General Assembly

16-18 January 2024 – Lecce, Italy

CMCC Headquarter in Lecce, via Marco Biagi 5

Cliquez ici pour rejoindre la réunion

MERCATOR OCEAN INTERNATIONAL

Introduction

Opening Words : L Panzera (CMCC), G Coppini (CMCC), Z Konstantinou (EC, DG MARE), N Segebarth (EC, DG RTD)

Introduction

Opening Words:

L Panzera (CMCC)
G Coppini (CMCC)

Z Konstantinou (EC, DG MARE)
N Segebarth (EC, DG RTD)

MISSION

To investigate and model our climate system and its interactions with society to provide reliable, rigorous, and timely scientific results to stimulate sustainable growth, protect the environment and develop science driven adaptation and mitigation policies in a changing climate. To develop foresights and quantitative analysis of our future planet and society.

OFFICES

CMCC is organized in the form of a network distributed throughout Italy.

The network connects public and private entities working together on multidisciplinary studies concerning issues of interest to the climate sciences.

MEMBERS AND INSTITUTIONAL PARTNERS

National Institute of Geophysics and Volcanology (INGV)

University of Salento

Ca' Foscari University Venice

University of Sassari

University of Tuscia

Polytechnic University of Milan

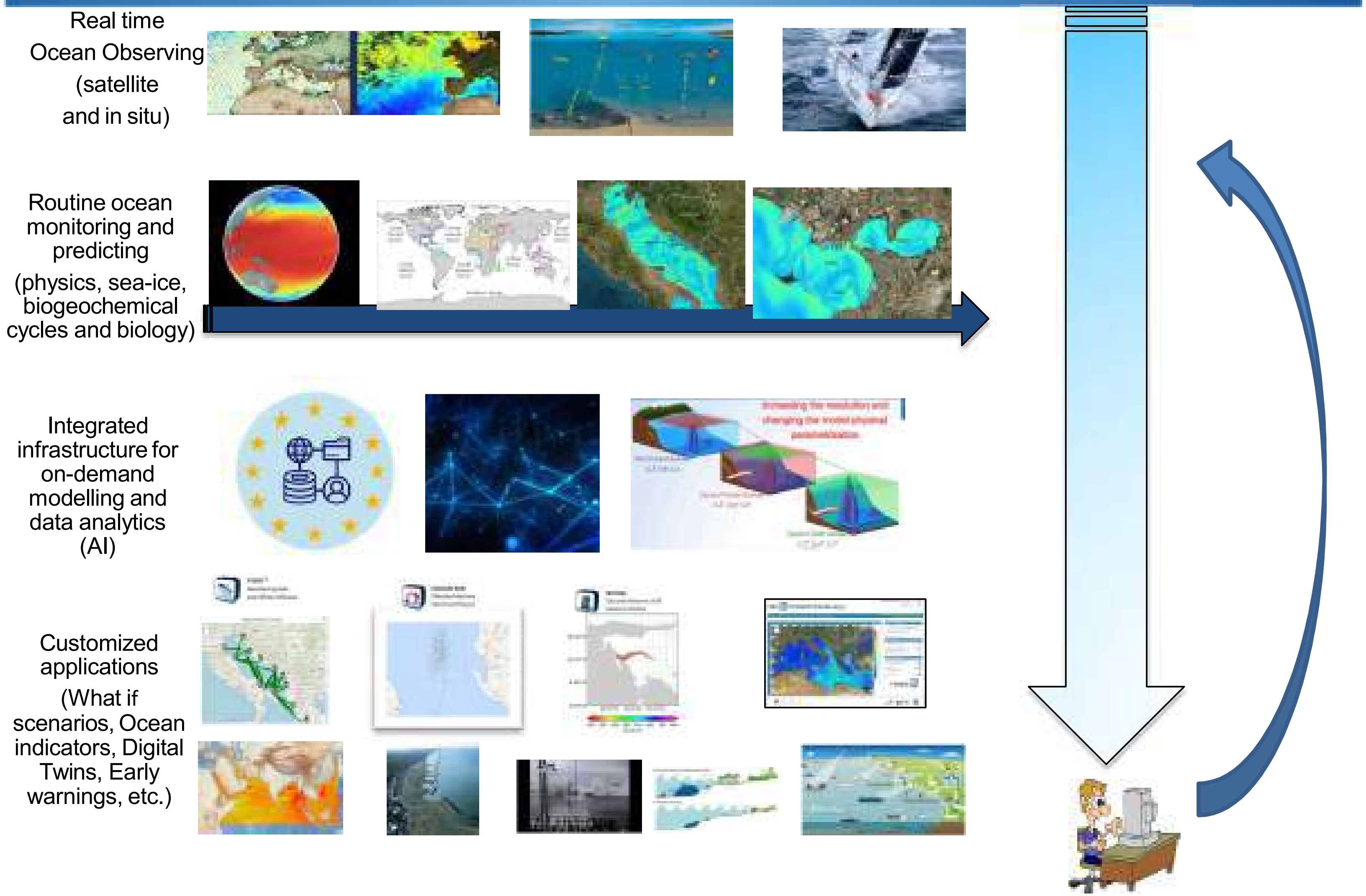
Resources for the Future (RFF)

University of Bologna

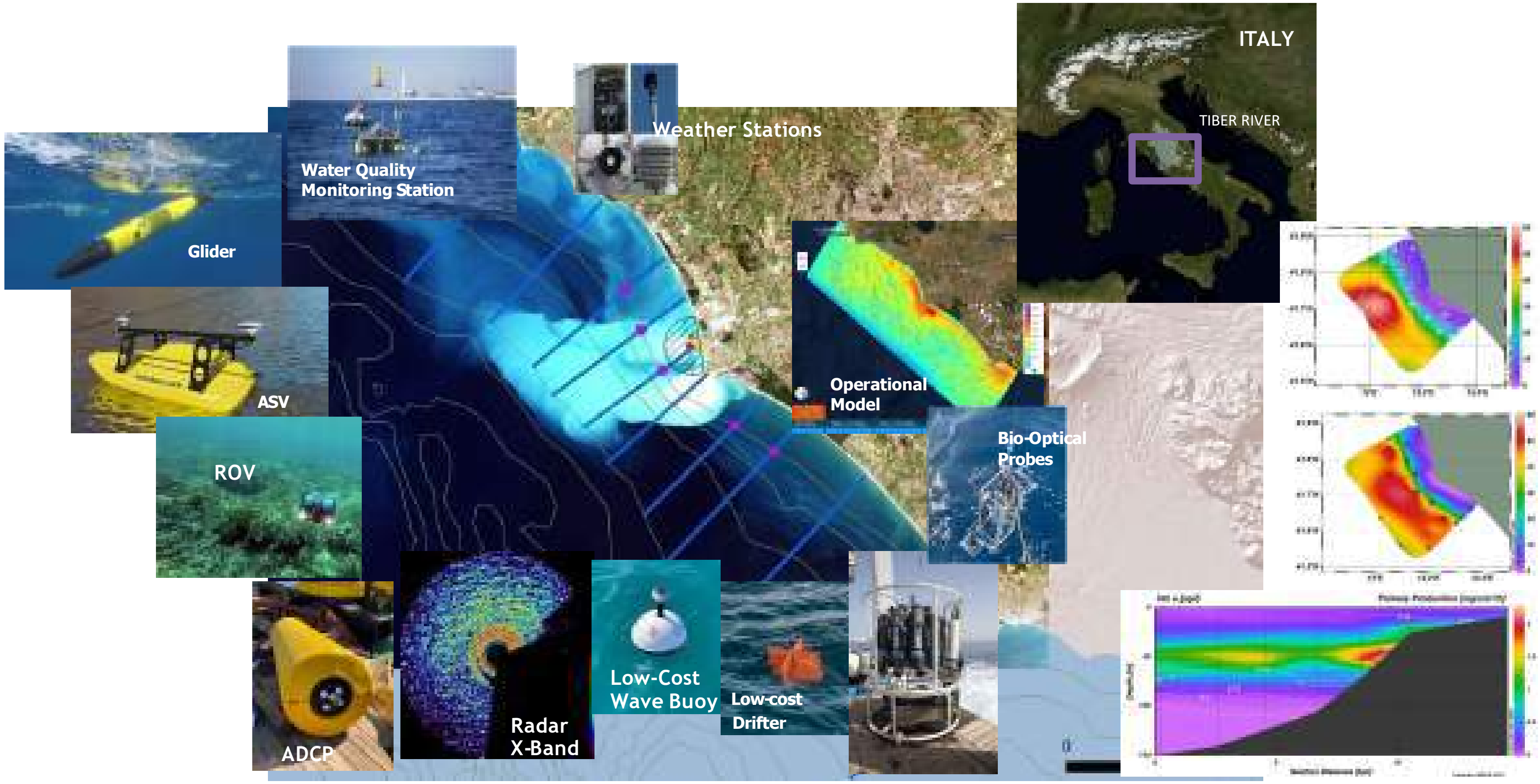
INTERDISCIPLINARY RESEARCH

The scientific organization enhances the integration and collaboration among interdisciplinary skills needed to deal with climate sciences related topics.

The integrated value chain for the Global Coastal Ocean at CMCC



ADVANCED OBSERVING SYSTEMS



UNIVERSITÀ TUSCIA

Med-MFC Consortium

MED-MFC
~40 experts

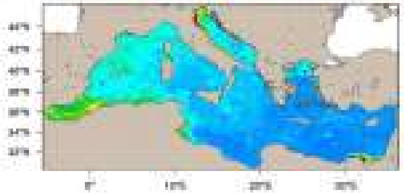
The Med-MFC is one of the 7 MFCs
A consortium of 4 institutes

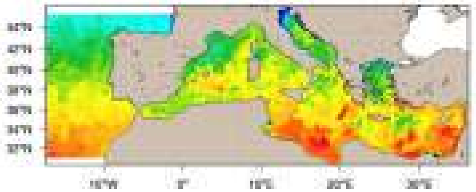
CMCC (Leader of the consortium and responsible for the Physical product) → **Med-PHY**
OGS (Responsible for the Biogeochemical product) → **Med-BIO**
HCMR (Responsible for the Wave product) → **Med-WAV**
CINECA Support to operational production (new from 2022)

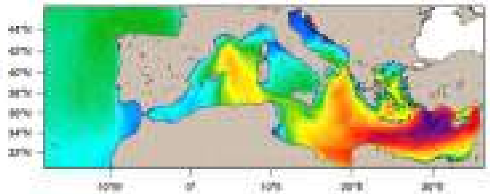
Med-Biogeochemistry PU — OGS

Med-Physics PU — cmcc

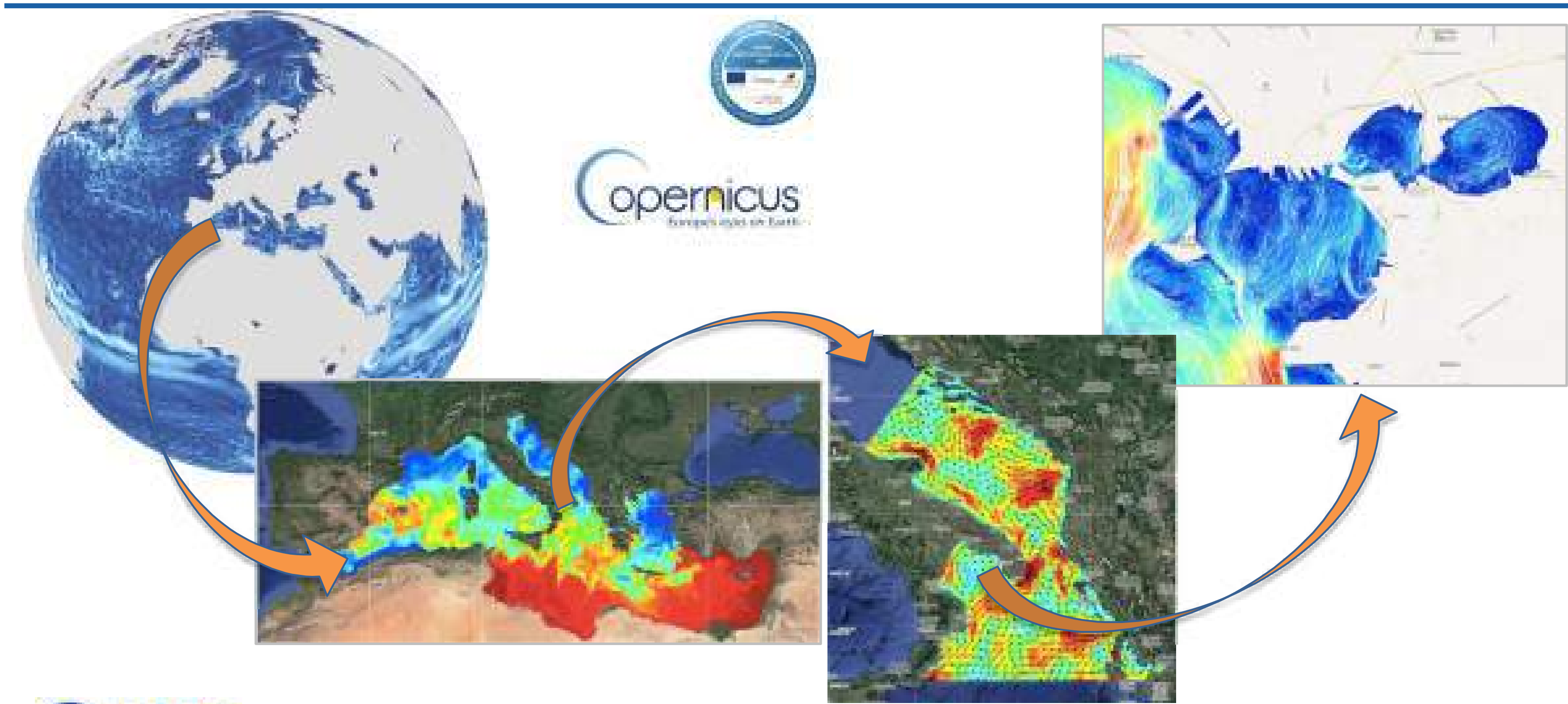
Med-Wave PU — hcmr



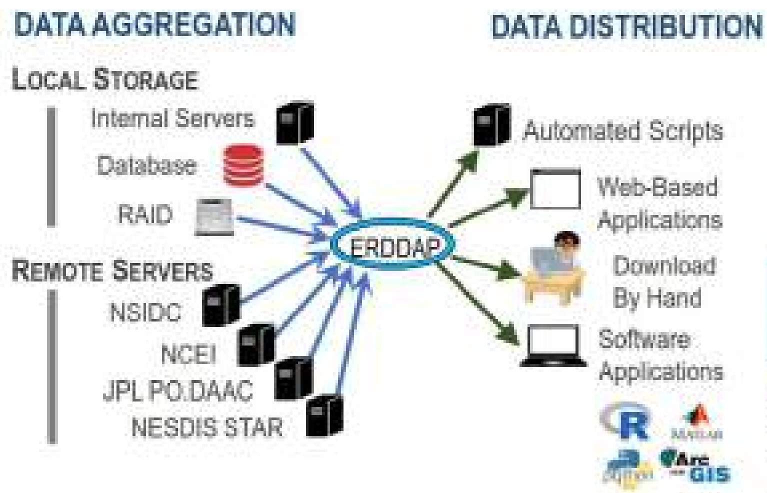


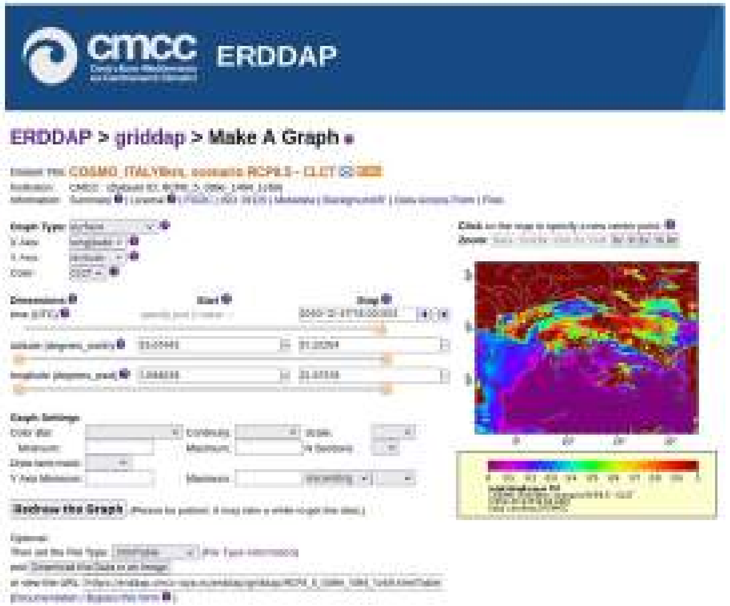


The modelling systems are based on **state-of-the-art community models**, **assimilate *insitu* and satellite observations** and are forced by **high resolution atmospheric fields**.
Improvements and functioning of the Med-MFC systems are based on the **full consistency among the three components** which **are jointly upgraded** and include a **continuous amelioration** of the accuracy of the products.



CMCC Data distribution systems



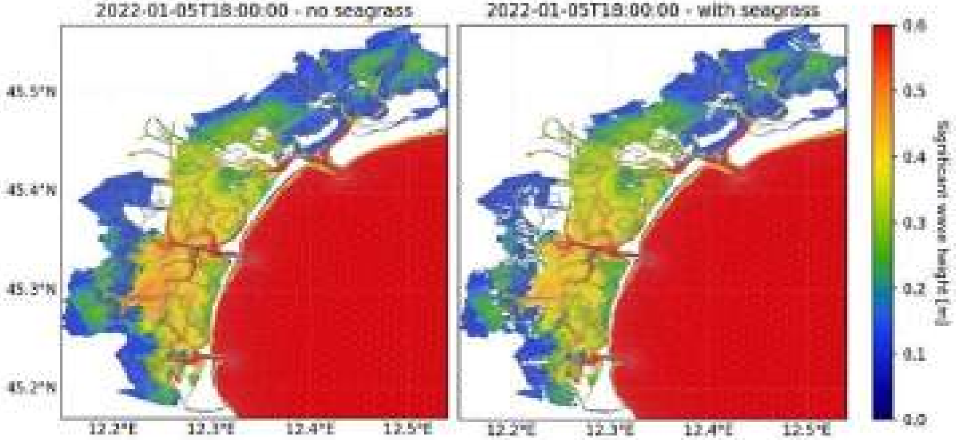


REST-COAST: modelling approach for the Venice Lagoon pilot coastal restoration

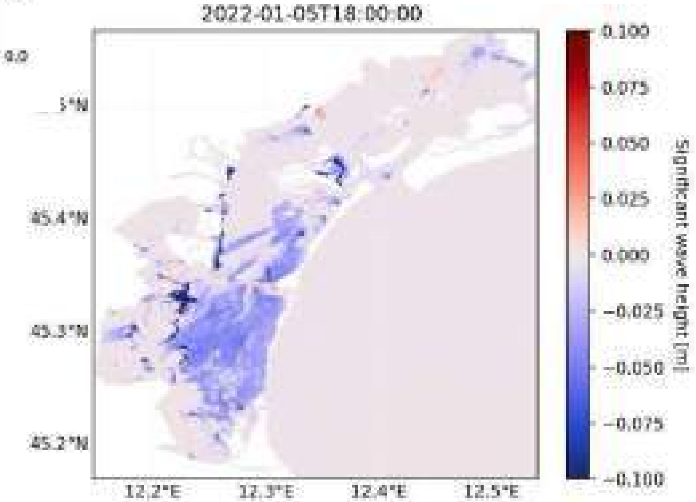
Preliminary results on vegetation

REF
(without seagrasses and barene)

VEG
(with seagrasses and barene)



DIFF=VEG-REF
(with seagrasses and barene)

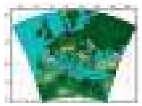


The climate downscaling at CMCC

WHAT STRATEGY ?

