. GES4SEAS [Achieving Good Environmental Status for maintaining ecosystem SERVICES, by ASsessing integrated impacts of cumulative pressures | GES4SEAS | Project | Fact sheet | HORIZON | CORDIS | European Commission \(europa.eu\)](#)
13. OTTERS [Social Transformation for Water Stewardship through Scaling Up Citizen Science | OTTERS Project | Fact Sheet | HORIZON | CORDIS | European Commission \(europa.eu\)](#)
14. SMARTLAGOON [Innovative modelling approaches for predicting Socio-environmental evolution in highly anthropized coastal LAGOONS | SMARTLAGOON Project | Fact Sheet | H2020 | CORDIS | European Commission \(europa.eu\)](#)
15. GREAT [Governance of REsponsible innovATIion | GREAT Project | Fact Sheet | FP7 | CORDIS | European Commission \(europa.eu\)](#)
16. ActNOW [Advancing understanding of Cumulative Impacts on European marine biodiversity, ecosystem functions and services for human wellbeing | ACTNOW Project | Fact Sheet | HORIZON | CORDIS | European Commission \(europa.eu\)](#)
17. BRIDGE-BS [Advancing Black Sea Research and Innovation to Co-Develop Blue Growth within Resilient Ecosystems | BRIDGE-BS Project | Fact Sheet | H2020 | CORDIS | European Commission \(europa.eu\)](#)
18. EERIE [European Eddy-Rich ESMs | EERIE Project | Fact Sheet | HORIZON | CORDIS | European Commission \(europa.eu\)](#)
19. ELISE [European Learning and Intelligent Systems Excellence | ELISE Project | Fact Sheet | H2020 | CORDIS | European Commission \(europa.eu\)](#)
20. EPOC [Economic Policy in Complex Environments | EPOC | Project | Fact sheet | H2020 | CORDIS | European Commission \(europa.eu\)](#)
21. ESIWACE3 [Excellence in Simulation of Weather and Climate in Europe, Phase 2 | ESIWACE2 Project | Fact Sheet | H2020 | CORDIS | European Commission \(europa.eu\)](#)
22. MaCoBioS [Marine Coastal Ecosystems Biodiversity and Services in a Changing World | MaCoBioS Project | Fact Sheet | H2020 | CORDIS | European Commission \(europa.eu\)](#)
23. NECCTON [NECCTON - New Copernicus Capability for Trophic Ocean Networks](#)
24. NextGEMS [Next Generation Earth Modelling Systems | NextGEMS Project | Fact Sheet | H2020 | CORDIS | European Commission \(europa.eu\)](#)
25. OCEAN ICE [Ocean Cryosphere Exchanges in ANTarctica: Impacts on Climate and the Earth system | OCEAN ICE Project | Fact Sheet | HORIZON | CORDIS | European Commission \(europa.eu\)](#)
26. OceanICU [Ocean-ICU Improving Carbon Understanding | OceanICU Project | Fact Sheet | HORIZON | CORDIS | European Commission \(europa.eu\)](#)
27. B-USEFUL [User-oriented Solutions for Improved Monitoring and Management of Biodiversity and Ecosystem services in vulnerable European Seas | B-USEFUL Project | Fact Sheet | HORIZON | CORDIS | European Commission \(europa.eu\)](#)
28. CLIMAREST [Coastal Climate Resilience and Marine Restoration Tools for the Arctic Atlantic basin | CLIMAREST Project | Fact Sheet | HORIZON | CORDIS | European Commission \(europa.eu\)](#)