GLOBAL **CLIMATE MODEL (CMIP5)** IPSL-CM5A-MR

REGIONAL **CLIMATE MODEL (MEDCORDEX)**
LMDZ+NEMO
atm (30km - 3h, daily, monthly)
Ocean (10km daily, monthly)



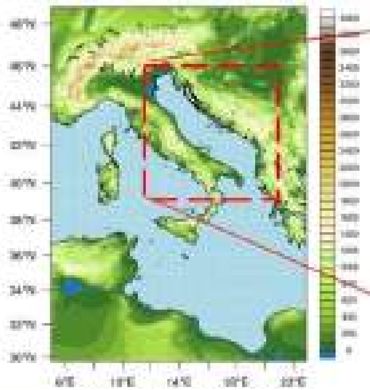
- ✓ historical: 1951-2005
- ✓ Projection RCP 8.5: 2006-2100

State of art ***global to regional*** climate projections

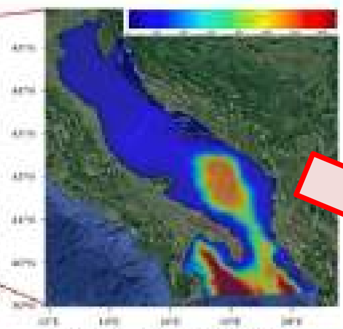
Res ~ 100km to 10km
Freq daily to monthly
Atm-Ocean models

AdriaClim Limited Area Climate Downscaling

SUB-REGIONAL **CLIMATE MODEL**



WRF (6km, 6h)+ WRFHYDRO (600m, 1h)

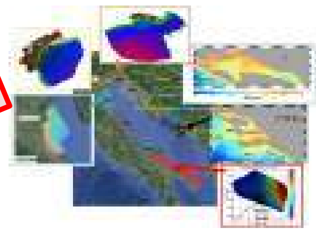


NEMO +WW3 +BFM
(2km, 3h-daily)

- ✓ Historical: 1990-2020
- ✓ Projection RCP8.5: 2020-2050

New generation ***regional to local*** climate projections

Res ~ few km to 100m
Freq 1h to daily
Atm-Land-Ocean-Wave-BGC model



COASTAL **CLIMATE MODELS**
SHYFEM, ROMS, BFM
(~100m)

CoastPredict
with The Global Ocean Observing System

CoastPredict's GlobalCoast initiative

coastpredict.org

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

This programme is endorsed by the UN Decade of Ocean Science

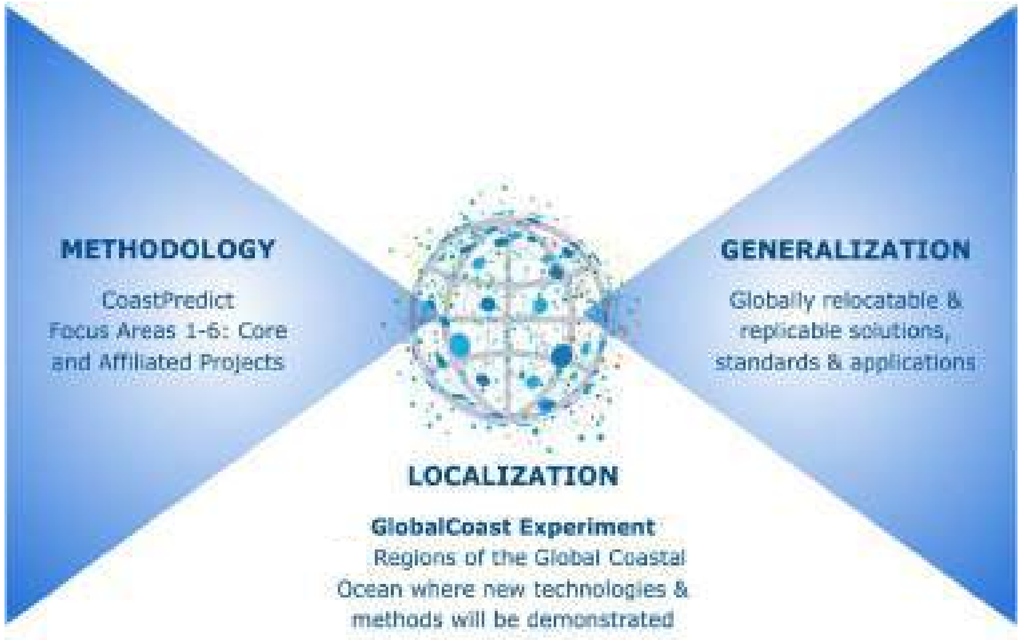
GlobalCoast

Demonstrate (at Pilot Sites) an integrated observing and predicting system for the global coastal ocean

Create globally replicable solutions, standards, and applications that enhance coastal resilience

Accelerate the data collection and advance modelling and analysis tools to be aligned with best practices and open and free data sharing

GlobalCoast
Global Coastal Ocean Experiment

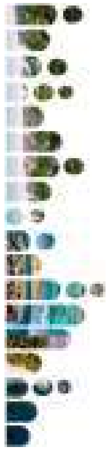


Barriers CoastPredict aims to overcome through GlobalCoast

1. International networking for Global Coastal Ocean innovation and solutions does not exist
2. Fragmentation of knowledge
3. Open and free data is still limited to the Global North
4. Coastal managers and the public generally not involved
5. I’rust in solutions still low
6. Study cases take a long time, with limited international collaboration

GlobalCoast survey insights

CoastPredict



30

Regions of the Global Coastal Ocean

125

Pilot Sites

225

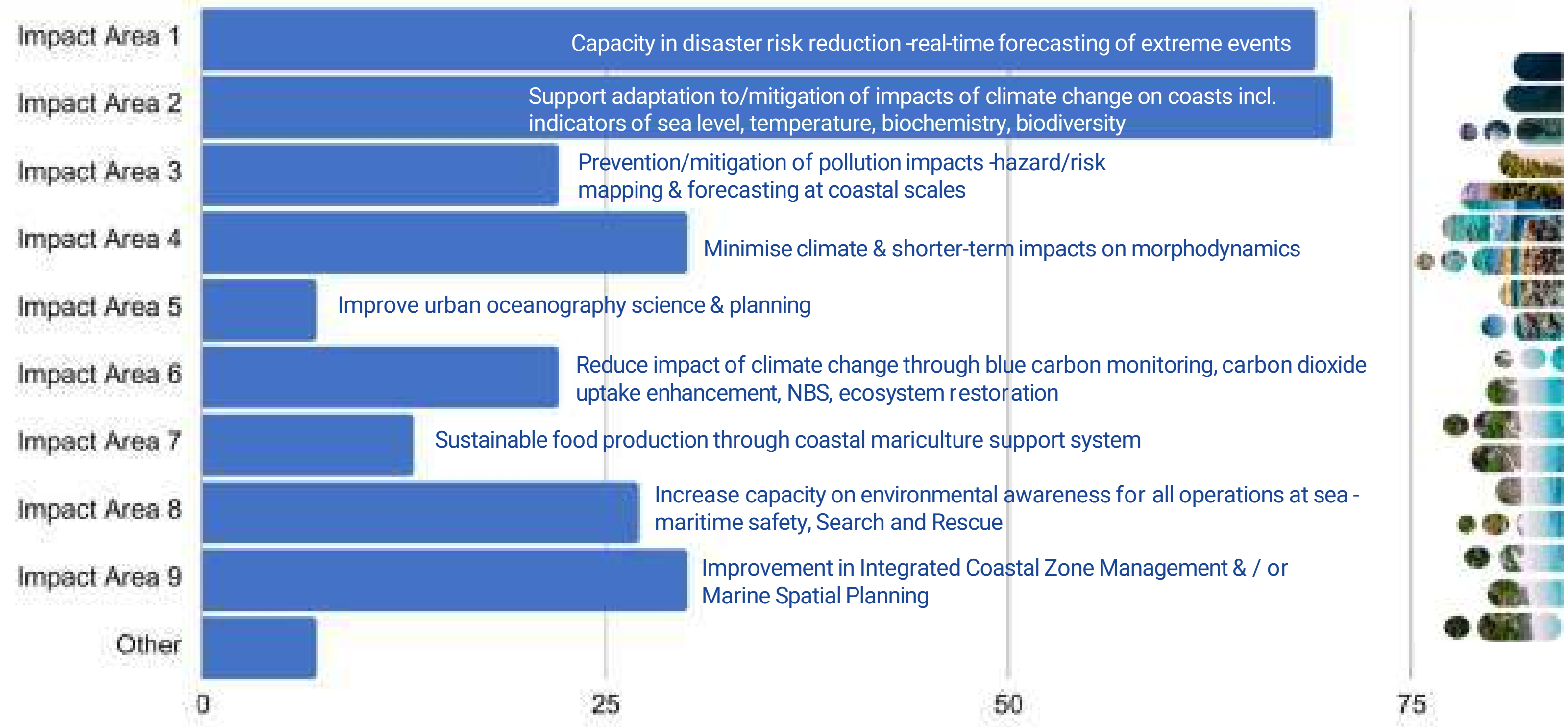
institutions in 65 countries

Pilot Site locations*

*subject to change -some locations to be verified

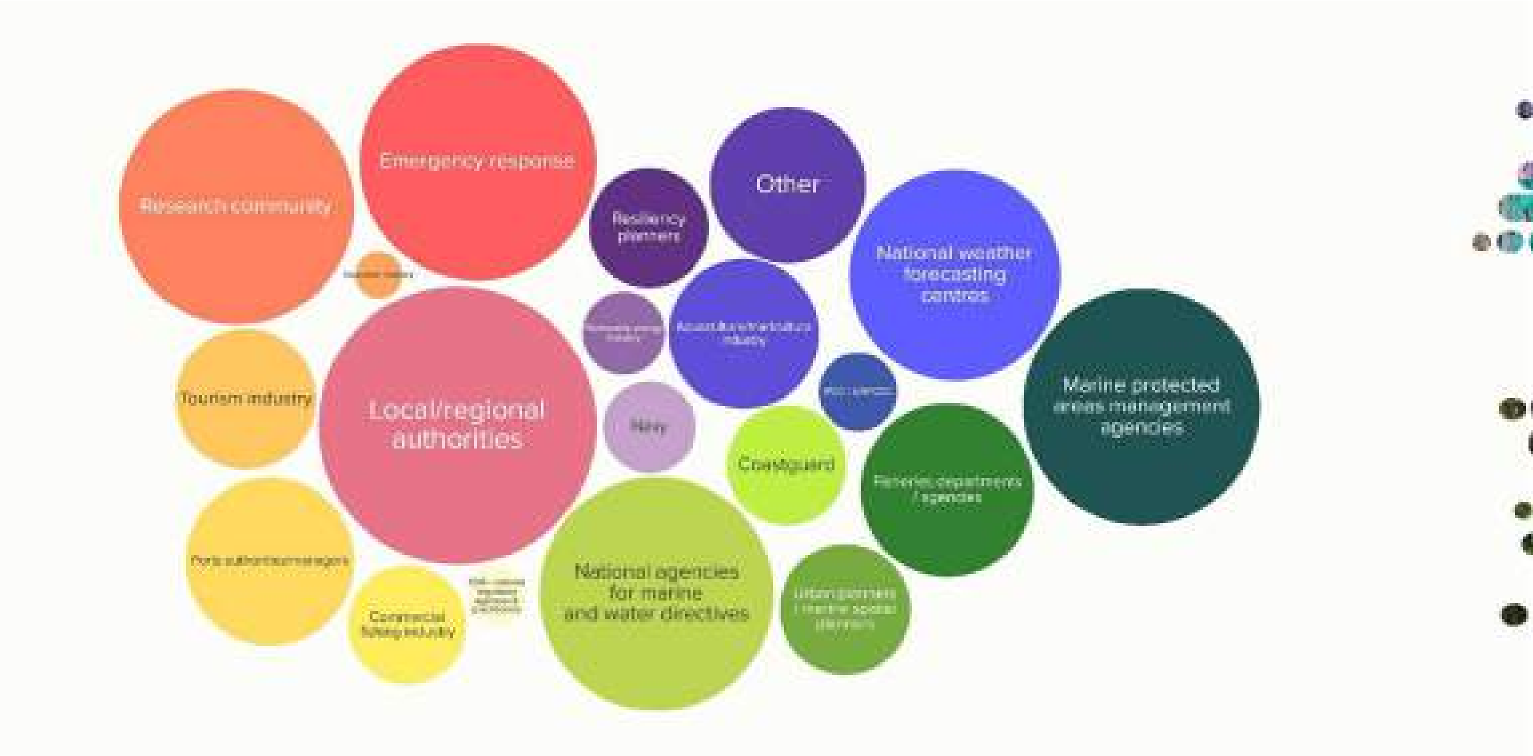
PRIORITY IMPACT AREAS

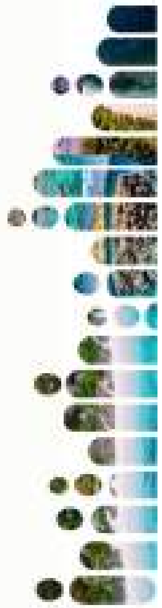
Q: Select up to three impact areas that will be addressed in your Pilot Site



STAKEHOLDER GROUPS

Q: Who are the key intermediate and end-users for the integrated observing and predicting system to be implemented in your Pilot Site?





Implementation at Pilot Sites

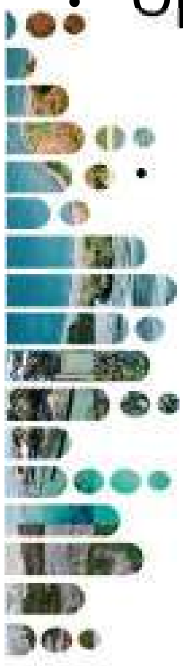
01. New technologies
for the coastal observing system will be implemented, innovated and tested at each Pilot Site to validate/calibrate regional and coastal models

02. Regional-coastal limited area models & AI-based models
will be implemented to assess the range of predictability and understand uncertainties, and provide an impact ensemble framework

03. 100 years projections
will be produced by implementing regional to coastal climate limited area and AI-based models to downscale climate scenarios

04. High resolution reanalysis to instruct AI networks
will be produced at the coastal scale

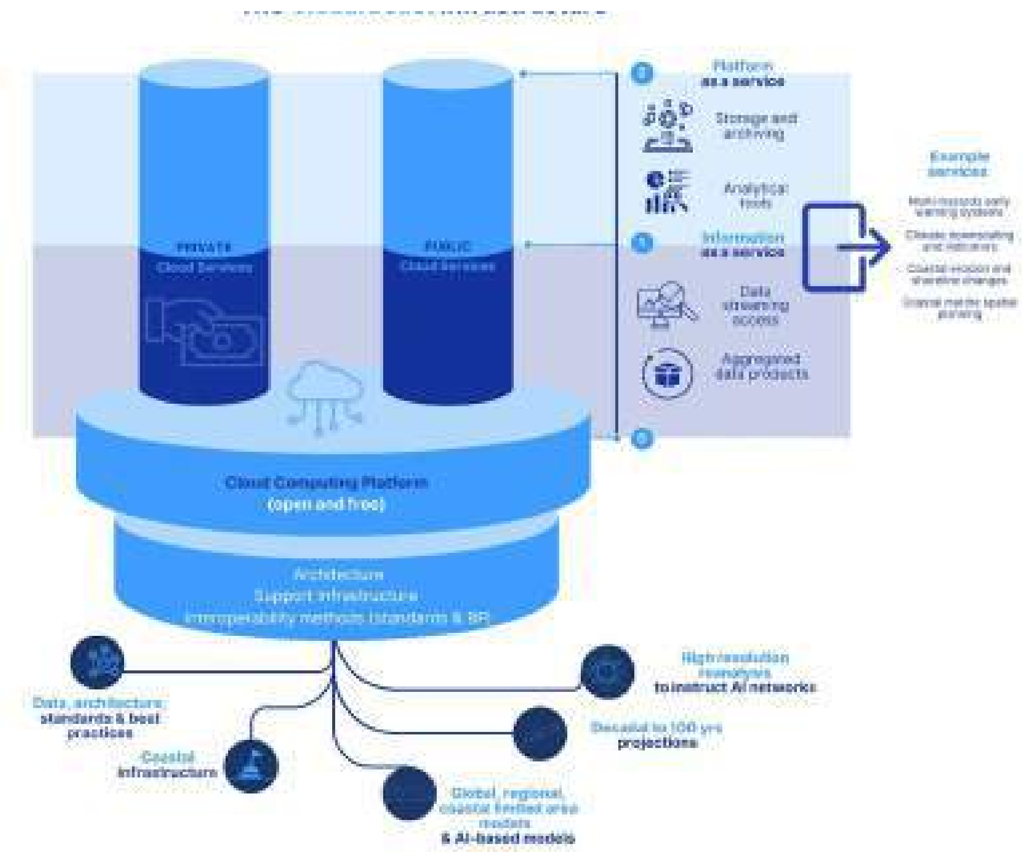
The ‘accelerator’



- Open, free GlobalCoast digital infrastructure

  - Coastal Resilience requires a vast data and computing infrastructure to make science-based information accessible and usable
    - increase the amount of coastal data open and freely available requiring the collection of cost-efficient and community observations with standard protocols
    - improve information quality, making analysis tools accessible and demonstrating services built on cloud data

GlobalCoast digital infrastructure



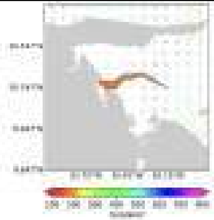
Services that could be developed

Relocatable models, Digital Twins, What-if scenarios, Ocean indicators, Early warnings

Early warning for Extreme events

Support to Coastal management

Marine pollution monitoring/forecasting



Nature Based Solutions planning and monitoring

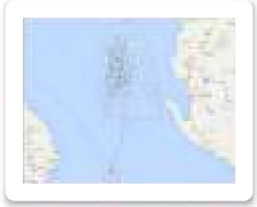
Aquaculture plannning and management

Coastal Sea Situational Awareness

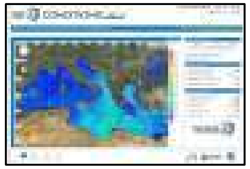
Ship routing

Climate indicators

Search and rescue



Data visualization



Planning/management of Marine Renewable energy

Marine Protected areas planning&management

CDR planning/monitoring

Ocean City and Ports management

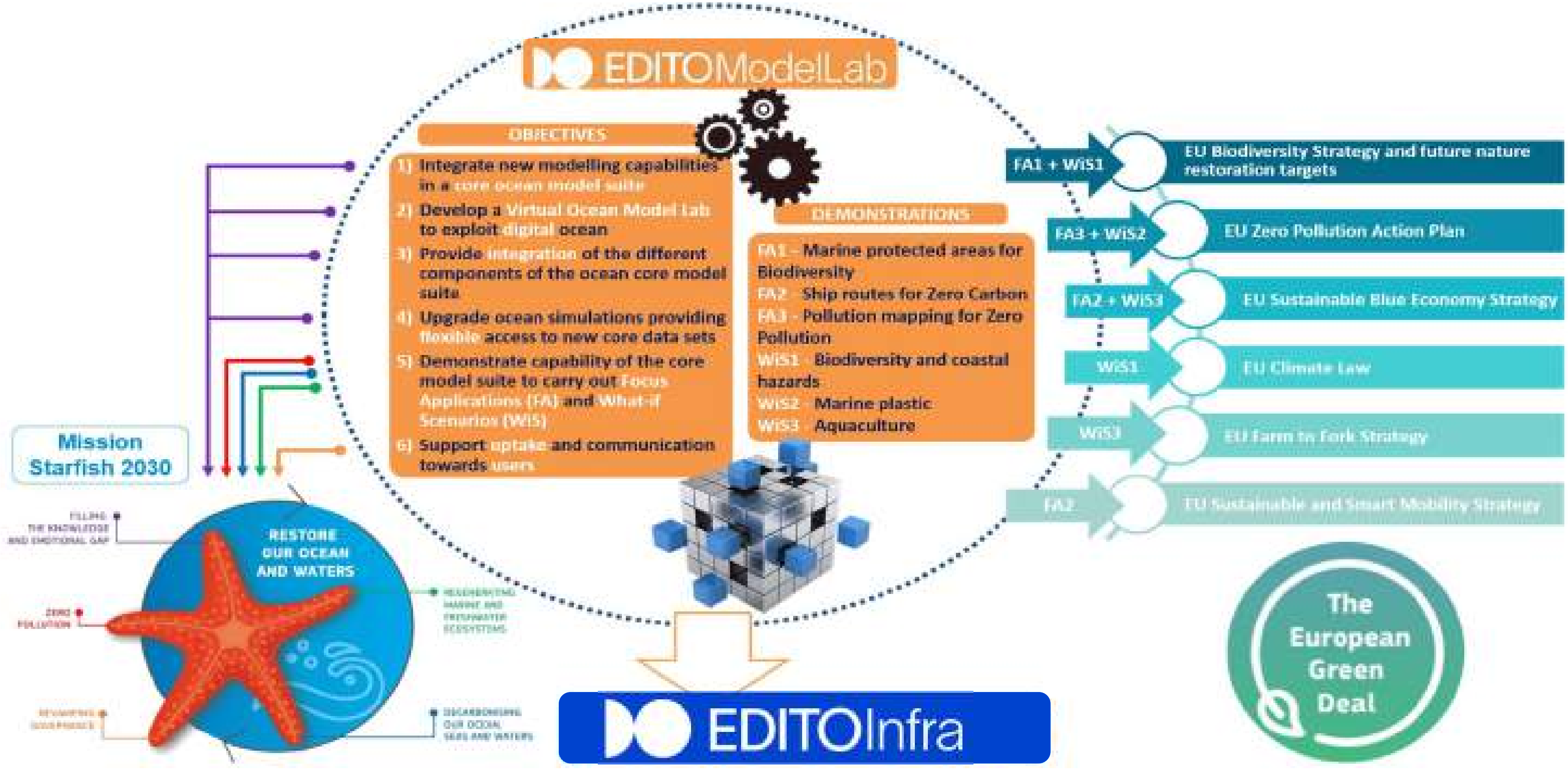
Thank you for your attention

Introduction

Meeting objectives and organisation

Y Drillet, M Malicet (MOi)

EDITO Model Lab : Underlying Models for Digital Twin Ocean



EDITOModelLab

To ensure an operational European Digital Twin Ocean (EDITO) core infrastructure by 2024, the building blocks of the initiative are underway through the Horizon Europe-funded sister projects:

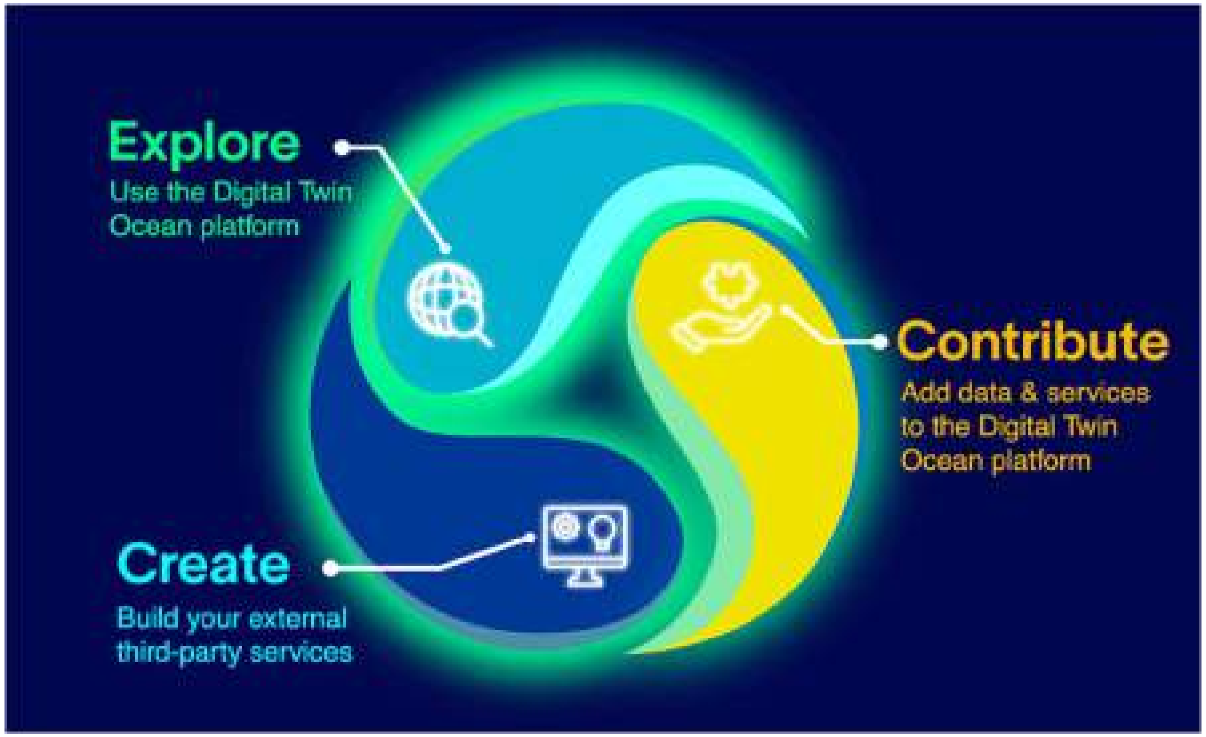
EDITOInfra   EDITOModelLab

Together, these two projects will build the Digital Twin Ocean platform, incorporating a data lake, processing engine and virtual simulation environment.

What EDITO will deliver ?

An integrated platform

New services



EDITOModelLab

A consortium based on ocean modeling expertise

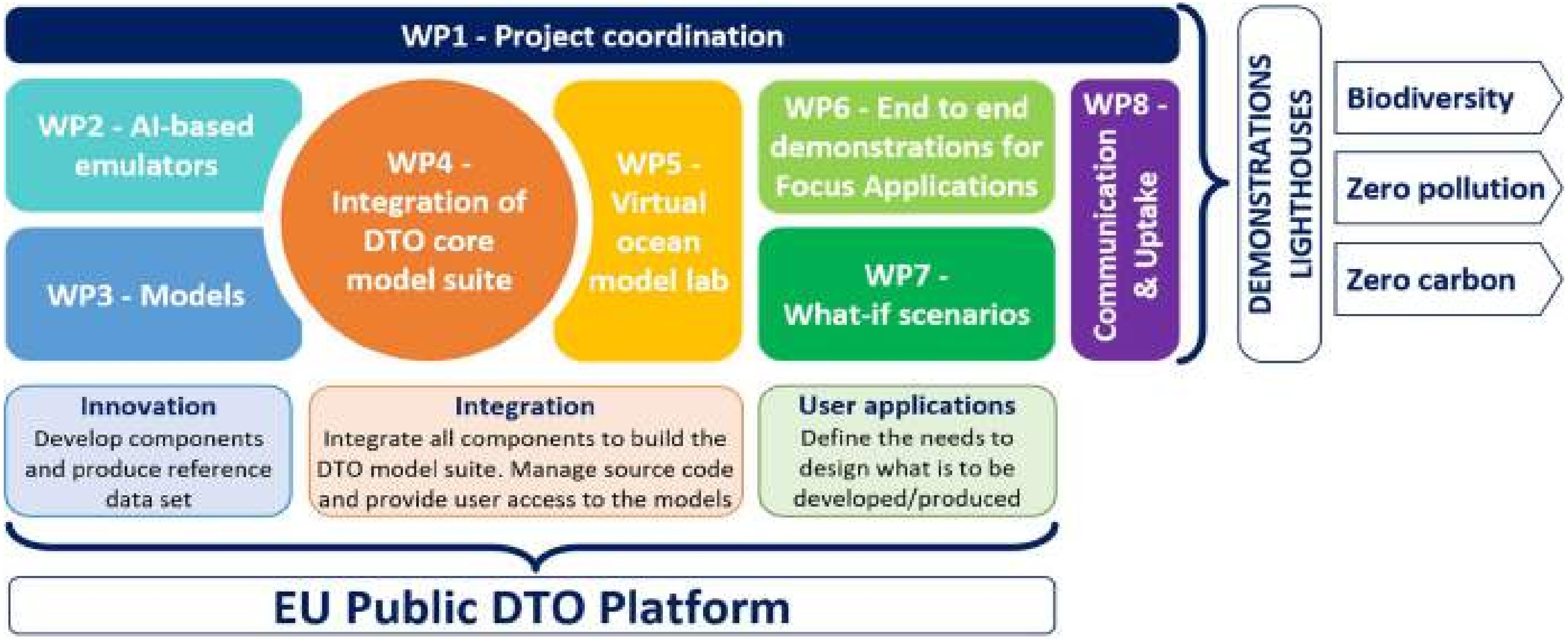
7M€
3-year project
Kickoff meeting 21-22 Feb 2023

13 partners from 8 countries with expertise in :

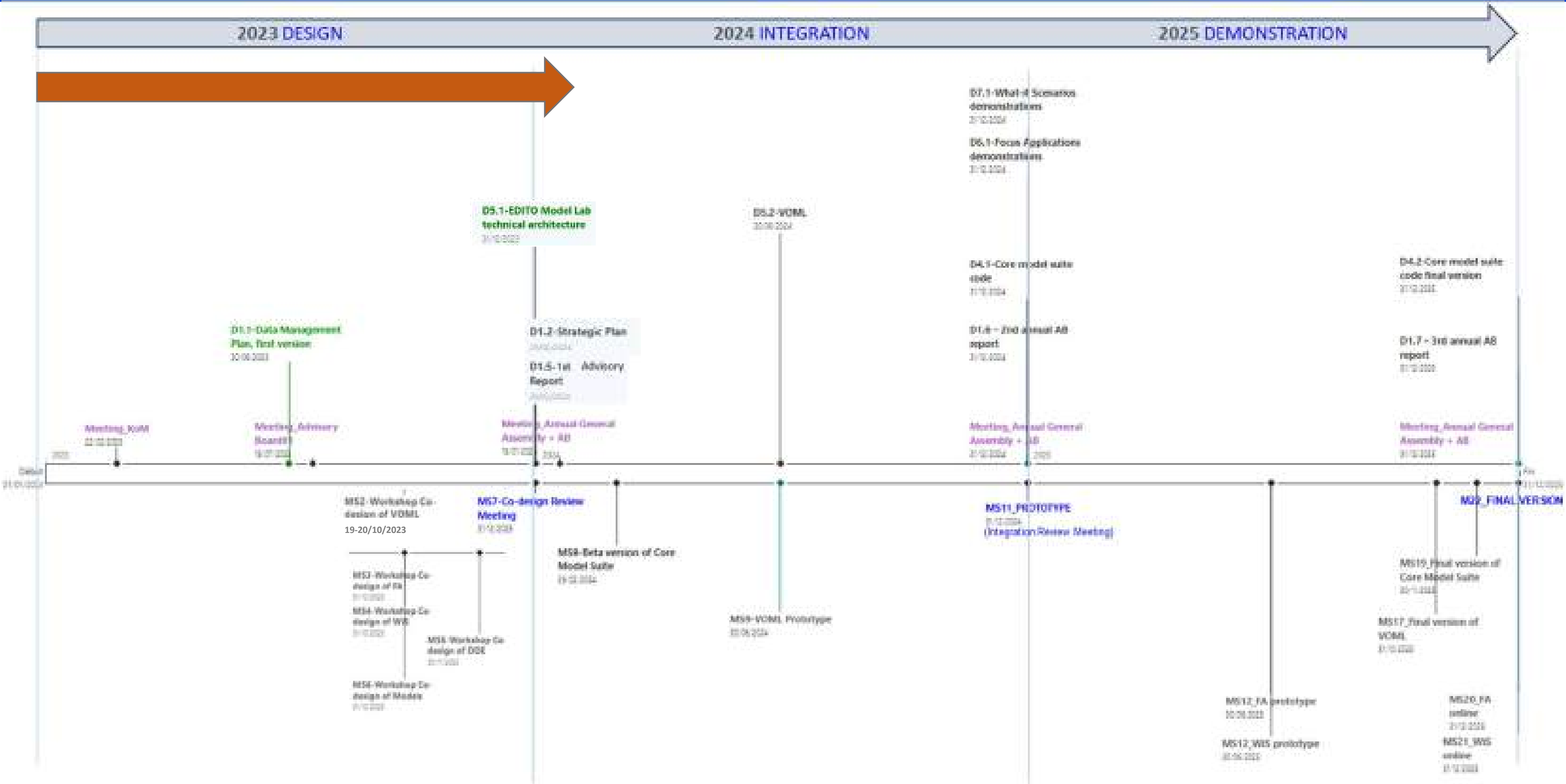
- **Ocean modeling from global scale to coastal, for ocean physics, biogeochemistry and marine environment**
- **Supercomputing including experts from computing centers**
- **Artificial Intelligence applied to ocean application**
- **Software development, model and tools co-development**
- **Operational oceanography with strong links with Copernicus Marine, Ocean Predict and UN decade**
- **Intermediate to final User applications**

EDITOModelLab

Project organisation



EDITO-Model Lab timeline: General



Objectives of this Annual General Assembly 2024

Status on the project

- Main achievements of the first year of the project : Co design phase of the project has been finalised
- Examples of development performed during the first year
- Plan for next year : Integration started

Link

Agenda

& Meeting organisation

M Malicet (Moi)

Agenda – DAY 1

Agenda LINK

DAY 1 – PROJECT ACHIEVEMENTS AND WORKPLAN

Tuesday	**16 January 2024**	**Ground floor, Conference Room**	
8:30 - 8:55	Welcome with coffee		
9:00 - 9:45	Opening words Goal Definition	CMCC - L Panzera, G Coppini EC - Z Konstantinou (DG Mare), Nicolas Segebarth (DG RTD) MOi - Y Drillet	Advisory Board
9:50-10:35	Achievements/Next steps Project Management/Comm-Dissem-Uptake (WP1/WP8)	+ATLANTIC, MOi	Advisory Board
10:40-11:05	*Break with cofree (Ground floor, Coffee Break Room)*		
11:10-12:40	Achievements and next steps AI and Models (WP2/WP3)	CMCC, IMT, MOi	Advisory Board
12:45-14:00	*Lunch Break – Restaurant Li Risi, via della Libertà 163*		
14:15-15:45	Achievements and next steps Core Model Suite and Virtual Ocean Model Lab (WP4 -WP5)	BSC CNS, MOi	Advisory Board
15:45-16:10	*Break*		
16:15-17:45	Achievements and next steps Focus applications and What-if-Scenarios (WP6- WP7)	CMCC, Deltares, HEREON	Advisory Board
17:45-18:00	Day Closure		
18:00-19:30	*Free Time*		
19:30 – 21:30	*Aperidinner – Restaurant Signuria, via Augusto Imperatore 13*		

Agenda – DAY 2 (morning)

DAY 2 morning – USER SESSIONS

Wednesday	17 January 2024	Ground floor, Conference Room	
9:30 - 10:30	User Session 1 WiS#1 - Nature Based Solutions for Biodiversity and coastal hazards 1-Presentation of Application 2-Demo 3-Discussion with users	CMCC, DMI, HEREON, UniBO	Advisory Board External Users
10:30-10:50	User Session 2 WiS#2/FA#3 – Zero Pollution 1-Presentation of Application	CMCC, UniBO	Advisory Board External Users
10:50-11:15	*Break with cofree (Ground floor, Coffee Break Room)*		
11:20-12:00	User Session 2 WiS#2/FA#3 – Zero Pollution 2-Demo 3-Discussion with users	MOi	Advisory Board External Users
12:00-12:40	User Session 3 FA#1 – Marine Protected Areas for Biodiversity 1-Presentation of Application 2-Demo 3-Discussion with users	Deltares	Advisory Board External Users
12:45-14:25	*Lunch Break – Restaurant Aglio&Olio, via Bachelet at Centro Commerciale Lo Spazio*		

Agenda – DAY 2 (afternoon) + DAY 3 *(Partners only)*

DAY 2 afternoon + DAY 3 – PROJECT TECHNICAL SESSIONS *(Partners only)*

Wednesday	**17 January 2024**	**Ground floor, Conference Room**
14:30-15:30	Setting up Uptake and Exploitation based on Co-Design Review (WP8)	+ATLANTIC, SOCIB
15:30-17:30	Meeting on Integration (WP4) • Development of the EDITO core model suite (Task 4.2)	CMCC, IMT, MOi
17:30-18:00	Day Closure	
18:00-20:00	*Tour of Lecce*	

Thursday	**18 January 2024**	**Ground floor, Conference Room**
9:30 – 11:00	Meeting on Integration (WP4) • Integration of the EDITO core models suite (Task 4.3) Dedicated session with EDITO Infra	BSC CNS
11:00-11:25	*Break with cofree*	
11:30-13:00	Meeting on Integration • Simulations and quantification of the benefit of EDITO models (Task 4.4) • Optimization of the workflow of EDITO Model and Technical support (Task 4.5) Dedicated session with EDITO Infra	CINECA, DMI,
13:00-14:15	*Lunch Break - TBC*	