29. CoCliCo [COASTAL CLIMATE CORE SERVICES | CoCliCo Project | Fact Sheet | H2020 | CORDIS | European Commission \(europa.eu\)](#)
30. DOORS [DOORS Black Sea](#)
31. EcoScope [Ecocentric management for sustainable fisheries and healthy marine ecosystems | EcoScope Project | Fact Sheet | H2020 | CORDIS | European Commission \(europa.eu\)](#)
32. EuroSea [Improving and Integrating European Ocean Observing and Forecasting Systems for Sustainable use of the Oceans | EuroSea Project | Fact Sheet | H2020 | CORDIS | European Commission \(europa.eu\)](#)
33. FAO-Blue Cloud-fisheries and aquaculture demos
34. FutureMARES [Climate Change and Future Marine Ecosystem Services and Biodiversity | FutureMARES Project | Fact Sheet | H2020 | CORDIS | European Commission \(europa.eu\)](#)
35. MARBEFES [MARine Biodiversity and Ecosystem Functioning leading to Ecosystem Services | MARBEFES Project | Fact Sheet | HORIZON | CORDIS | European Commission \(europa.eu\)](#)
36. MSP4BIO [Improved Science-Based Maritime Spatial Planning to Safeguard and Restore Biodiversity in a coherent European MPA network | MSP4BIO Project | Fact Sheet | HORIZON | CORDIS | European Commission \(europa.eu\)](#)
37. REST-COAST [Improved Science-Based Maritime Spatial Planning to Safeguard and Restore Biodiversity in a coherent European MPA network | MSP4BIO Project | Fact Sheet | HORIZON | CORDIS | European Commission \(europa.eu\)](#)
38. ULTfarms [circUlar Low Trophic offshore Aquaculture in wind farms and Restoration of Marine Space | ULTFARMS Project | Fact Sheet | HORIZON | CORDIS | European Commission \(europa.eu\)](#)
39. A-AAGORA [Blueprint for Atlantic-Arctic Agora on cross-sectoral cooperation for restoration of marine and coastal ecosystems and increased climate resilience through transformative innovation | A-AAgora Project | Fact Sheet | HORIZON | CORDIS | European Commission \(europa.eu\)](#)
40. AD4GD [All Data 4 Green Deal - An Integrated, FAIR Approach for the Common European Data Space | AD4GD Project | Fact Sheet | HORIZON | CORDIS | European Commission \(europa.eu\)](#)
41. AquaINFRA [Infrastructure for Marine and Inland Water Research | AquaINFRA Project | Fact Sheet | HORIZON | CORDIS | European Commission \(europa.eu\)](#)
42. BlueRemediomics [BlueRemediomics: Harnessing the marine microbiome for novel sustainable biogenics and ecosystem services | BlueRemediomics Project | Fact Sheet | HORIZON | CORDIS | European Commission \(europa.eu\)](#)
43. EMODnet [European Marine Observation and Data Network \(EMODnet\) \(europa.eu\)](#)
44. iAtlantic [iAtlantic: Health Of Deep-Sea And Open-Ocean Ecosystems Research](#)
45. iNest - DT upper Adriatic <https://www.consorzioinest.it/en/>
46. MISSION ATLANTIC [Towards the Sustainable Development of the Atlantic Ocean: Mapping and Assessing the present and future status of Atlantic marine ecosystems under the influence of climate change and exploitation | MISSION ATLANTIC Project | Fact Sheet | H2020 | CORDIS | European Commission \(europa.eu\)](#)
47. SBEP [A climate neutral, sustainable and productive blue economy Partnership | SBEP Project | Fact Sheet | HORIZON | CORDIS | European Commission \(europa.eu\)](#)
48. SEAMLESS [Services based on Ecosystem data AssiMiLation: Essential Science and Solutions | SEAMLESS Project | Fact Sheet | H2020 | CORDIS | European Commission \(europa.eu\)](#)

49. STRAITS <https://www.europeantrackingnetwork.org/en/about-straits>
50. SusTunTech [Sustainable tuna fisheries through advanced earth observation technologies | SUSTUNTECH Project | Fact Sheet | H2020 | CORDIS | European Commission \(europa.eu\)](#)

## DAY1- JUNE 14, 2023 - BREAKOUT OUTCOMES

### 3.1 Breakout 1 - DATA

The “Data” breakout session focussed on gaining insight into the needs and expectations from existing projects and initiatives regarding the data resources that will be offered by the DTO, as well as new data they can potentially contribute.

All participants shown a keen interest in using the DTO data offer (biology, biogeochemical, physical, socioeconomic data), as well as in sharing their project outputs. However, participants also expressed concern on consistency, harmonisation and standardisation of data formats and the conditions for sharing data. The interoperability of the DTO on a European and global scale is one of the main expectations of participating projects.

#### 3.1.1 Questions to and answers from the projects

**Will your project access the data from EMODNET and CMEMS, made available in the EU DTO Data Lake?**

- Positive expression of interest to use the data provided. All types of data are interesting to use.
- There were questions about the added value of using the EDITO infrastructure as opposed to accessing EMODNET and CMEMS as individual components. (“*why duplicate data that is in other platforms in this one.*”). Answers argued that the EDITO infrastructure will not duplicate existing components such as EMODNET and COPERNICUS, but will build on top of it, and will provide with extra services close to the data.

**What additional data types and resources are needed to support the scenario or modelling development in your project?**

- Socioeconomic data, scenario data, some very specialized data (inland waters), water treatment data not currently available, as well as sediments.
- Strong support to consider the quality of the data included.
- There is concern in terms of which format is needed by the possible users of our data. It seems unclear how different community users require the data to be useful for their activities.

**What kind of data could your project share in EU DTO? What could be the constraints to contribute to the EU DTO Data Lake?**

- Projects are willing to share their data (microbiomes sequence data, surface ocean carbon, data derived from other models, mapping of species community and services.)