EDITOModelLab

Project Advisory Board

S. Garavelli
(**CSC**, FI (EOSC, Fair Data))

F. Jourdin
(**SHOM**, FR)

D. Macias Moy
(**JRC**, EU (Modelling))

A. Oliveira
(**LNEC**, PT (Coastal))

J. Piera
(**CSIC**, SP (Citizen Science))

A. Rocha
(**INESC TEC**, PT (Iliad))

B. Chapron
(**IFREMER**, FR)

F. Courteille
(**NVIDIA**, UK)

EDITOModelLab

DAY 2 User Sessions – Participants (39)

Your name	Your organization / Your project
Christine Pequignet	Met Office
Giulio Ceriola	Planetek Italia
Aditi Goswami	Boeing/ AI in Aerospace
Marta Rodrigues	LNEC - Laboratório Nacional de Engenharia Civil / Project: CONNECT
Marcos G Sotillo	NOW Systems
Manuela D'Amen	ISPRA - ITALY
Fearghal O'Donncha	IBM Research Ireland
Stefania Ciliberti	NOW Systems
Janaka de Silva	IUCN
Luc Vandenbulcke	seamod.ro / SYROCO
Katerina Spanoudaki	FORTH
GEORGIOS SYLAIOS	DEMOCRITUS UNIVERSITY OF THRACE / ILIAD
Barış Salihoğlu	BRIDGE-BS / Middle East Technical University
Pınar Uygurer	BRIDGE-BS / Middle East Technical University
Ute Brönner	SINTEF Ocean / Iliad Digital Twins of the Ocean
Thomas Geenen	ECMWF DestinE
Patricia Cabrera	VLIZ-BlueCloud2026
Lawrence Whatley	VLIZ
Manuel García	NOW Systems
Derval Corinne	Copernicus Marine, Mercator Ocean
Gideon Gal	IOLR
Arne J. Berre	SINTEF
Christophe BRIERE	REST-COAST

Your name	Your organization / Your project
Daiga Cepite-Frisfelde	Hywasport
Audrey Hasson	GEO Blue Planet, Mercator Ocean
Elena Osipova	European Environment Agency
Stefania Ciliberti	NOW Systems
Francesco de Franco	Torre Guaceto MPA
Paolo D'Ambrosio	Porto Cesareo MPA
Nicola Ungaro	Environmental Agency of Apulia Region
Comandante di Vascello Francesco Perrotti	Capitaneria di Porto di Gallipoli
Tenente di Vascello Francesco Walter di Marco	Capitaneria di Porto di Otranto
Prof. Alberto Basset	University of Salento
Prof. Stefano Piraino	University of Salento
Prof. Francesco Mastrototaro	University of Bari
Gaetano Internò	Port Authority of Taranto
Francesco Ronco	Apulia Region
Valentina De Pinto	Apulia Region
Carmelo Calamia	Province of Lecce

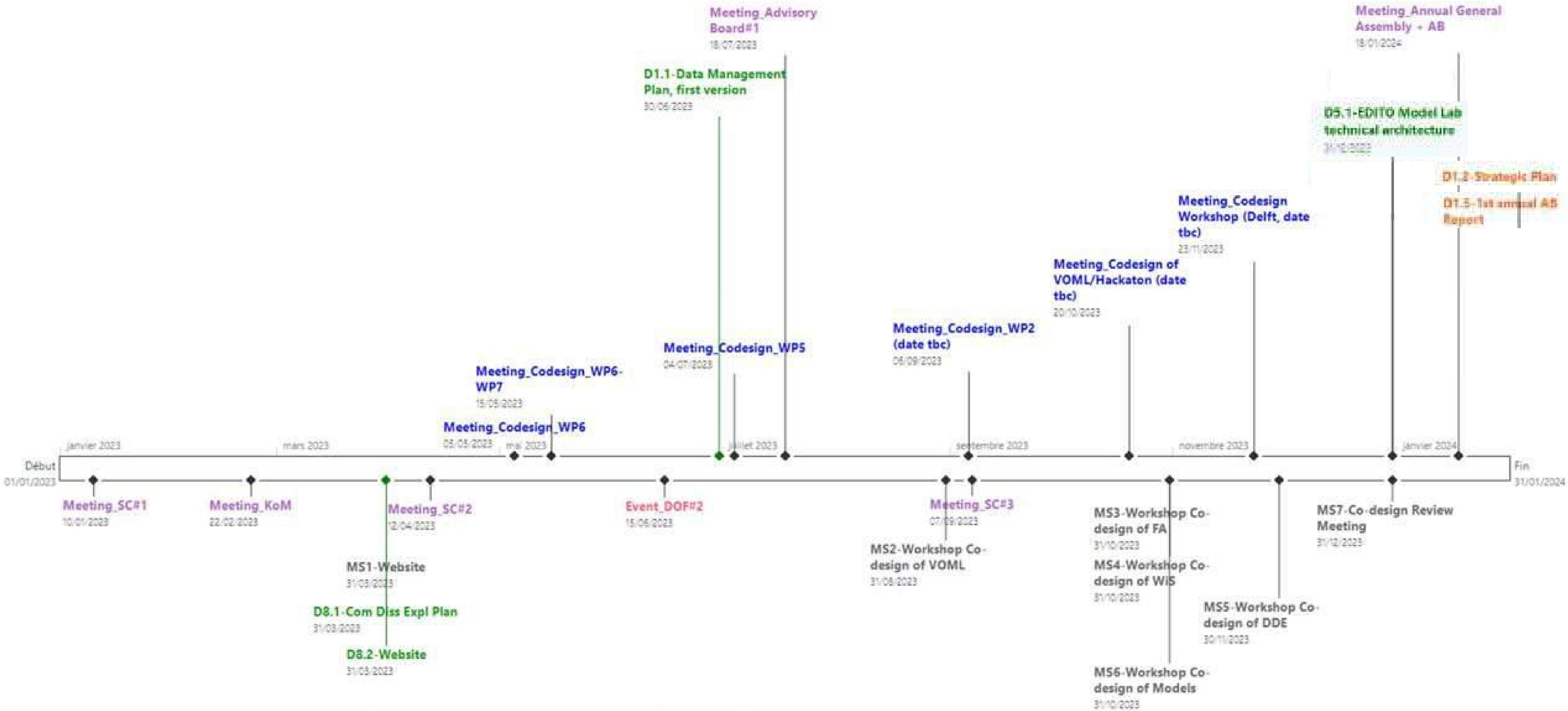
EDITOModelLab

Achievements and next steps

Project Management / Communication-Dissemination-Uptake (WP1/WP8)

Moderator: Y Drillet (MOi)

Year 1 overview



Year 1 overview

4 Deliverables submitted:

- D8.1 Plan for Communication, Dissemination and Exploitation of results (WP8, April 2023)
- D8.2-Website (WP8, April 2023)
- D1.1-Data Management Plan - first version (WP1, June 2023)
- D5.1 EDITO-Model Lab Technical Architecture (WP5, December 2023)

7 Milestones reached:

- Milestone 1-Website (WP8, March 2023)
- Milestone 2-Workshop for co-design of the Virtual Ocean Model Lab (WP5, October 2023)
- Milestone 3-Workshop for co-design of Focus Application (WP6)
- Milestone 4-Workshop for co-design of What-if-Scenarios (WP7)
- Milestone 5-Workshop for co-design of Deep Differentiable Emulators (WP2)
- Milestone 6-Workshop for co-design of the models (WP3)
- Milestone 7-CO-DESIGN (WP1, November 2023)

Numerous Project Meetings, over 20 EDITO events, etc.

EDITOModelLab

WP1 - Task 1.1 Technical coordination

Task 1.1 Technical coordination (Lead: MOi | Partners: all). [M1-M36] (D1.2, D1.4; Milestone M7,M11,M22)

MOi, the Project Coordinator (PC) supported by the Project Management Office (PMO), will coordinate scientific, technical and strategic delivery of EDITO-Model Lab, including overseeing the Steering Committee (SC), chairing the decisions of the General Assembly (GA) and managing resources for the external Advisory Board (AB), in addition of taking care of gender balance in each committee and board. The SC will be responsible for the execution of work plan activities.

The internal communication will be coordinated with the communication activities (WP8). A dedicated communication portal that will be settle will offer archiving of conversations, document collaboration features, a repository for documentation, software codes and tracking of project milestones. Technical coordination will be managed with internal reviews, including a design phase and integration phase that will be organised during the project to integrate first the beta version and, at the end, the final version of EDITO core model suite. The technical coordination will be also in charge of management of IT resources dedicated to the project (including HPC and Cloud resources). A strategic plan including scientific and technical roadmap, feedback from the design and HPC and Infrastructure needs will be delivered (D.1.2 and D1.4).

WP1 - Task 1.1 Technical coordination

WP1-T1.1 ACHIEVEMENTS (Year 1)

- ❑ **1 Kick-off Meeting** l 21-21 February 2023 (with AB)

- ❑ **3 Steering Committees:**
  - -SC#1 l 10 January 2023
  - -SC#2 l 12 April 2023
  - -SC#3 l 7 September 2023
  - *-SC#4 l 11 January 2024*

- ❑ **1 dedicated meeting with Advisory Board** l 18 July 2023

- ❑ *1 Annual General Assembly , 16-18 January 2024 (presently)*

EDITOModelLab

WP1 - Task 1.1 Technical coordination

WP1-T1.1 ACHIEVEMENTS (Year 1)

Building on completion of Milestone 2 (WP5):

- Milestone 2-Workshop for co-design of the VOML (WP5, 19-20 October 2023) (with EDITO-Infra)

- Milestone 3-Workshop for co-design of Focus Application (WP6)
- Milestone 4-Workshop for co-design of What-if-Scenarios (WP7)
- Milestone 5-Workshop for co-design of Deep Differentiable Emulators (WP2)
- Milestone 6-Workshop for co-design of the models (WP3)

✓ *A Co-Design technical meeting organized on 19-20 October 2023 in Toulouse, France at Mercator Ocean International, that gathered over 50 on-site beta-testers and remote participants testing and refining the Virtual Ocean Model Lab (VOML) for the EU DTO.*

✓ *https://edito-modellab.eu/news/users-co-design-meeting-kicks-off-testing-for-edito-s-virtual-ocean-model-lab*

EDITOModelLab

WP1 - Task 1.1 Technical coordination

WP1-T1.1 ACHIEVEMENTS (Year 1)

- ❑ **Milestone 7-CO-DESIGN (WP1)**

Co-design review meeting closing Year 1 Co-Design Phase

-Planned Month 12 (December 2023)

-Achieved **Month 11 l 22-23 November 2023 l CO-DESIGN REVIEW MEETING** (with AB, EDITO-Infra, Users)

- ✓ *A Co-Design Review organized in Delft, The Netherlands, gathering over 70 participants from the Project, its Advisory Board and external parties from across Europe, validating components crucial for the EDITO-Model Lab Technical Architecture.*
- ✓ https://edito-modellab.eu/news/edito-model-lab-wraps-up-co-design-phase-with-empowering-testers-rsquo-workshop

EDITOModelLab

WP1 - Task 1.2 Monitoring progress

Task 1.2 Monitoring progress (Lead: MOi | Partners: all). [M1 – M36] (D1.1, D1.3, D1.5, D1.6, D1.7)

The Project Manager (PM) will oversee the day-to-day operational management and administration tasks of the project with the support of the PMO. A project kick-off meeting and three annual meetings will be held at the end of each project year. Quarterly project virtual meetings will help to: a) monitor general progress and achievement of KPIs of the WPs and risks; b) facilitate communication and scientific discussion and c) assist the reporting process. Annual GA virtual meetings will monitor progress, discuss issues and opportunities and devise mitigation strategies where needed. A risk register and process diagram will be set up at the project inception and managed throughout, the PC will report deviations from the work plan to the GA. The Data Management Plan (DMP) will be defined at the first stage of the project for data and software produced by EDITO-Model Lab (D1.1) and updated at the end of the project D1.3).

WP1 - Task 1.2 Monitoring progress

WP1-T1.2 ACHIEVEMENTS (Year 1)

- ❑ **D1.1-Data Management Plan - first version (WP1, June 2023)**

-Planned & Delivered **Month 6 (June 2023)**

Describes the preliminary plan for the cycle for the data to be collected, processed and/or generated by EDITO-Model Lab, including the description of the management procedure, storage infrastructures and standards that will be used during the project. D1.3-Data Management Plan (final) due Month 36.

Horizon Europe

EDITO-MODEL LAB

Data Management Plan

EDITOModelLab

WP1 - Task 1.3 Financial and management reporting

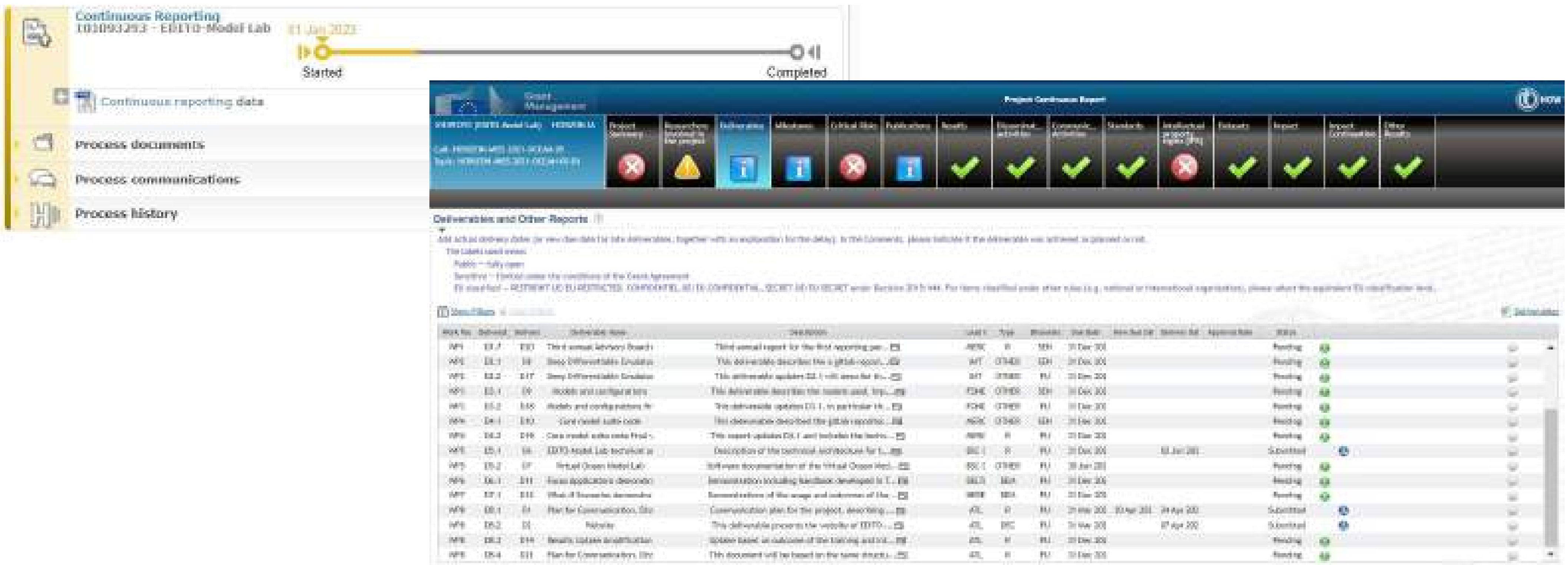
Task 1.3 Financial and management reporting (Lead: MOi). [M1 – M36]

This task coordinates the financial flows between the EC and the consortium partners and oversees the financial reporting of the WPs. Periodical financial and management reporting, as well as scientific and technical reporting will be undertaken by the PC along with all partners. WP leaders will be responsible for scientific and technical reporting at the WP level. The number and timing of the financial and management reports are expected to be agreed with the EC in the Grant Agreement.

WP1 - Task 1.3 Financial and management reporting

WP1-T1.3 ACHIEVEMENTS (Year 1, 2023)

- ❑ Continuous Reporting through EU Funding & Tenders Platform since start of the project



EDITOModelLab

WP1 – WORKPLAN for 2024 (Year 2)

WP1-WORKPLAN for 2024

DELIVERABLES

- ❑ D1.2 Strategic Plan (WP1-T1.1)

  Strategic Plan including scientific and technical roadmap, feedback from the design and HPC and Infrastructure.