#### 3.1.2 Specific needs and expectations

**Identified constraints:**

- standards and quality of the data,
- Not using existing networks and system for data ingestion.

**Concerns about:**

- the consistency of the data format;
- the validation of the data (how to);
- harmonization;
- clear standards (organizations working in data standards should be involved);
- data sharing issues (privacy, ownership, acknowledgement, ...) and;
- duplication of data on different platforms.

**Needs and expectations:**

- Involve standards organizations;
- Provide guidance about the supply chain;
- Definition of a “Twin ready data” format;
- DTO should serve not only European objectives but also global ones.

### 3.2 Breakout 2 - MODEL

The “Model” breakout session focused on gaining an understanding on the need for models across ongoing projects, as well as identifying potential contributions from projects to the DTO, from a modelling perspective. Projects shown a strong interest in the modelling component of the DTO, expecting that it covers a large diversity of thematics (e.g., physics, biogeochemistry, sea ice, atmosphere, land ocean continuum, coastal, seabed), as well as responding to interaction, coupling and forcing between ocean components at different (time and space) scales.

Projects posted questions and recommendations on capacity running models and chaining model in a modelling suite, managing/versioning model code and validating model output.

#### 3.2.1 Questions to and answers from the projects

**Do you need models that will be available on EU DTO platform?**

- Physical, biogeochemical, biodiversity and/or application models component
- To produce your own simulations, on demand, operational production

Yes. Specific needs were identified in addition to physical and biogeochemical models for atmospheric, coastal, seabed, sea ice models and capability to “couple” or “chain” these models.

**In your project do you develop model components that will be part of an application or a digital twin?**

- Specific input
- Interface with other models and capability to chain model components
- User interface to design and to run your model.

Yes. Several types of code and models are or will be developed regarding artificial intelligence and hybrid models, data pre and post processing and coupling between earth system model components, stressors and model and specific application (e.g. DT of research vessel)

**Your project produces models or application components that could become part of the EU DTO offering in the future? What could be the main issue?**

- Management of properties, licenses, policy
- Common rules for code development
- Provision of test bed, benchmark, and user support

Yes. Three main topics were identified about 1) climate change scenario and downscaling capacities, 2) model for specific applications 3) ecological and simplified 1D model.

### 3.2.2 Specific needs and expectations

Projects expressed their need for various model's components to be available on DTO platform, such as:

- Atmospheric models,
- Sea Ice models,
- Coastal models,
- Seabed models,
- Ocean Physics models,
- Biogeochemistry models,
- Coupling Physics/Biogeochemistry/Sea Ice models.

Model developments to be available on EU DTO platform, such as:

- Projections,
- Fairness and access to software,
- Containerisation,
- TRL level and maturity of the model,
- Simple coupler and one-dimensional model.

AI and Hybrid models and tools to be available on EU DTO platform, such as:

- Ecological models,
- Decision-support tools,
- Multi-risk assessment,
- Ensemble ecosystem,
- Eddy tracker,
- Coupler,
- Iceberg drift,
- Uncertainty quantification,
- Risk-assessment tools,
- Data pre-processing requirements,

Coupling parameters to be available on EU DTO platform, such as:

- Waterbed model with physics and geochemistry,
- Ecosystem,
- Ice shelf,
- Iceberg,
- Earth system,
- Stressors and impact on marine species,

Applications to be available on EU DTO platform, such as:

- Ecosystem models,
- Socio-economic and socio-ecological models,
- Ocean interaction in fjords,

Downscaling Scenario to be available on EU DTO platform, such as:

- IPCC climate scenarios,
- Statistical downscaling,
- Fisheries management,
- Blue economy scenarios.

### 3.3 Breakout 3 - OCEAN INTELLIGENCE

The "Ocean Intelligence" breakout session sought to discuss the participants' needs to better develop their projects, as well as to scope the ocean intelligence tools that they might be able to share with the DTO in the future.

Participants' expectations were mostly centred on how the DTO will support decision making and policy implementation, both in terms of **what** the DTO will provide and **how** it will be built to facilitate this.

The term Ocean intelligence encompasses ocean data visualisation; data exploration; viewers adapted to different technicity/usage levels, from schools to scientific study purposes; user support; capacity building; user feedback collection and traceability of feedback implementation; post-processing tools; AI tools; what-if scenarios; Virtual Research Environment; Jupyter Notebooks etc.

The DTO could therefore provide a 'virtual place', understood as a multipurpose virtual environment to:

- Co-design and co-share: enabling projects to reference and promote their applications.
- Provide sectorial services: developed and promoted by the projects on the DTO
- Act as societal hub targeting citizens, NGOs, policymakers who need information (ocean literacy resources, pedagogic resources for schools and students, policy-briefs, ocean knowledge summaries etc).