-Planned Month 12

-Extented to Month 14 (February 2024)

- ❑ D1.5 First Annual Advisory Board Report (WP1-T1.2)

-Planned Month 12

-Extented to Month 14 (February 2024)

- ❑ D1.6 Second Advisory Board Report (WP1-T1.2)

-Planned Month 24 (December 2024)

EDITOModelLab

WP1 – WORKPLAN for 2024 (Year 2)

WP1-WORKPLAN for 2024

Reporting					Payments	
Reporting periods			Type	Deadline	Type	Deadline (time to pay)
RP No	Month from	Month to				
1	1	12	Periodic report	60 days after end of reporting period	Interim payment	90 days from receiving periodic report
2	13	21	Periodic report	60 days after end of reporting period	Interim payment	90 days from receiving periodic report
3	22	30	Periodic report	60 days after end of reporting period	Final payment	90 days from receiving periodic report

MILESTONES

- ❑ Milestone 11 Prototype (WP1)

Integration review meeting Closing Year 2 Integration Phase

-Expected Month 24 (December 2024)

REPORTING

- ❑ Continuous Reporting

- ❑ Periodic Report #1 (technical+financial) (Month 1 to Month 12)

-Planned end of February 2024

- ❑ Periodic Report #2 (technical+financial) (Month 13 to Month 21)

-Expected end of November 2024

WP1 – Project Reviews

WP1-WORKPLAN for 2024

CHECKS & PROJECT REVIEWS (RV) *(GA Art. 25)*

- Project reviews are organisedback to back with the reporting periods
- In-depth review of the progress in implementing the work (plan)
- Generally with external reviewers (experts)

❑ RV#1

-Planned Month 15 (March 2024)

-Ongoing organisation with EC

❑ RV#2

-Planned November 2024

PROJECT REVIEWS

Project Reviews

Grant Preparation (Reviews screen — Enter the info)

Review No	Timing (month)	Location	Comments
RV1	15	Brussels, TBC	
RV2	23	Brussels, TBC	
RV3	36	Brussels, TBC	

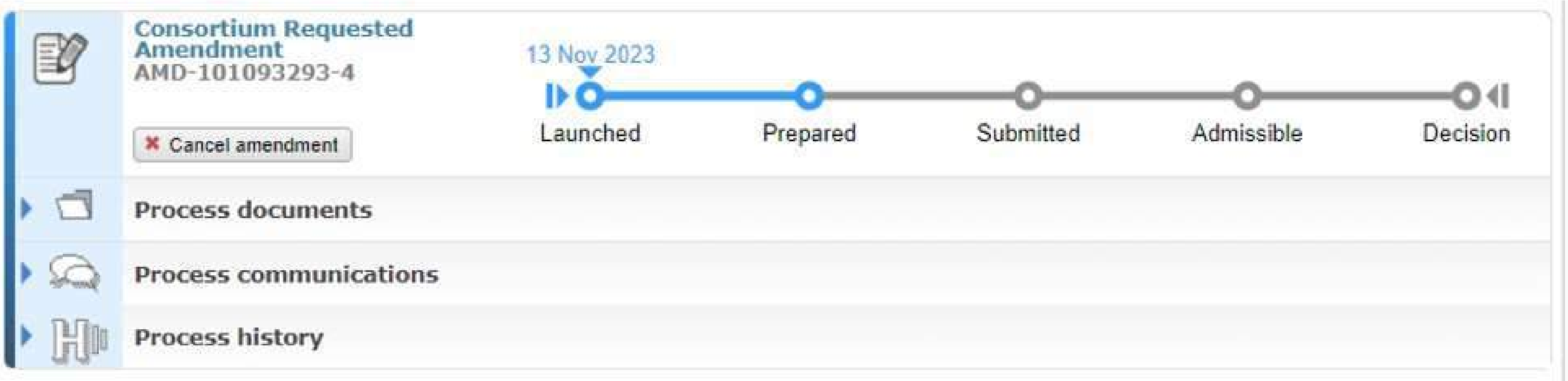
DAY 2	X March 2024	Roles	Location
EDITO-MODEL LAB			Remotely
9:00 - 9:10	Introduction	PO	
9:10 - 9:30	EDITO-Model Lab Objectives	MOI	
9:30 - 10:50	WP Progress WP1 (10') WP2 (10') WP3 (10') WP4 (10') WP5 (10') WP6 (10') WP7 (10') WP8 (10') *Present progress, justify deviations, Participation to events…*	Partners	
10:50 – 11:15	Break		
11:20 – 11:40	Discussion with EC and Reviewers	PO, Partners, Reviewers	
11:40 – 12:00	Closing remarks/words *Approved / rejected / revision*	PO	

EDITOModelLab

WP1 – Amendment

❑ Ongoing Amendment Process

Following NVIDIA withdrawal from the Project consortium (regarding IP clause towards ownership of results)



EDITOModelLab

European Digital Twin Ocean

2023 General Assembly

16-18 January 2024 – Lecce, Italy

WP 8

Communication, dissemination and uptake

WP Leader
+ATLANTIC

WP Partners
All Beneficiaries

MERCATOR OCEAN INTERNATIONAL

WP8 Objectives

MAIN GOALS

- Make EDITO and the **project known** by a significant network of key stakeholders
- **Foster the uptake** of the projects' outcomes by relevant users
- **Boost networking** on DTO matters

SPECIFIC GOALS

- Run a wide-ranging communication plan to **publicise the project's progress (all WPs) and EDITO matters**
- **Organise two training events (with WP6 and WP7)** to further develop the project's products and to demonstrate their utility for end-users
- Expand the awareness of society about EDITO, **supporting key global ocean related initiatives**

TOP CHALLENGE

- Get significant visibility and build a relevant audience in the **very competitive EU projects' landscape**

KEY SOLUTION

- Join forces with existing networks and use communication channels of **partners and relevant initiatives** on DTO and marine matters

WP8 Tasks

T8.1
COMMUNICATION & DISSEMINATION

Lead: +ATLANTIC
Partners: All
Duration: M1 to M36

T8.2
TRAINING ORGANISATION

Lead: MOi
Partners: +ATLANTIC, Deltares, DMI, Hereon, UniBO
Duration: M25 to M36

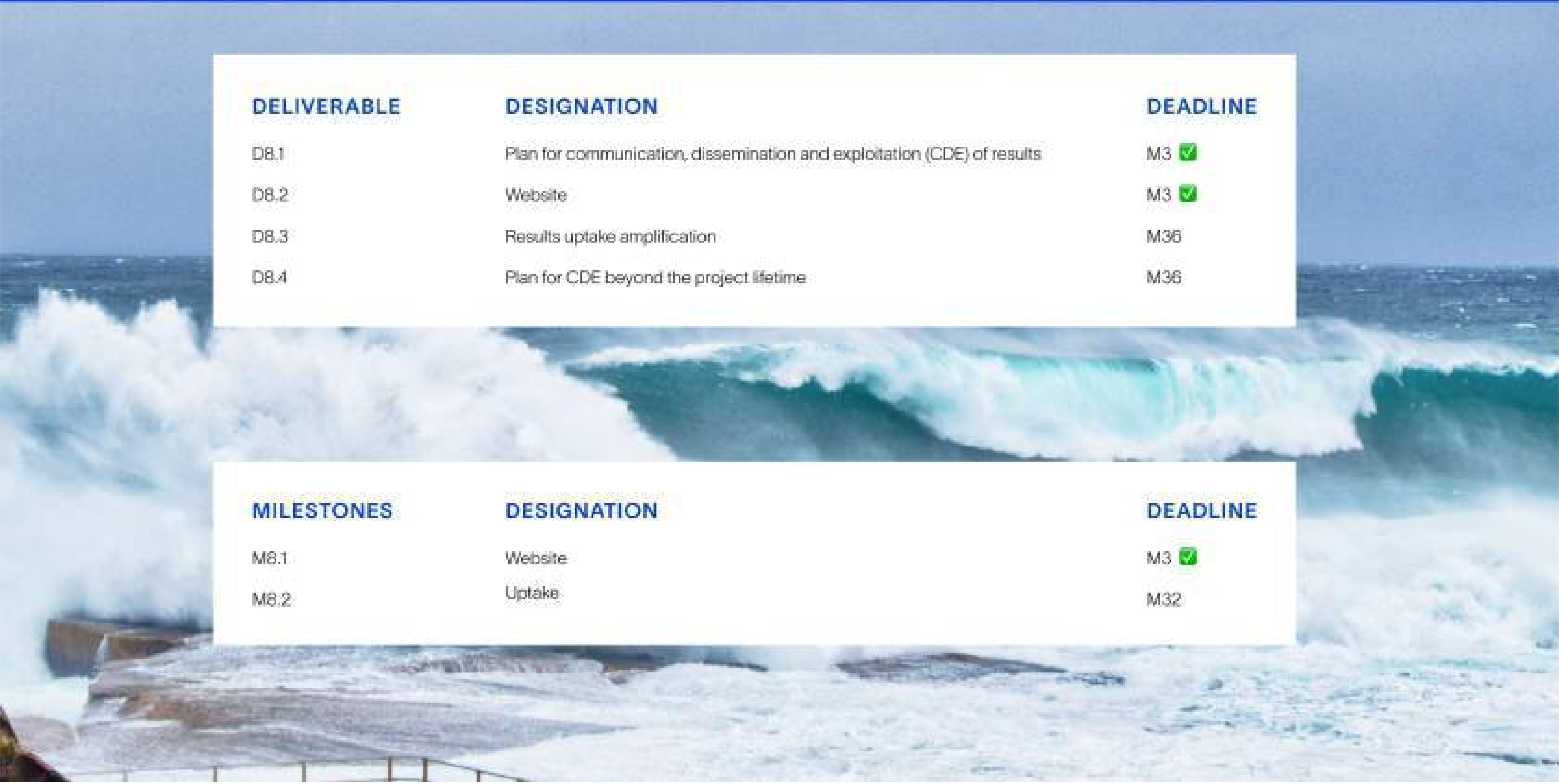
T8.3
INTERNATIONALISATION

Lead: +ATLANTIC
Partners: MOi
Duration: M1 to M36

WP8 Milestones & Deliverables

DELIVERABLE	DESIGNATION	DEADLINE
D8.1	Plan for communication, dissemination and exploitation (CDE) of results	M3 ✅
D8.2	Website	M3 ✅
D8.3	Results uptake amplification	M36
D8.4	Plan for CDE beyond the project lifetime	M36

MILESTONES	DESIGNATION	DEADLINE
M8.1	Website	M3 ✅
M8.2	Uptake	M32



Communication Working Group

PARTNER	REPRESENTATIVE	EMAIL
+ATLANTIC	Tiago Garcia	tiago.garcia@colabatlantic.com
MERCATOR OCEAN	Lilian Diarra	ldiarra@mercator-ocean.fr
NERSC	Julien Brajard	julien.brajard@nersc.no
UNIBO	Paolo Oddo	paolo.oddo@unibo.it
DELTARES	Eveline Filon	eveline.filon@deltares.nl
BSC	Miguel Castrillo Rosa Rodriguez Gasen	miguel.castrillo@bsc.es rosa.rodriguez@bsc.es
CINECA	Simona Caraceni	s.caraceni@cineca.it
CMC	Paola Agostini	paola.agostini@cmcc.it
CNRS		
DMI	Jun She	js@dmi.dk
HEREON	Carolina Gramcianinov	carolina.gramcianinov@hereon.de
IMT	Priscillia Creach	s.caraceni@cineca.it
SOCIB	Baptiste Mourre	bmourre@socib.es

DISSEMINATION IN EVENTS BY PARTNERS

2023 EMD
Brest, FR | Stand

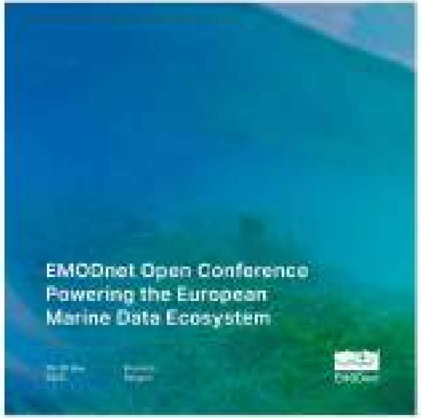
2023 DOF
Brussels, BE | Presentation

2023 EuroGOOS Conference
Galway, IE | Presentation

2023 EMODnet Conference
Brussels, BE | Stand and presentation

2023 DITTO Conference
Xiamen, CH | Presentation

2023 EDITO-Model Lab Co-Design events
Toulouse, FR and Delft, NL | Presentation and hackathon



2023 Results

JOINT COMMUNICATION WITH EDITO-INFRA

33
total amount of posts

642
total amount of followers

22336
impressions

9.84%
engagement rate

649
reactions

2023 Results

JOINT COMMUNICATION WITH EDITO-INFRA

214
total amount of followers

33400
impressions

47
total amount of created posts

208
Retweets

4.1%
engagement rate

481
reactions

WEBSITE

news articles 8

JOINT COMMUNICATION WITH EDITO-INFRA

Newsletter
1 email

Mailing list
193 subscribers

EDITO

Happy New Year

from EDITO

As we welcome the new year, we are thrilled to highlight EDITO's key achievements in 2023 and share upcoming milestones and events towards the co-creation of the European Digital Twin Ocean (EU DTO). Our teams, working on Horizon Europe projects EDITO-Infra and EDITO-Model Lab, have diligently crafted the digital architecture of the EDITO virtual platform. This includes a data lake, processing engine, virtual simulation environment, and more.

The EDITO Data Lake integrates components from existing EU ocean data programmes, such as the Copernicus Marine Service and EMODnet, creating a robust core infrastructure. Once launched, it will pave the way for a thriving EU DTO digital ecosystem, with additional projects aiming for full operational status by the end of 2024.

Next steps

Missing 2023 website news articles (with WP2, WP3 and WP4)

Planned early 2024 website news articles (with WP6 and WP7)

New video on WiS and FAs (with WP6 and WP7)

Editorial plan for 2024 (April to December)

EDITO Newsletter (with EDITO-Infra)

Intermediate user engagement plan

UN Ocean Decade Conference
Barcelona, SP
Stand, workshop and poster
(with MOi and EDITO-Infra)

2024 EGU General Assembly
Vienna, AU
Presentation (lead by DELTARES)

2024 DOF
Brussels, BE
Presentation and demonstration

Setting Up Uptake and Exploitation based on Co-Design Review | Day 2 14h30

MODERATOR +ATLANTIC (T Garcia)

RAPPORTEUR +ATLANTIC (S AGUIAR)

- OVERALL PLAN AND UPCOMING ACTIONS
- CALENDAR
- SUPPORTING PARTNERS
- TARGETED USERS
- PRODUCTS AVAILABILITY


European Digital Twin Ocean
EDITO
ModelLab
Just remember,
great communication
starts with you
#teamwork
Many thanks

BACK AT 11:10 AM

Achievements and next steps

AI and Models (WP2/WP3)

Moderator: G Coppini (CMCC), J She (DMI)

WP 2 – AI based emulators for ocean modelling and forecasting

WP2

□ **Year 1 Achievements - Year 2 Workplan, IMT (R Fablet) (25')**

- Example: Towards deep differentiable emulators for NEMO, HEREON (D Greenberg) (15')

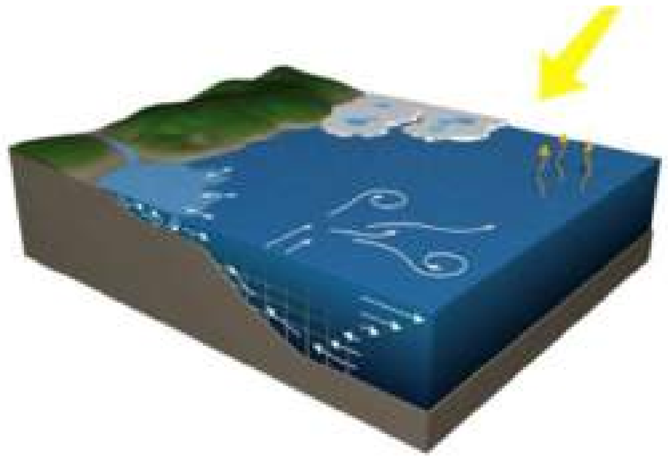
Discussion (5')

https://docs.google.com/presentation/d/1FySlS4-aAOLVPyBis81JqdDnUWo7mX1a/edit?usp=sharing&ouid=110563430246103777852&rtpof=true&sd=true

https://www.dropbox.com/scl/fi/t2sot0s15f0rfgh1gn2vk/pres_EditoModelLab_WP2_GA_202401-1.pptx?rlkey=jo192l8sscg3iu3n0wqah7fi7&dl=0

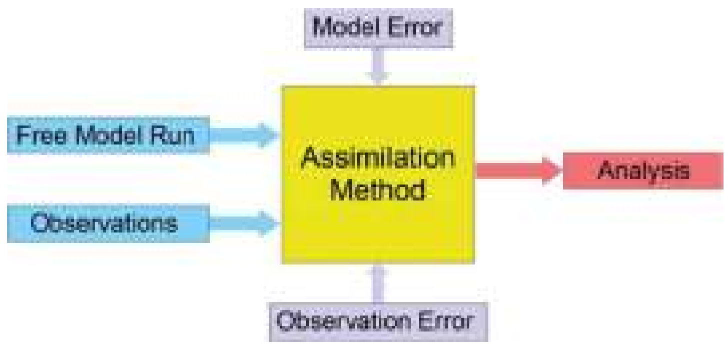
WP2 AI-based Emulators for Ocean Modelling and Forecasting

- **WP2 partners: IMT**, BSC, CNRS, Deltares, NERSC, Hereon
- **General objective**: **Bring AI/DL into the DTO core suite both for ocean modelling and data assimilation systems**



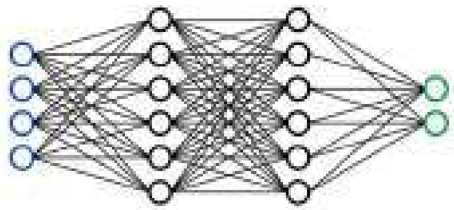
Ocean Modelling

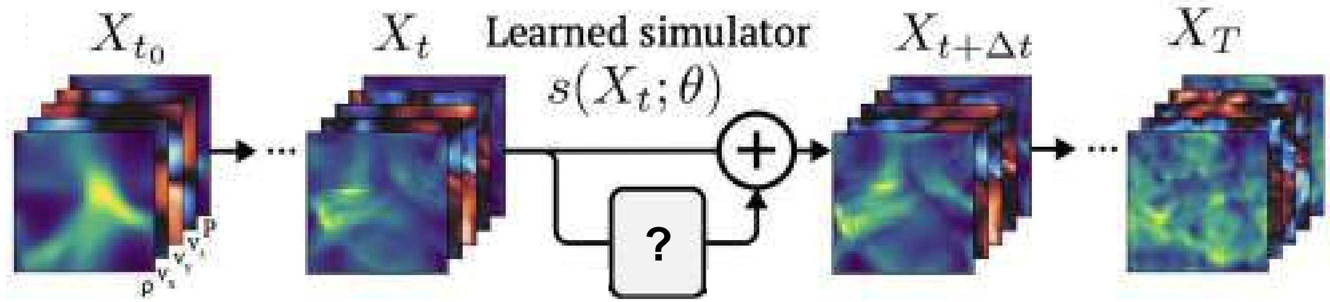
Deep Learning

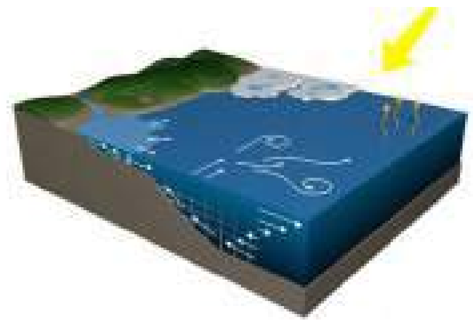


Data Assimilation

PATHWAY TO BRING AI TO EDITO MODEL LAB







Deep Differentiable Emulators

encoded in
high-level framework

Parameters are
optimized

Mimic models or
observations

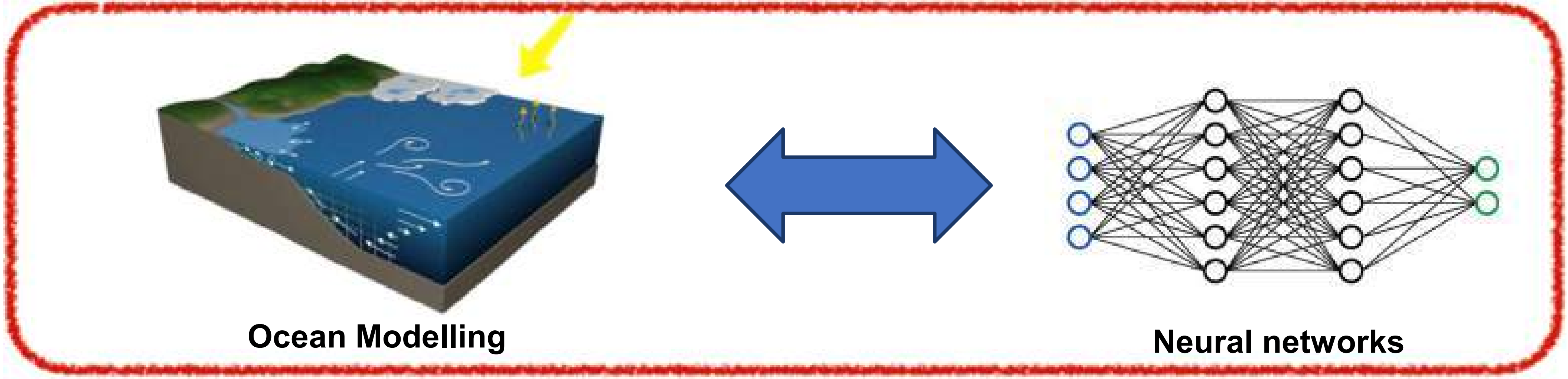
MAKING THE MOST OF EXISTING TOOLS AND MODERN SCIENTIFIC MACHINE LEARNING

WP2 Reminder

- **General objective**: Bring AI/DL into the DTO core suite both for ocean modelling and data assimilation systems using DDEs
- **Task 2.1**: DDEs for improving ocean models (lead: HEREON)
- **Task 2.2**: DDEs for simulation, forecasting and reconstruction (lead: CNRS)
- **Task 2.3:** DDEs for ocean Data Assimilation systems (lead: NERSC)
- **Demonstration case-studies**: Lagrangian drift, sea surface dynamics, turbidity dynamics, NEMO-PISCES
- **Year-1 Milestone**: co-design of the DDEs