#### 3.3.1 Questions to and answers from the projects

##### **What are the essential Ocean Intelligence elements that appear (or should appear) in the DTO offer?**

The different elements mentioned by the group can be divided within 4 main categories: from what the DTO should be ('core values') to the importance of data access & management, and the need to visualise data and further support decision making.

DTO core values:

- Adaptability;
- Sustainability;
- Transferability.

Data access & management:

- Data format & Homogenization;
- Intelligent Text Search Engine;
- Easy access to EOVs;
- APIs for data management;
- DPS infrastructures.

Data visualisation:

- Customizable dashboards, aggregators;
- Visualization, Temporal & Spatial scales;
- Policy Implementation & Decision making;
- Management & decision making & analysis tools;

- Policy briefs, reporting.

Decision-making tools to support policy implementation & environmental assessments:

- Prioritization tools;
- Interactive what-if scenarios;
- Connection to open universities repositories.

**What are the Ocean Intelligence capabilities of the DTO that would increase the impacts of your project's results? How can the DTO assist you, how do you envision that the DTO would work?**

A strong policy orientation for the DTO was highly recommended to increase the impact of the projects represented in the Working Group, with various features being mentioned in that sense. Various user experience and interoperability propositions were also made, along needs for data.

Policy orientation:

- What-if scenarios need to be built around examples;
- Flagship example around MSP directive;
- Policy briefs & ad hoc synthesized information for policy reporting;
- Link with policy implementation;
- Decision support system;
- Sea Basin approach.

Interoperability & User Experience:

- Compatibility with other systems;
- Single entry point;
- Customizable data dashboards;
- User requirement traceability.

Data:

- Data quality insurance, maturity metrics;
- Semi-automatic updates with new data.

**What Ocean Intelligence contributions from your project could be shared on the DTO? Will your project build any demonstrators, virtual labs, etc? Could they become part of the DTO?**

How you, as H2020 programme or EU projects, can contribute to the DTO? Which part of the Ocean Intelligence you are developing can be part of the DTO? What does the DTO need to collect and plug your resources?

The group mentioned multiple elements from their projects which could be shared within the DTO, from toolboxes to demonstrators and framework.

Toolboxes, Models, VREs, Quality best practices:

- Toolboxes for risk assessment and policy;
- Virtual Research environment;
- Data quality flagging systems;
- Models (Predictive habitats, collapse of species, invasive species, etc.).

Demonstrators:

- Local demonstrators with Indicators;
- EOVs;

- Test locally the accuracy of methods to be ultimately extended or replicated on other areas.

Frameworks:

- Policy needs & requirements;
- Best practices across the full value chain;
- Socio-economic framework and data.

### 3.3.2 Specific needs and expectations

Expectations were mostly centred on how the DTO will support decision making and policy implementation, both in terms of **what** the DTO will provide and **how** it will be built to facilitate this. Projects indeed mentioned the need for interoperability, customizability, compatibility, and adaptability to best leverage the DTO. The expression of needs for what-if scenarios, analysis tools, best practices and flagship examples also relate to the policy orientation expectation.

## 3.4 Breakout 4 - INNOVATION & DIGITAL COMPONENT

The “Innovation & Digital Component” breakout session focused on addressing two objectives: The first objective was to understand what resources and content might be needed by ongoing projects; the second one was to discuss the way that the different projects could contribute to the Digital Twin of the Ocean, i.e., how the value added by their project would be integrated to the Digital Twin of the Ocean, e.g., what new data, new services and new processes would they embed.

Several projects have shown interest in relying partially or totally on the Digital Twin of the Ocean platform for their implementation. More technical details need to be communicated to precise this feasibility. While some projects need storage resources that cannot be fully provided in the first version of the Digital Twin of the Ocean platform, the requirements were collected and will be used in the definition of the platform evolution.

Most projects have foreseen contribution to the DTO in various manner. Concerns regarding the rightfulness or the open and collaborative approach were collected. Technical discussions were raised about the foreseen DTO features to answer the concerns and the conclusions were fruitful.

### 3.4.1 Questions to and answers from the projects

**What kind and which capacity of resources would you need, in terms of storage, RAM, CPU, connections?**

- There is a significant disparity in responses regarding storage and CPU RAM resources, which was expected - some projects require a 500TB storage capacity. Several projects have highlighted the requirement for high-performance computing (HPC) resources and, for one, GPU capability.

**What specific tools or technologies can be integrated into the DTO to improve its effectiveness in simulating and monitoring ecosystems?**

- Next to the obvious RStudio, JupyterHub and Docker it looks like there is need to spin up virtual machines (VMs) with Pangeo connectors for convenient data access.

**What kind of contribution will you make to the DTO?**



- There is clearly a strong willingness to contribute (data and models), although there are some concerns regarding data quality that we may explore further.

### 3.4.2 Specific needs and expectations

Some virtual machines have been asked in the post-its, during the discussion it has been agreed that containerisation with the possibility to have access to docker, is a valid solution.

As anticipated, depending on their projects, users will have the option to either upload their data to the storage spaces of the EDITO-infra or simply reference them in the catalogue if the data is already accessible on another cloud storage platform.

During the conversation with the representative of the AG4D project, their initial belief that the second question was irrelevant to their project shifted. It became apparent that several tools could indeed be applicable to their project, and they also expressed the possibility of requiring additional tools. Therefore, further discussion could be beneficial. These tools might offer valuable services, even if they are not directly linked to the utilization of the data.

Some questions over the quality of the data have raised, that the type of data and their specificity should be explicit. A component would be needed to display geographic differences and uncertainty.

There were numerous and varied proposals for contributions, ranging from configuring existing tools like the Jupyter toolbox to thematic ideas such as coastal biodiversity. Some proposals also focused on mapping data and exploring the potential applications of these tools with specific datasets.

## 3.5 Breakout 5 - BLUE OCEAN

The “Blue Ocean” breakout session focused on two main topics: Understanding the requirements of the projects for the DTO with regard to the Blue Ocean, and; identifying the outcomes of the projects that could be shared within the DTO.

The participants expressed requirements regarding products, variables, and resolution, with a particular interest for the intercomparison, connections and compatibility aspects. Participants were interested into sharing their results within the DTO, but raised concerns about how the storage will work.

It is important to note that most of the projects of this session were involved in biodiversity and marine conservation.

### 3.5.1 Questions to and answers from the projects

#### What do the stakeholders targeted by your projects require?

Whereas requirements of Blue Ocean products (variables, metrics and diagnostics, resolution, coverage, etc.) or requirements in the consistency between Blue Ocean and other ocean components.

Products requirements:

- Climate & Impact:
  - Erosion;
  - Sea level;
  - Nature-based solutions;

- New ways to highlight ocean interactions and interconnections (e.g., link between marine heatwaves and ocean currents, waves & sea ice);
- Ecosystem indicators;
- Wave and sea ice, ice shelf stability.
- Coastal:
  - Coastal sea level rise, risk assessment, nature-based solution.
- Fisheries:
  - Ecosystem and fisheries metrics and assessment.
- Search & Rescue
- Need of specific variable for Arctic regions sea ice, SST, circulation, high resolution topography and bathymetry

Specific requirements in term of products identified:

Variables requirements:

- Management & planning;
- Patterns;
- New variables;
- Need of clear definition of variable and products;
- Temperature, salinity, velocity, oxygen, vertical velocity, mixed layer, sea surface height, bottom pressure, age tracer, air sea heat momentum, fluxes, stratification, turbulent mixing, etc.;
- Second moment products ( $uT$ ,  $vT$ ,  $uu$ ,  $vv$  ...);
- Need for consistency between large scale open ocean to small scale local/coastal area and between physical and biogeochemical data.

Resolution requirements:

- Data missing for coastal areas;
- Not enough resolution for mesoscale eddies;
- Timescale & spatial resolution;
- Open ocean to coastal areas;
- Southern Ocean data;
- Greenland data;
- High resolution, documentation;
- Eddy resolution.

**What outcomes developed by your projects can be shared within the DTO? Such as Blue Ocean-related products that could be used as demonstrators. How DTO platform can host your demonstrator?**

Examples of demonstrators:

- Polar portal;
- Ecosystems;
- Sea ice & iceberg;
- Sea level rise;
- Shelf collapse;
- Statistical downscaling;
- Change in ocean circulations.

Virtual Lab & Sharing Codes & Tools:

- Workflow;
- Multidiscipline data;
- Data format and conversion.

Indicators, Time series:

- Computing indicators, Essential Ocean Variables (EOVs);
- Tools for calculating index of climate variability;
- Regional Paleo & Future simulations.

### 3.5.2 Specific needs and expectations

The main expectations from the DTO mentioned within the Blue Ocean working group were to enable **intercomparison, connections and compatibility** among projects, including proposing automated data conversion.

A question was raised around the **storage space**. The projects representatives expressed interest in sharing their data and having the DTO storing their data but were wondering what was planned to accommodate all the data shared.

## 3.6 Breakout 6 - BIODIVERSITY and MARINE CONSERVATION

The “Biodiversity and Marine Conservation” breakout session targeted two objectives: The first objective was to understand whether the data and models generated by the participating projects will influence current biodiversity and marine environment research, management, or policymaking, and how the DTO can help improving the outcomes of the projects. The second objective was to appreciate if projects were willing to share those outcomes in the DTO and if they were expecting concerns in doing so such as practical, technical or policy issues.