TASK T2.1 : DDES FOR IMPROVING OCEAN MODELS (HEREON, IMT, CNRS)

Why : for parameter calibration, for training ML-based closures



Specific objectives:

- Develop elementary DDE blocks for OGCM parameterization
- Assess the relevance of DDEs for OGCM parameterization
- Demonstration for intermediate-complexity flows (e.g., multi-layer QG flows)

15' Focus presentation by D. Greenberg (Hereon) to follow

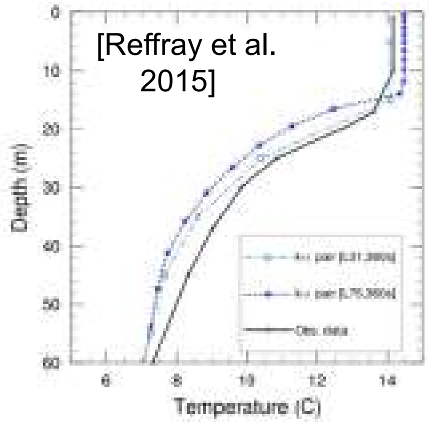
TASK T2.1 : DDEs FOR IMPROVING OCEAN MODELS (HEREON, IMT, CNRS)

Achievements:

- Develop elementary DDE blocks for OGCM parameterization
- Defined a 2D NEMO setup for development, and generated simulations [Hereon]
- Identified relevant inputs/outputs, prepared training data & dataloaders [Hereon]
- Preliminary emulation experiments [Hereon]

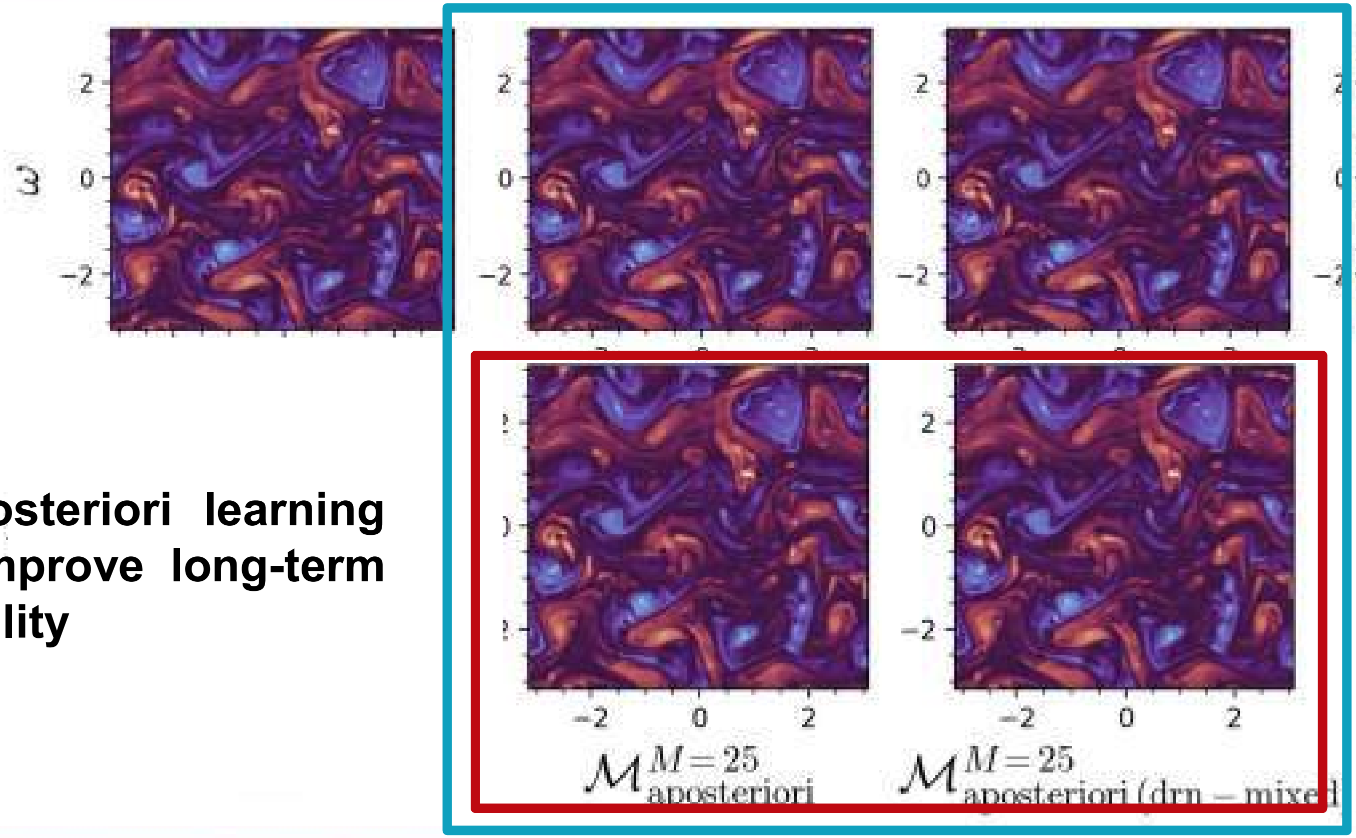
Workplan for year 2:

- A differentiable 1Dz version of NEMO schemes in Jax as a baseline for DDEs [CNRS]
- A benchmark case for intercomparing calibration algorithms for vertical physics [CNRS]
- Implementation and evaluation of emulators for NEMO in 2D and 3D [Hereon]



TASK T2.1 : DDEs FOR IMPROVING OCEAN MODELS (HEREON, IMT, CNRS)

Training neural closures with DDEs for non-differentiable codes



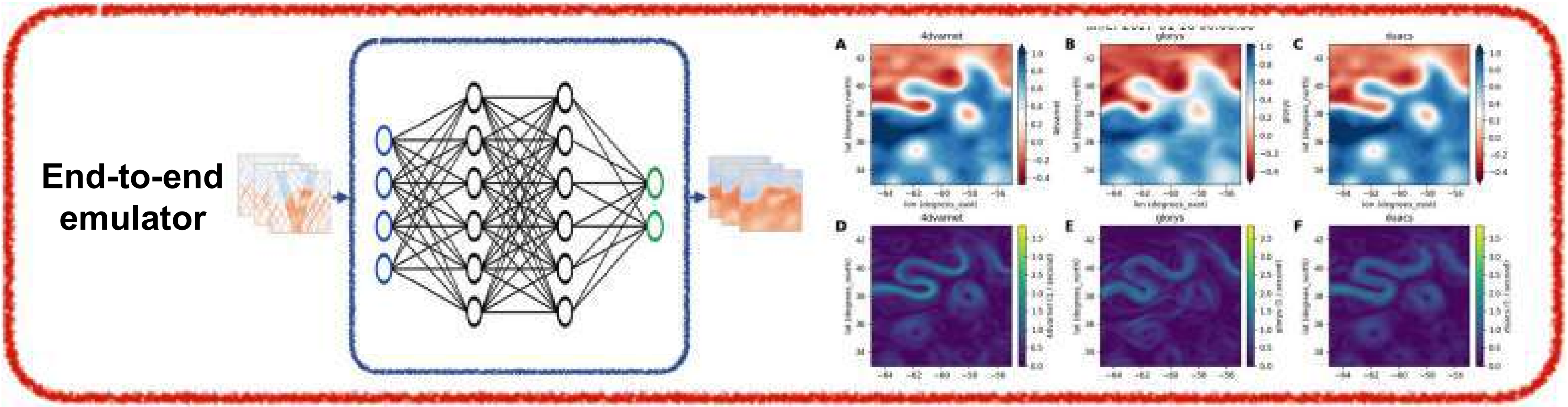
A posteriori learning to improve long-term stability

Emulators to deal with non-differentiable LES models.

https://arxiv.org/abs/2309.14350

TASK T2.2 : DDEs FOR SIMULATION AND FORECASTING (CNRS, BSC, IMT, DELTARES)

Why : (End-to-end) DL approaches to forecasting and reconstruction problem



Specific objectives:

- Emulation of PISCES (BSC)
- Lagrangian drift simulation (IMT, CNRS)
- Mapping and short-term forecasting of sea surface dynamics (SSH, SSC) (IMT, CNRS)
- Mapping of turbidity dynamics (IMT, Deltares)

Task T2.2 : DDEs for simulation and forecasting (CNRS, BSC, IMT, Deltares)

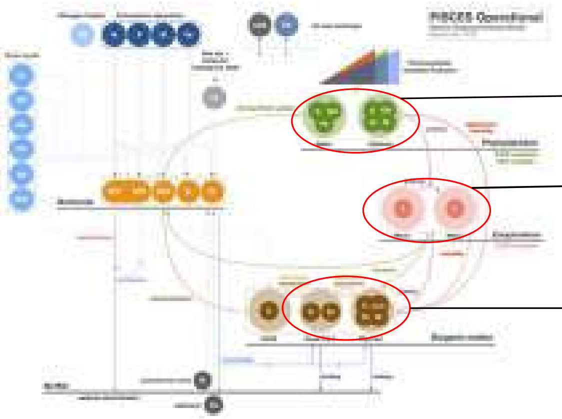
Emulation of PISCES (BSC)

Achievements:

- Development of tool to build training dataset for each PISCES target variable
- Compilation of all dependencies for each PISCES target variable

Workplan for year 2:

- Definition of sampling strategy for training dataset
- Training and validation of emulators in incremental steps (one variable at the time)



New ML parameterization

Seasonal variability
Driven by 1D dynamics
phytoplankton, zooplankton, particle fluxes

TASK T2.2 : DDEs FOR SIMULATION AND FORECASTING (CNRS, BSC, IMT, DELTARES)

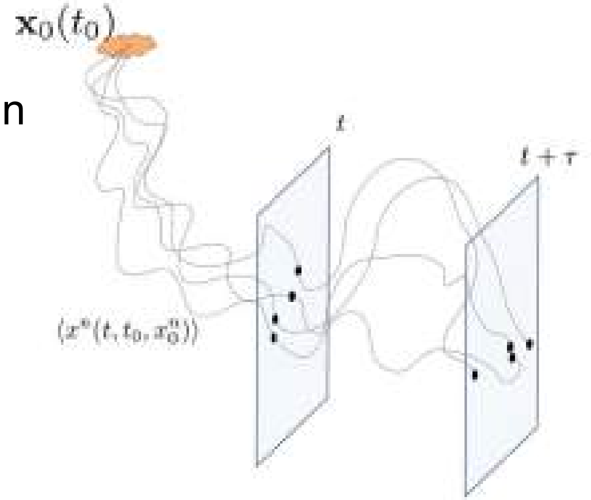
Lagrangian drift simulation (CNRS, IMT)

Achievements:

- DDE for the conditional simulation of Lagrangian trajectories. DriftNet (Botvinko et al., 2023; in Prep.)
- OSSE-based POC of probabilistic predictions of lagrangian drift (in prep. for Journ. Oper. Oc., Med Sea)
- Deployment and evaluation for simulation datasets (OSSE) (Gulf Stream and East Pacific regions)
- Preliminary evaluation for real datasets of drifter trajectories

Workplan for year 2:

- A benchmark case for ML based reconstruction of lagrangian drift deployed on EDITO platform through OceanBench (global scale, geostrophic currents)
- ML-based models for stochastic predictions of lagrangian drift [CNRS]
- Evaluation for real datasets and case-studies
- Transfer to WP4
- Extension to probabilistic conditional simulations



TASK T2.2 : DDEs FOR SIMULATION AND FORECASTING (CNRS, BSC, IMT, DELTARES)

Mapping and Forecasting of Sea Surface dynamics (IMT, CNRS)

Achievements:

- Dual OSSE-OSE training and evaluation framework for SSH mapping and forecasting (nadir altimetry)
- State-of-the-art performance for a Gulf Stream region (w.r.t. operational mapping/reanalysis schemes)
- OSSE-based POC of SSH forecasting and SSC reconstruction from satellite observations
- Development of a generic toolkit to facilitate the uptake of ocean-related processing and case-studies by ML scientists and of ML tools by ocean scientists (OceanBench, NeurIPS'2023)

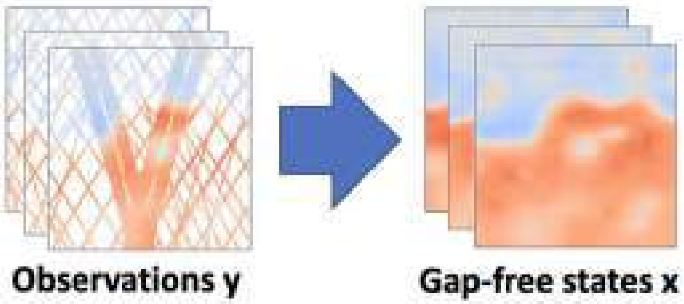
Workplan for year 2:

- Transfer to WP4 (OceanBench and trained models, dedicated staff at CNRS/IMT-A)
- Benchmarking experiments with real data for SSH short-term forecasting
- OSSE-based POC for the reconstruction/forecasting of 3D+t ocean variables (incl. an operation DA baseline)?

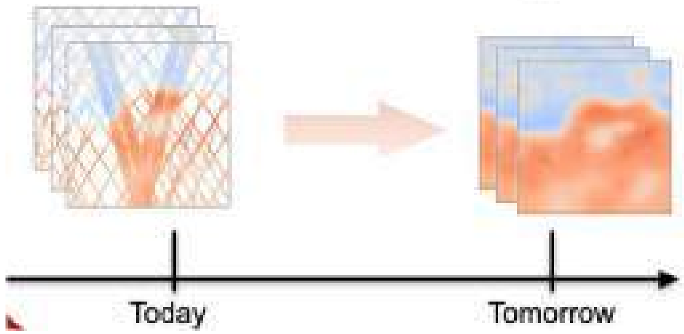
Task T2.2 : DDEs for simulation and forecasting (CNRS, BSC, IMT, Deltares)

Mapping and Forecasting of Sea Surface dynamics (IMT, CNRS)

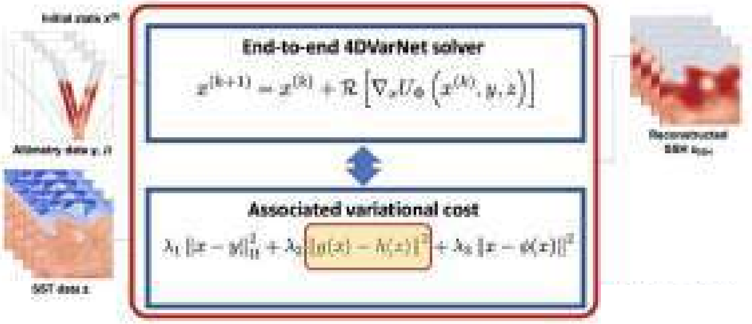
SSH mapping



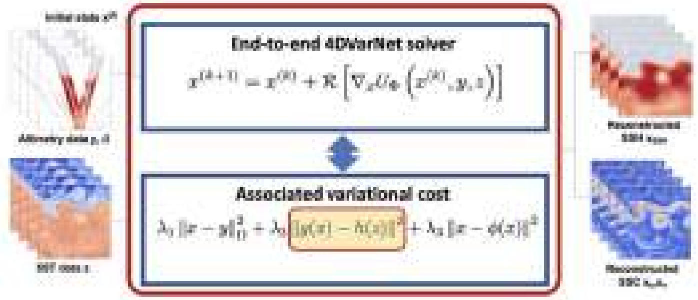
SSH forecasting



Multimodal mapping

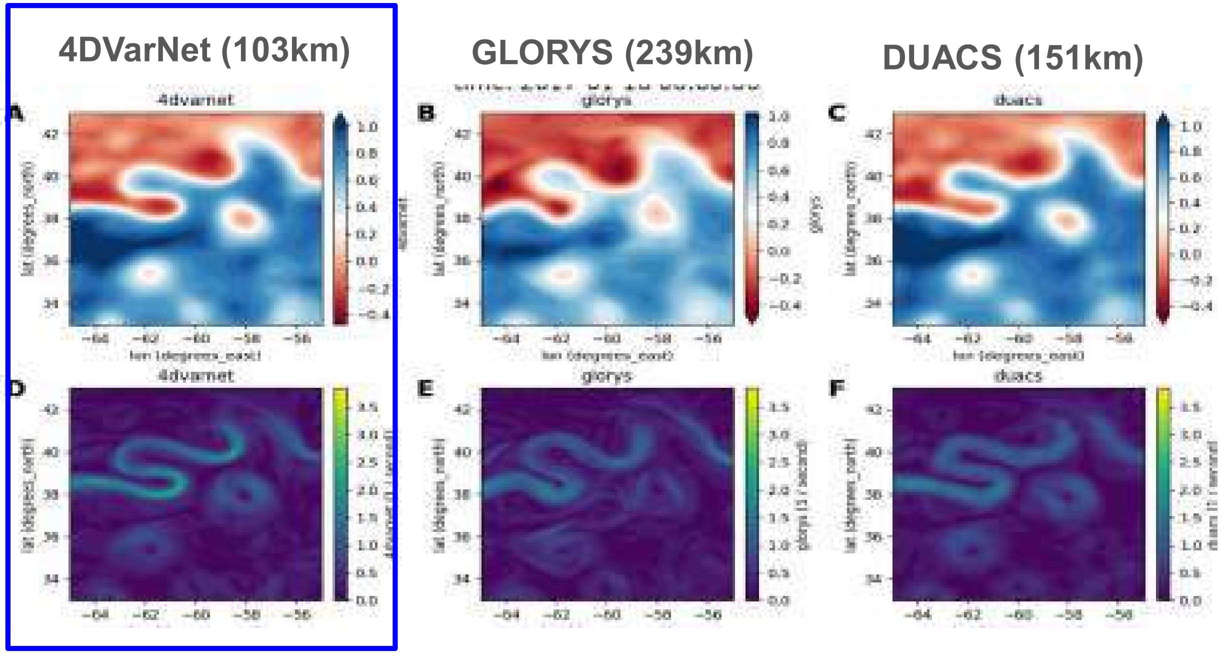


SSC mapping

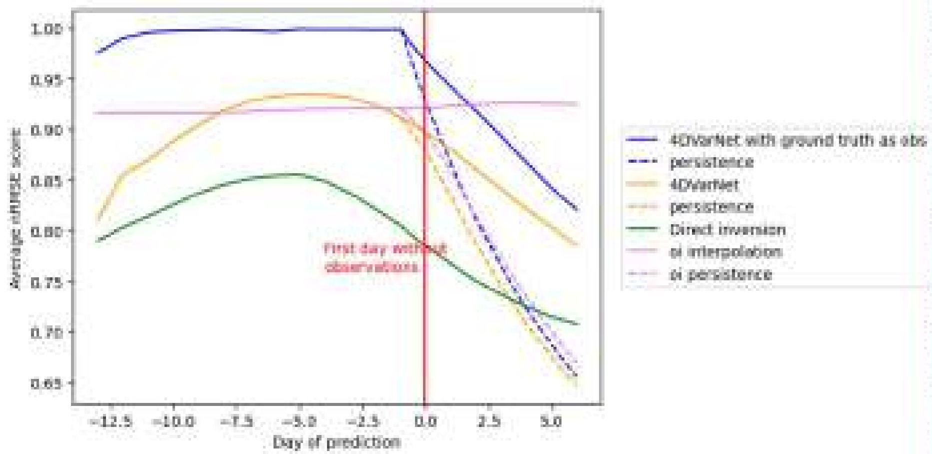


TASK T2.2 : DDEs FOR SIMULATION AND FORECASTING (CNRS, BSC, IMT, DELTARES)