While the utility of the EU DTO to improve biodiversity and marine conservation was generally validated, some doubts were raised (resources, interoperability, overall coordination, etc.) .

### 3.6.1 Questions to and answers from the projects

**Will your project generate new data, data products, models or applications that have an impact on the way we do biodiversity and marine environment research and management or on conservation policy?**

**How can the DTO add value to this? Improve the outcomes of your project?**

Almost the totality of the projects will generate data that have impact on biodiversity and marine environment and conservation policy.

The following types of data / models / products relating to biodiversity and marine conservation were highlighted as relevant to be shared into the DTO:

Data:

- Biodiversity, biological and climate data;
- EBVs or EOVs or other indicators that can serve assessment of environmental status;

- Carbon storage and reduction of emissions;
- Reforestation of kelp forest and wetlands;
- Diversity (taxonomic and functional) indicators;
- Acoustic data (zooplankton, fish);
- Plankton size spectrum.

Models :

- Blue carbon;
- Morphodynamic;
- Coupled hydro-vegetation;
- Early warning systems;
- Fish habitat modelling (30 most important commercial species);
- Tuna species distribution model (Indian ocean);
- VME and deep sea mapping (images);
- Predictive deep sea species distribution;
- Predictive spatial mapping of biomass in deep sea.

DTO added value:

- Positive feedbacks from projects:
  - Standardization of the data;
  - Increased visibility;
  - Dissemination;
  - Demonstration;
  - Exploitation;
  - Structured data access;
  - Easing use of model coupling;
  - Harmonization of the data;
  - Duplication avoided by giving access to EMODnet, CMEMS, etc.
- Areas for improvement:
  - EU DTO should collaborate with global activities and communicate about it. Eg mention work done in the Ocean Decade and DiTTO

**Could outcomes developed by your project be shared within the DTO?**

**Do you foresee technical or policy issues?**

**Practical issues? storage space on the data lake, standards, data policies, security, HPC power**

Most of the projects are willing to share the data within the EU DTO.

Foreseen issues:

- Ethical issues (information about threatened species could be a concern, etc.).
- Need to develop standards for being compatible with others (citizen science generated data, etc.)
- Technical issues: space storage; data update cycle; semantics; CPU resources; capability to ingest the data; how the uncertainty (ecological model, etc.) will be represented.
- Need to align with the UN decade concepts (DiTTO).

### 3.6.2 Specific needs and expectations

It is to note that the participants have shown interest, expectations and willingness to understand the DTO added value for their projects but more in a top-down posture so that the co-design/co-

development nature of the EU DTO (and, thus, of the present Breakout session) had to be recalled and explained.

Also, the particular sensitivity of biodiversity and marine conservation in terms of data policy was raised.

### 3.7 Breakout 7 - DECISION-MAKING

The “Decision-Making” breakout session focused on scoping concrete “decision making” use cases that ongoing EU project consortia and (EU & international governance bodies) could contribute, as well as reflecting on how the EU DTO can make a step-change in decision-making processes. All the projects agree on the major role played by the EU DTO in supporting decision-making with a holistic approach enabling the coherence between policy area and the scale of implementation and ensuring the legitimacy in policy context, at European and global scale.

To achieve this, the EU DTO must ensure a high level of interoperability, the sharing of best practice and capacity building.

#### 3.7.1 Questions to and answers from the projects

**What concrete use cases in decision making can the community of EU project consortia and (international/EU) bodies contribute? How can the DTO make a step-change in the decision-making processes?**

##### **Ensuring legitimacy and validity**

The DTO is perceived as a potential EU Reference instrument for planning, monitoring, and reporting purposes in the context of EU policies (directives, regulations, decisions, recommendations, etc.). In a use for appraisal and assessment of policies and policy impacts, the services delivered by the DTO must guarantee legitimacy and validity.

In an international policy context and external dimension of EU policy, the legitimacy-validity of the DTO must sustain EU leadership and diplomacy through support in areas such as science diplomacy, knowledge transfer and capacity building in the context of multilateral policy instruments (BBNJ/ABNJ, CBD, IPCC, etc.).

##### **Providing environment for complex decision-making**

For the participants, the DTO must provide a favourable environment to promote co-design and co-development of complex decision-making processes such as:

- Development of ‘what-if’ scenarios
- Modelling and development of complex decision-making processes (Risk assessments, de-risking of high-risk investments, prediction of impact from multiple stressors including climate change; safe operating space for companies and sectoral activities; Tool for weighing trade-offs in decision making; Instrument for Aquaculture infrastructure siting; Calculate carrying capacity for ecosystems; identify (qualitative/quantitative) ecosystem services such as carbon sequestration and carbon storage against new developments...)
- Maritime Spatial Planning with an access to user agreements, considering the different types of users and with the objective to document and support the full policy cycle.