Mapping and Forecasting of Sea Surface dynamics (IMT, CNRS)



SSH mapping (real data)



SSH forecasting from gappy data

Febvre et al., 2023. https://arxiv.org/abs/2309.14350

TASK T2.2 : DDEs FOR SIMULATION AND FORECASTING (CNRS, BSC, IMT, DELTARES)

Mapping of Turbidity dynamics (IMT, Deltares)

Achievements:

- Design of a North Sea case-study for sea surface turbidity mapping with real satellite data
- Benchmarking of 4DVarNet schemes for the considered case-study
- Development and evaluation of end-to-end learning strategies from gappy training data

Workplan for year 2:

- Transfer learning across bio-optical tracers and regions
- 4DVarNet extensions to conditional and/or 3D turbidity reconstruction
- Transfer to WP4

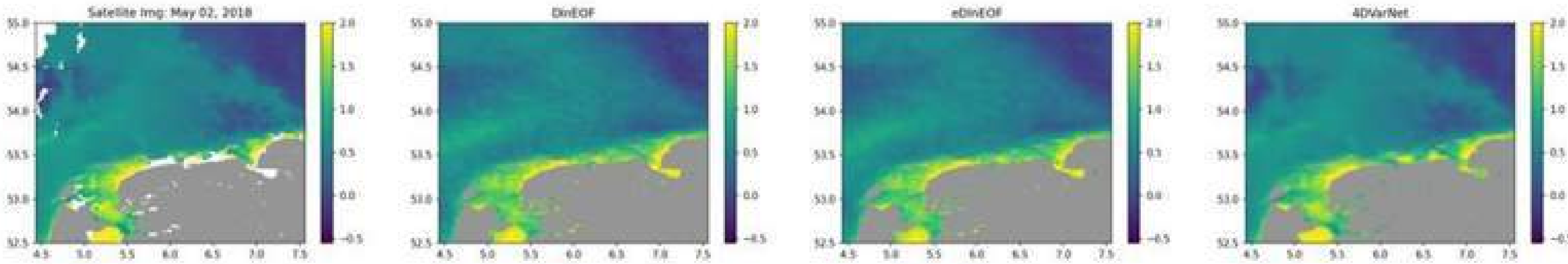
TASK T2.2 : DDEs FOR SIMULATION AND FORECASTING (CNRS, BSC, IMT, DELTARES)

Mapping of Turbidity dynamics (IMT, Deltares)

Considered parameter: Non-Agal (Inorganic) Suspended Particulate Matter (SPM) Concentration: unit [mg/l].

Observation data: multi-sensor CMEMS product (incl. SeaWIFS, MERIS, MODIS-A, MODIS-T, VIIRS-SNPP & JPPS1, OLCI-S3A & S3B

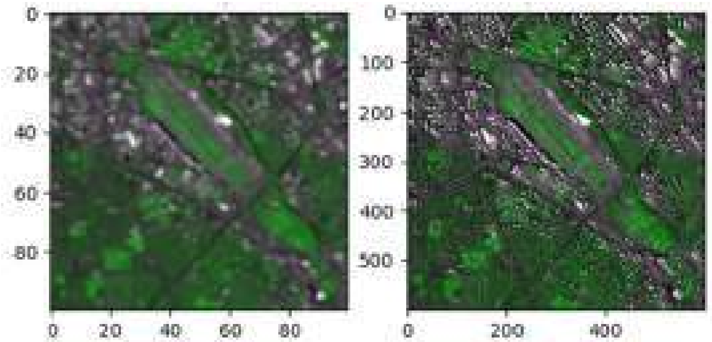
Resolution: 1km/pixel, 240km*300km area, daily measurement



TASK T2.3 : DDEs FOR DA SYSTEMS (NERSC, CNRS, IMT, DELTARES)

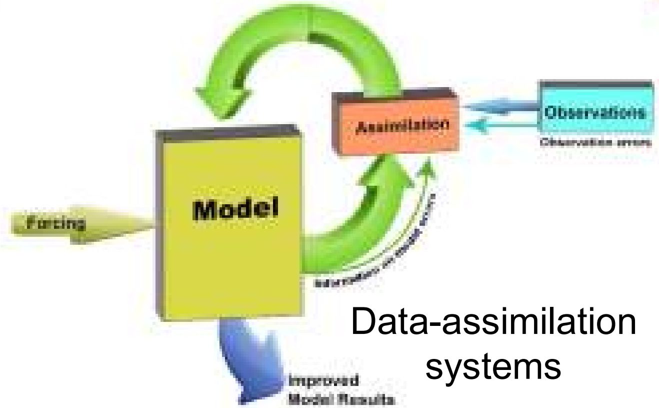
Why : better exploiting observations in ocean DA systems

Super-resolution DA



[Barthelemy et al., 2022]

Neural super-resolution



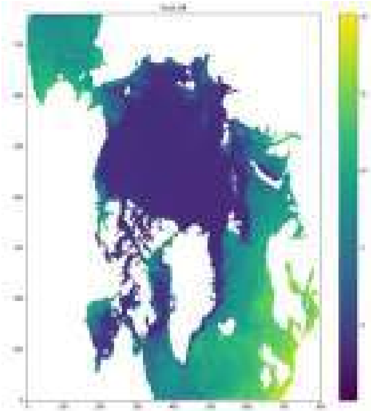
Data-assimilation systems

Specific objectives:

- Demonstration of SR-DA schemes for a realistic OGCM setting
- Demonstration of end-to-end neural DA (4DVarNet) (intermediate-complexity setups and uncertainty quantification)

TASK T2.3 : DDEs FOR DA SYSTEMS (NERSC, CNRS, IMT, DELTARES)

Super-Resolution Data Assimilation (NERSC)



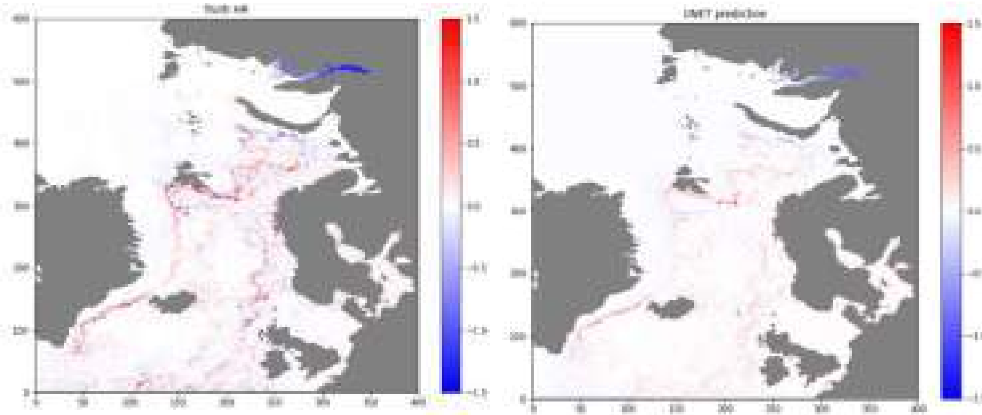
An example of the surface temperature in TOPAZ (HR)

Achievements:

- Creation of the training database, consisting of 2 consistent runs: 1 High Resolution (6 km) and 1 Low Resolution (12 km) with TOPAZ (coupled ocean/ice model in the North Atlantic and Arctic regions)
- Training of a Unet and validation for the surface temperature
- Extension of the EnKF (without ML) for the assimilation for the LR model

Workplan for year 2:

- Extension of the super resolution step for the other variables
- Integration of the Super Resolution in the Data Assimilation process



Residuals to emulate the HR field from the LR field (zoomed in the North Atlantic): targeted truth (left) and computed prediction (right)

TASK T2.3 : DDEs FOR DA SYSTEMS (NERSC, CNRS, IMT, DELTARES)

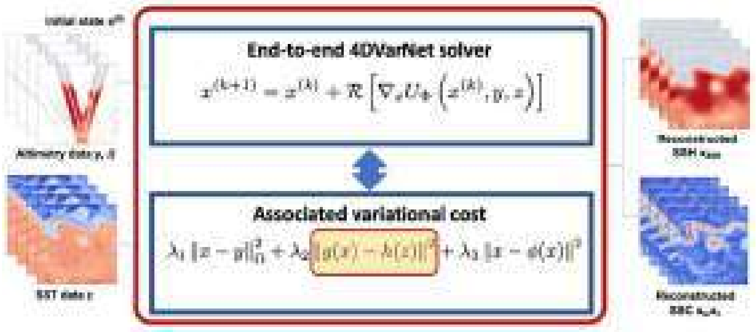
End-to-end neural DA- 4DVarNet (IMT)

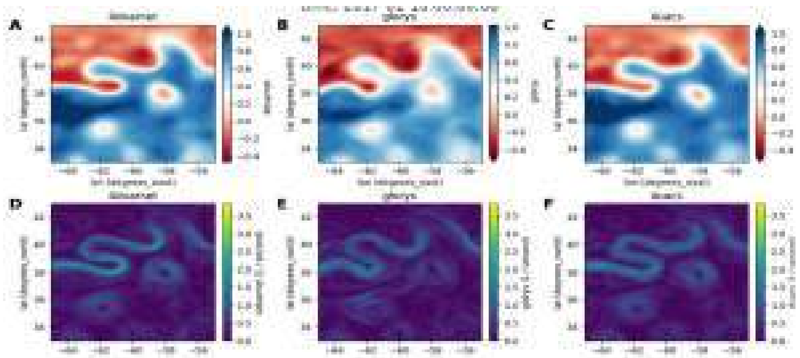
Achievements:

- 4DVarNet configurations for short-term forecasting applications
- 4DVarNet with SPDE priors for Uncertainty Quantification (Beauchamp et al., 2023)
- New learning strategies: OSSE-based learning, learning from gappy training datasets
- Ongoing design of intermediate-complexity AI-native benchmarking setups (eg, QG)

Workplan for year 2:

- Intermediate-complexity and AI-native benchmarking experiments for end-to-end neural DA
- 4DVarNet schemes for joint model calibration and state estimation
- Transfer to WP4

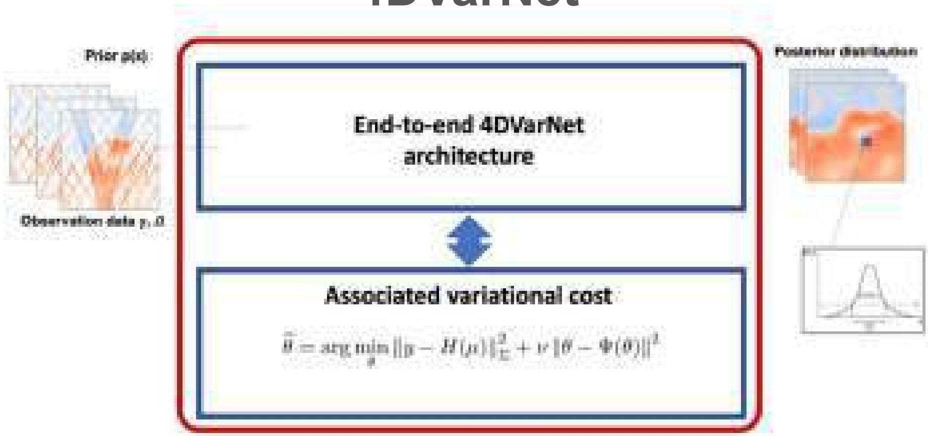




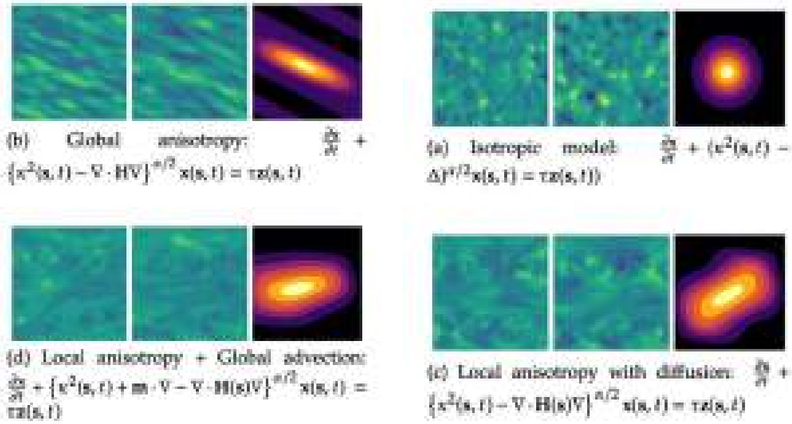
TASK T2.3 : DDES FOR DA SYSTEMS (NERSC, CNRS, IMT, DELTARES)

End-to-end neural DA- 4DVarNet (IMT)

4DVarNet



SPDE



4DVarNet with physics-informed prior (advection-diffusion)

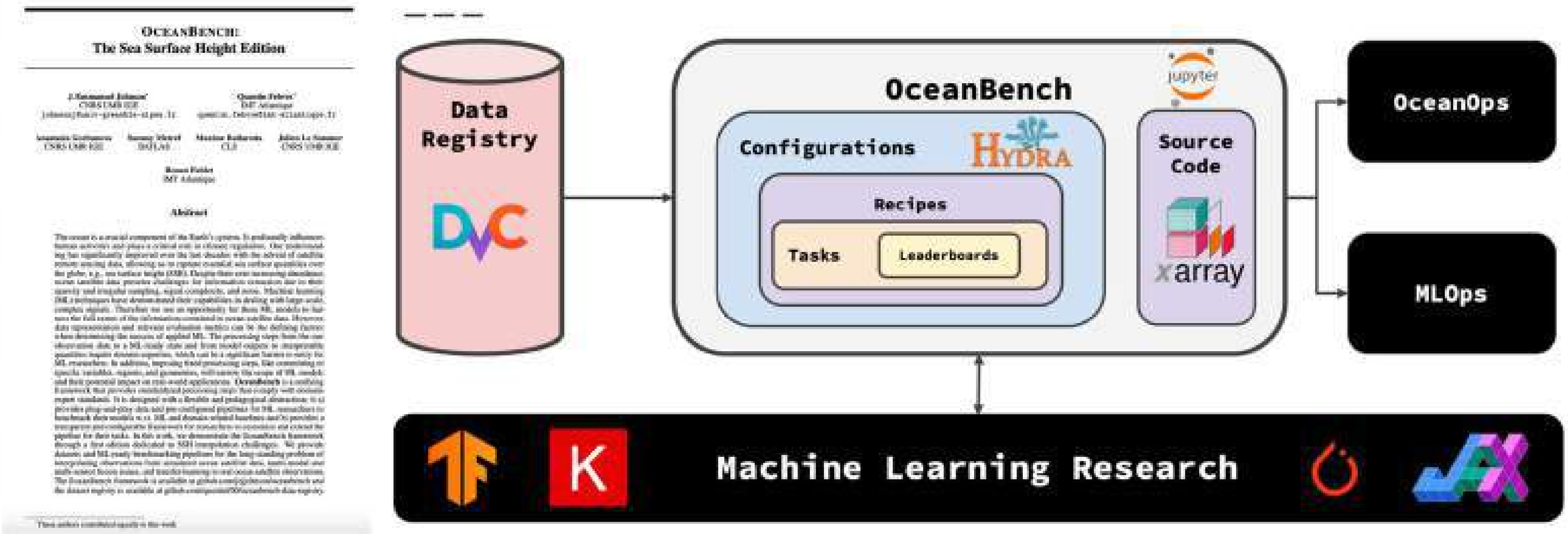
State-of-the-art performance for SSH mapping (OSSE)

Resulting conditional sampling of the state given the observation data

Beauchamp et al., https://arxiv.org/abs/2311.01783

Tools to bring AI into EDITO Model Lab suite

ML-ready processing and evaluation pipelines for physical oceanography



Johnson et al., NeurIPS, 2023

SUMMARY

- **General objective**: Bring AI/DL into the DTO core suite both for ocean modelling and data assimilation systems using DDEs

- **Task 2.1**: DDEs for ocean model parameterization (lead: HEREON)
- **Task 2.2**: DDEs for simulation, forecasting and reconstruction (lead: CNRS)
- **Task 2.3:** DDEs for ocean Data Assimilation systems (lead: NERSC)

- **Demonstration case-studies**: Lagrangian drift, sea surface dynamics, turbidity dynamics, NEMO-PISCES

- **Year-1 Milestone**: co-design of the DDEs
- **Workplan Year-2**: Moving on + transfer to WP4

WP 2 – AI based emulators for ocean modelling and forecasting

WP2

□ Year 1 Achievements - Year 2 Workplan, IMT (R Fablet) (25’)

- **Example: Towards deep differentiable emulators for NEMO, HEREON (D Greenberg) (15’)**

Discussion (5’)

https://docs.google.com/presentation/d/1FySlS4-aAOLVPyBis81JqdDnUWo7mX1a/edit?usp=sharing&ouid=110563430246103777852&rtpof=true&sd=true

https://www.dropbox.com/scl/fi/t2sot0s15f0rfgh1gn2vk/pres_EditoModelLab_WP2_GA_202401-1.pptx?rlkey=jo192l8sscg3iu3n0wqah7fi7&dl=0