- Implementation of Ecosystem-Based-Management and Dynamic Ocean management: e.g. Map Biological connectivity of marine species – migratory species, ecological corridors, to decide on effective MPA (dynamic ocean management)

### 3.7.2 Specific needs and expectations

The DTO is expected to help:

- **Building interoperability in the full value chain:** from vocabularies, to standers, to indicators, to materials/models/methods, to monitoring to reporting.
- **Developing coherence in policy domains** (different but overlapping) and scale of implementation when “cascading” from EU to local (same at different geographic scales).

Particular attention must be paid to the need to define **Geo-Physical Boundaries of the DTO** (build on other learning processes between EU/Member States):

- Inland waters, Coastal zone, Scope of policies, socio-economic, includes economy data.
- Boundaries are not static; they can be modified depending on the topic that is in discussion.

The DTO must be committed to:

- Develop, Document and Share Best practices for the full value chain (see OBPS of IOC-IODE) with possible actions such as:
  - Create one model: from process to procedures to operations: how roles, policies and procedures are decided in the DTO; Including the co-design component,
  - Design sustainability of the model,
  - Generate ‘carbon free’ or carbon footprint labels for consumer products,
  - Citizen engagement by sharing examples of impact,
  - Develop user friendly interface to create ownership and engagement.
- Implement capacity development cooperation, addressing the FAIR, CARE and ‘Leave no one behind’ principles:
  - Beyond the Global South, DTO can also help to address intra EU inequity and inequality,
  - Enhance accessibility and discovery of (public) data, leverage Open Data (where possible) and FAIR data,
  - Enhance ocean literacy for all,
  - Tool for virtual training (MOOCs...),
  - Engage citizens as contributors in full partnership.

## 3.8 Breakout 8 – BLUE ECONOMY

The “Blue Economy” breakout session sought to gather information on specific use cases that the DTO could enable, based on the insights and experience of ongoing EU projects and initiatives, as well as formulating the specific added value that the DTO can contribute to stakeholders connected with such actions. Participants classified their contributions in pre-identified categories, namely: Marine living resources; Marine non-living resources; Marine renewable energy; Port activities; Shipbuilding and repair; Maritime transport; Coastal tourism; Environmental protection; Policy (national & international); Other. **Marine living resources & Environmental protection** were seen as the areas where DTO could provide most “quick wins”, building up on and amplifying developments within the projects. From a value-added perspective, participants highlighted that the DTO can contribute to significantly enhance stakeholder interactions and communications, especially with policy makers and citizens. This would require that the DTO is able to cater to a broad range of users, with different

digital skills, needs and expectations. An open and sustained dialogue with stakeholders across Blue Economy and related Ocean communities is considered key towards that end.

### 3.8.1 Questions to and answers from the projects

#### **Which use cases, linked to the Blue Economy, do you see possible with the DTO?**

Participants proposed use cases across all identified Blue Economy sectors, ranging from Shipping, over Marine non-living resources, to Marine living resources and Environmental protection.. More specifically:

Regarding Marine living resources and Environmental protection, it was suggested that new data dashboards could be built for fisheries & aquaculture, where monitoring data can be enhanced by modelling data.

- Regarding other sectors, applications were foreseen for informing and supporting decision making in emerging sectors, such as carbon storage, autonomous shipping, coastline conditions, coastal tourism, and beach nourishments.
- Participants expressed needs and expectations for models and data for decision support for (new and established) offshore renewables.
- New, emerging sectors such as Carbon storage were also noted for potential use cases.

#### **Where do you think the DTO can deliver additional added value for your project stakeholders?**

- As with the previous question, participants saw potential added value across all Blue Economy sectors, ranging from Coastal tourism, over Marine robotics, to Offshore renewables, with most “quick wins” seen in the Marine living resources and Environmental protection. Several points were raised in terms of added-value for stakeholders on existing initiatives:
  - The DTO can contribute to easier interactions with stakeholders, and specifically with policy makers. The desirability of a "simplified, user-friendly" DTO was discussed, also linking back to increasing the possibilities for citizen engagement.
  - In connection with the above, participants highlighted that visualisation through the DTO could leverage the sensible re-use of existing visuals to avoid unnecessary duplication. In addition, it was also indicated that the DTO could provide building blocks or modules for users, so that they can build their own visualisations based on available data.
  - Participants suggested that another aspect of the DTO added value could be providing standard data, e.g., for Environmental, Social and Governance (ESG) and Corporate Sustainability Reporting Directive (CSRD) reporting.
  - They also expressed a desire to see the DTO as a source of novel datatypes in support of a "new" Blue Economy". With new, emerging sensor technology, comes new, emerging datatypes: The DTO could accommodate this data and provide “What If” scenarios for interested, new users.

### 3.8.2 Specific needs and expectations

The DTO is expected to:

Features:

- Enable easier interactions with Ocean stakeholders, including non-expert audiences, which will require “user-friendly” features that enable catering to different (expert and non-expert) audiences, with different digital skills, and user needs and requirements.
- Be open to onboard recommendations stemming from different user communities, based on sustained stakeholder engagement and dialogue with such communities.

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Standards:

- Support both standard and modular visual tools.
- Create and push standard of sensors maintenance, due to their criticality regarding ocean observation.
- Standard method and data for ESG and CRSD reporting

Collaboration:

- Activate and support a fluid and responsive connection and interactions with all target users.



## CONCLUSION

The 2<sup>nd</sup> edition of the Digital Ocean Forum#2 took place in Brussels on June 14-15, 2023. The event successfully brought together a large community of EU research projects and national initiatives to inform them about the development of the EU DTO core infrastructure, including its planned offering of services and capabilities. It also served to launch an interactive process of stakeholder interactions towards understanding the interest and readiness of existing consortia to use this core infrastructure, and to contribute to co-design and co-develop the EU DTO, as well as identifying concerns, expectations and recommendations from these expert communities.

Overall, more than 50 EU projects representing scientists, users, and ocean communities offered insights and suggestions. Key highlights for consideration stemming from the first day of the event (14 June) include:

- The European Commission is investing in the development of a core European Digital Twin Ocean, conceived as a public service and a public good that will transform data into knowledge, for everyone's benefit. The European DTO will provide consistent high-resolution, multi-dimensional descriptions of the ocean, leveraging existing European science and assets. This includes the physical, chemical, biological, socio-ecological and economical dimensions of the ocean, with forecasting periods ranging from seasons to multi-decades.
- To ensure that the DTO can be valuable to as many different stakeholders as possible, its development will, by principle, follow an inclusive process. The DOF will continue to be one of the key fora supporting this end.
- The building blocks of the core infrastructure of the EU DTO are underway under the funded EDITO projects, namely EDITO-Infra and EDITO-Model Lab. Together, these two projects will build the DTO platform, incorporating 1) a Data Lake, 2) a Processing Engine, and 3) a Virtual Simulation Environment.
- Participants to the DOF2023 largely agree on the added value and opportunities brought by the development of the EU DTO core infrastructure:
  - The EDITO Data Lake attracted interest from participants, who showed a keen interest in using its data offer (including i.e., biology, biogeochemical, physical, socioeconomic data, amongst other).
  - Projects also showed a strong interest in the modelling component of the DTO, expecting that it covers a large diversity of thematics.
  - Expectations on using the DTO to support decision making and policy implementation were voiced, both in terms of what the DTO will provide and how it will be built to enable these processes.
  - Suggestions were made towards ensuring that the EU DTO provides a multipurpose "virtual environment" for 1) co-designing and co-sharing, enabling projects to reference and promote their applications; 2) provide sectorial services, as developed by a wealth of initiatives and projects; and 3) act as a societal hub targeting citizens, NGOs and policy makers.
  - The large majority of projects confirmed their interest in contributing to shape the EU DTO. Several projects expressed interest in relying partially or totally on the DTO platform for their implementation.
  - Participants agreed that the EU DTO can contribute to significantly enhance stakeholder interactions and communications, especially with policy makers and citizens. This will

require that the DTO is able to cater to a broad range of users, with different digital skills, needs and expectations.

- Concerns were also expressed on different issues, namely:
  - The consistency, harmonisation and standardisation of data formats and the conditions for sharing data.
  - The interoperability of the DTO on a European and global scale. The EU DTO must ensure a high level of interoperability, enable the sharing of best practice and support capacity building.
  - The capacity of the DTO in terms of running models and chaining models into a modelling suite, managing/versioning model code and validating model output.
  - The need to communicate more technical details to existing projects and communities, for them to assess the feasibility of implementing initiatives on the EU DTO, or to inform the DTO roadmap towards enabling future implementation. A collaborative approach must be ensured, to achieve this end.
  - The fact that to successfully capture opportunities for enhanced stakeholder interactions, an open and sustained dialogue with Blue Economy and ocean related communities must be maintained, working towards ensuring that the EU DTO offers a high level of “user-friendliness” to enable onboarding users across a wide range of audiences with different skills, needs and expectations.

As the core infrastructure of the EU DTO continues to evolve, these conclusions will inform the next phase of developments and stakeholder interactions. DOF 2024 will offer new opportunities to take stock of the progress achieved, as well as identifying new challenges and opportunities emerging through its development and feedback from engaged communities.