EDITO ModelLab
European Digital Twin Ocean

HORIZON EUROPE

m-dml.org

helmholtz · zentrum hereon

HELMHOLTZ AI | ARTIFICIAL INTELLIGENCE COOPERATION UNIT

Deep Differentiable Emulators
Concepts, Aims and Initial Progress for NEMO

David Greenberg
Model-driven Machine Learning Group
Helmholtz Centre Hereon

Deep Learning and Optimization
IMT Atlantique
January 16, 2024

Outline

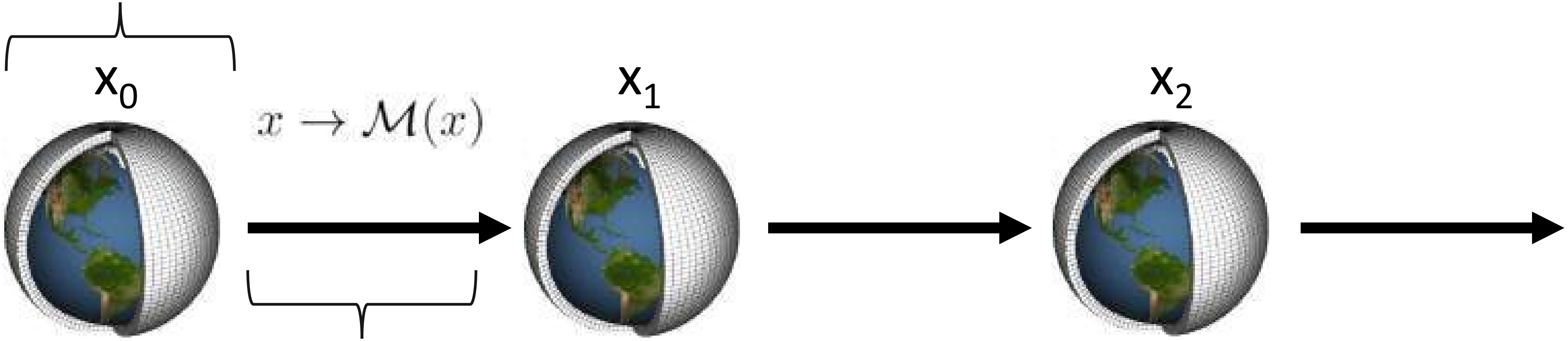
1 Deep Differentiable Emulators

2 Hybrid Emulators

3 Progress in Emulation of NEMO

Simulators as State space models

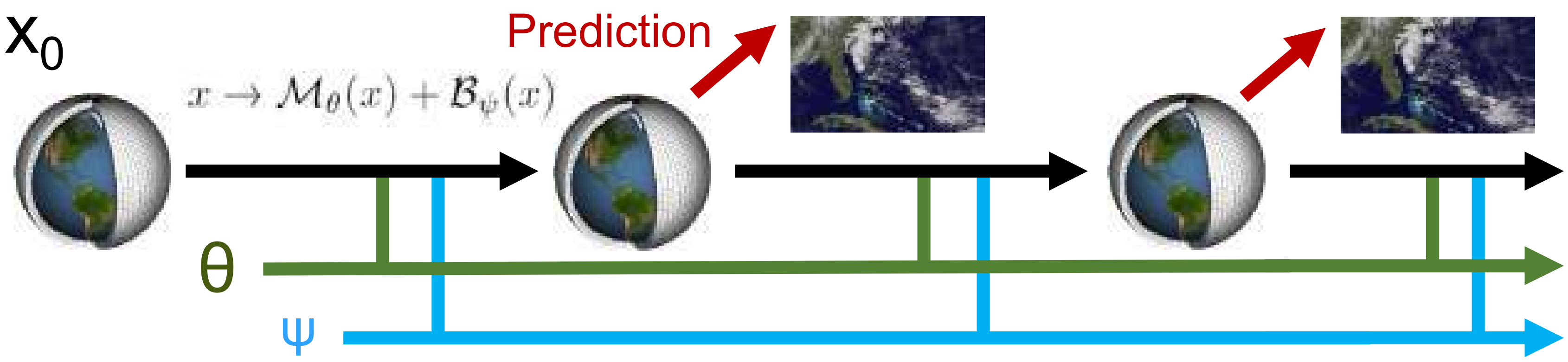
System state
- Physical variables (pressure, temperature, moisture, …)
- Snapshot for one time point



State update function
- Fluid dynamics
- Local physical processes (radiation, turbulence, phase changes, …)
- Advection of tracers (droplets, aerosols, etc.)

3 optimization tasks in the geosciences

EDITOModelLab hereon



1 **Data assimilation**: choose x_0 so predictions match observations

2 **Model tuning**: choose simulation parameters θ so predictions match observations

3 **Learning corrective terms**: choose ψ so predictions match observations

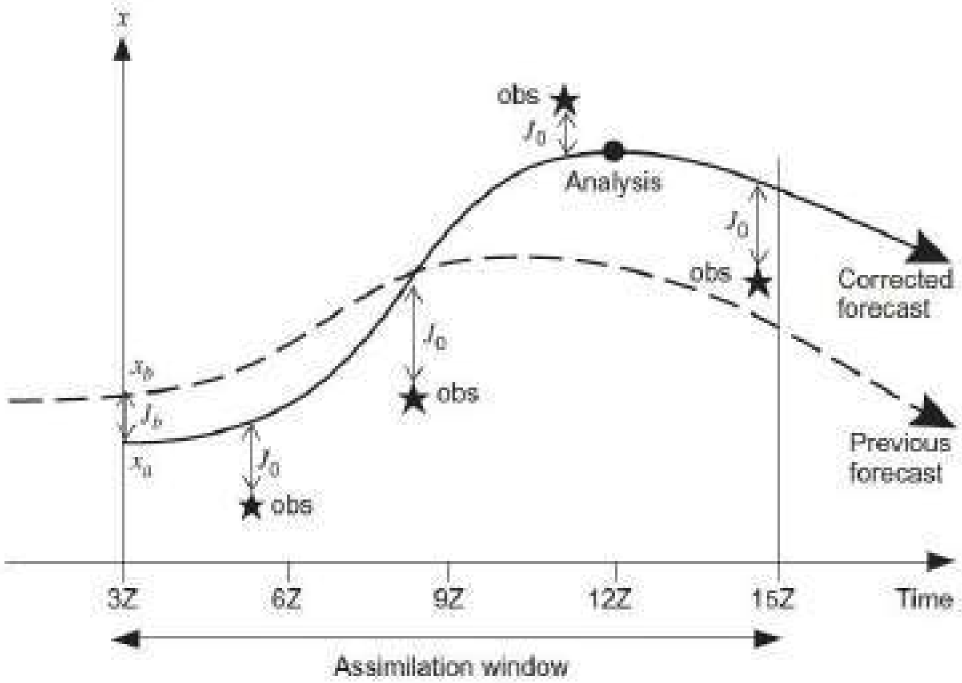
Because: unknown physics, sub-grid-scale processes

For all 3 problems, we need $\frac{d\mathcal{M}}{dx}$ in order to optimize our predictions over x_0, θ or ψ.

But these derivatives are not available for most simulators!

Task 1: Data Assimilation

Goal: find a sequence of system states that matches both model and data



Holton, 2012

Use numerical optimization with hand-written simulator gradient (adjoint) routines?

Costly maintenance, inflexible workflows, prone to errors!

Rewrite Earth system models using with automatic differentiation for all computations (JAX, Pytorch, Julia…)?

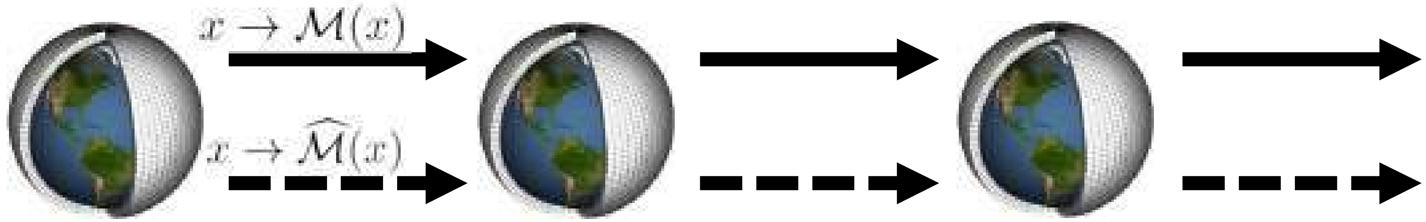
Large up-front cost, years from feasibility, hardware+software issues!

Another way?

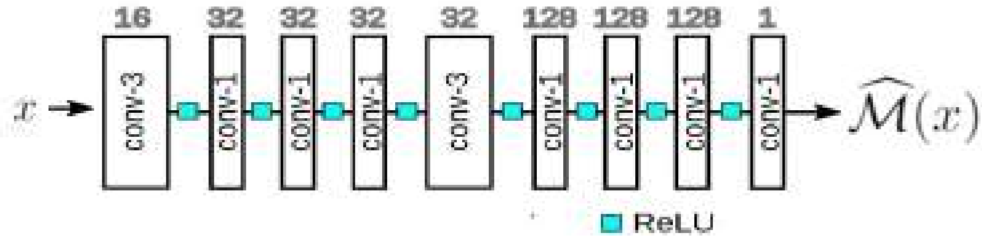
Differentiating Simulators with ML

How can we obtain derivatives of the state update function $\mathcal{M}$?

1. Generate simulations



2. Train a neural network to *emulate* the state update function

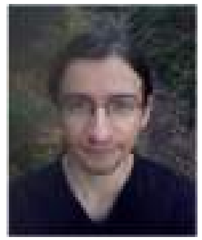


3. Differentiate the neural network's outputs w.r.t its inputs to obtain:

$$\frac{d\widehat{\mathcal{M}}}{dx} \approx \frac{d\mathcal{M}}{dx}$$

We've used the differentiability of $\widehat{\mathcal{M}}$ twice:
once to train it, once to estimate simulator gradients.

Marcel Nonnenmacher



Nonnenmacher & Greenberg, 2020, *JAMES*

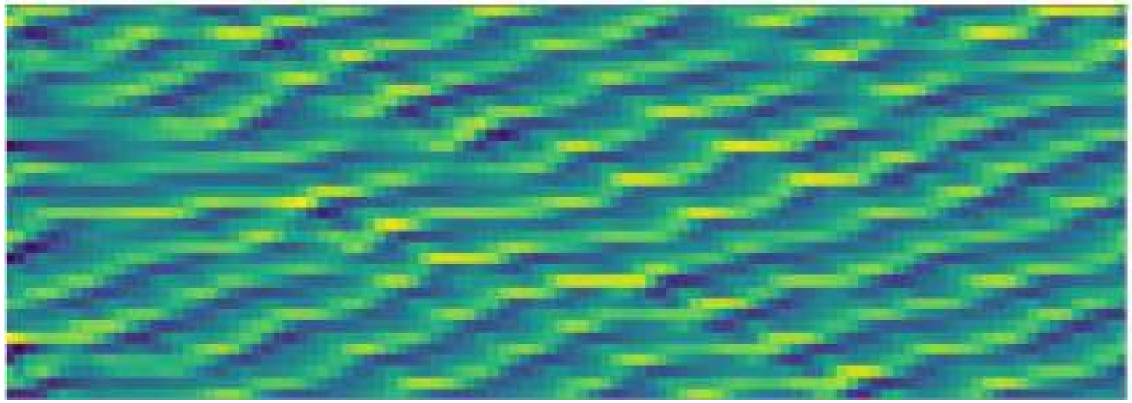
Model System: Lorenz `96

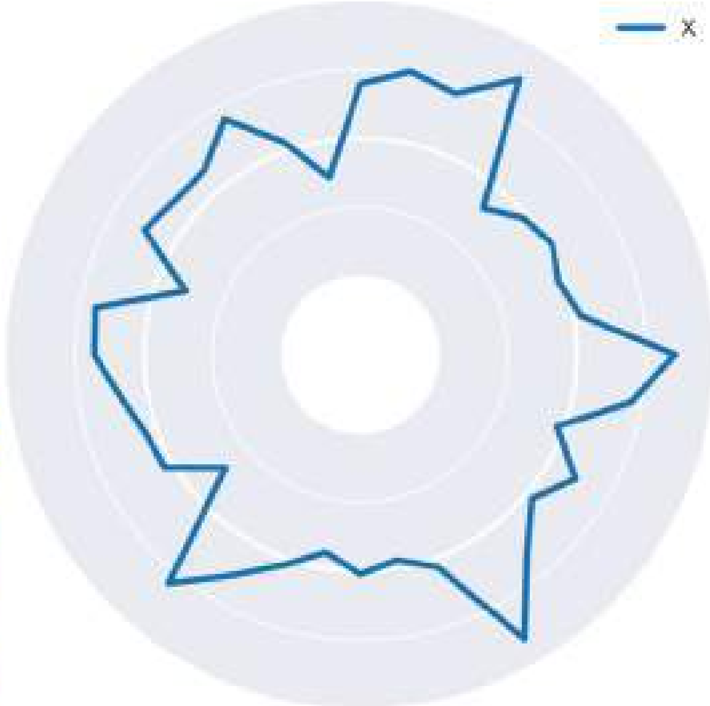
$$\frac{dx_k}{dt} = -x_{k-1}\left(x_{k-2} - x_{k+1}\right) - x_k + F$$

Lorenz, 1996

- 40 coupled nonlinear differential equations
- Chaotic dynamics (Lyapunov time 1.67 for F = 8)

Time





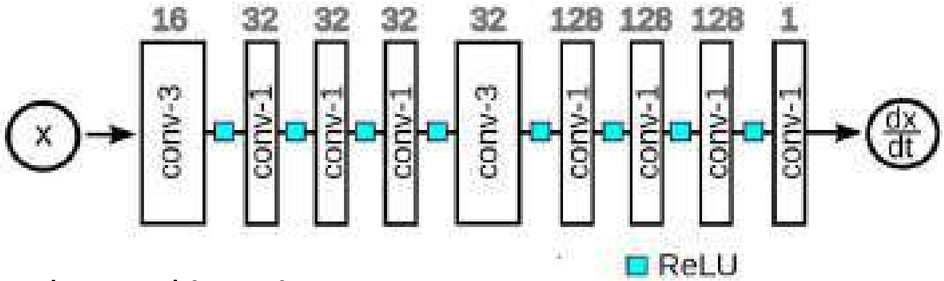
Choosing a Neural Network Architecture for our Emulator

$$\frac{dx_k}{dt} = -x_{k-1}\left(x_{k-2} - x_{k+1}\right) - x_k + F$$

How should we design the network architecture of the emulator?

Decisions to be made:

- Number of layers
- Number of units in each layer
- Type of layers (convolutional, recurrent, …)
- Activation function (Relu, tanh, Elu …)

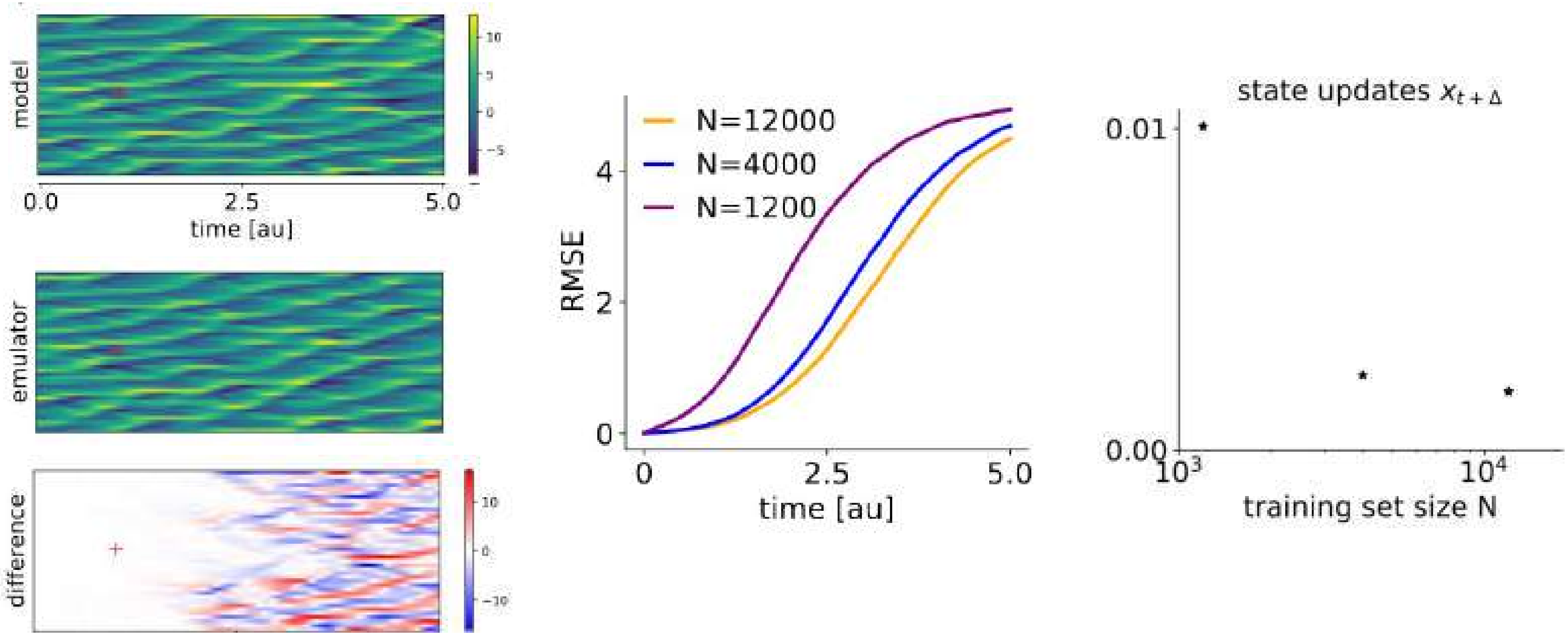


For L96:

- We use 1D convolutional layers to exploit **spatial structure** and spatial **invariance**
- We use **periodic** convolutions to match information flow in the state space
- We use a limited number of layers with size 3 kernels, and the rest operate on each spatial location independently to preserve **causal structure** for any network depth
- We could also have tried to **match the mathematical operations** in the simulator (e.g. bilinear layers)

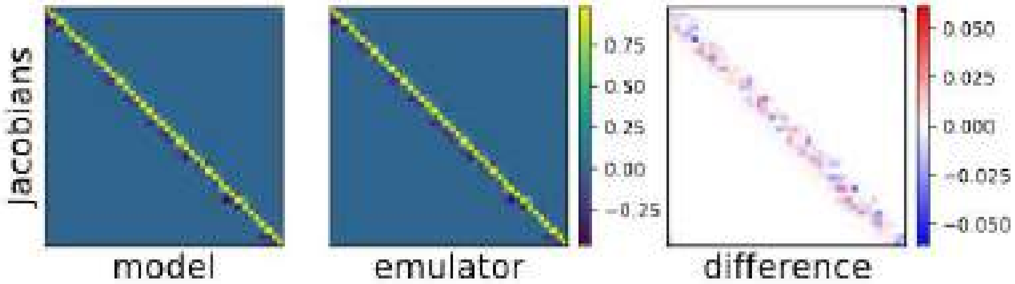
Overall: we can benefit from **partial knowledge** in architecture design

Accuracy of emulators trained on Lorenz `96

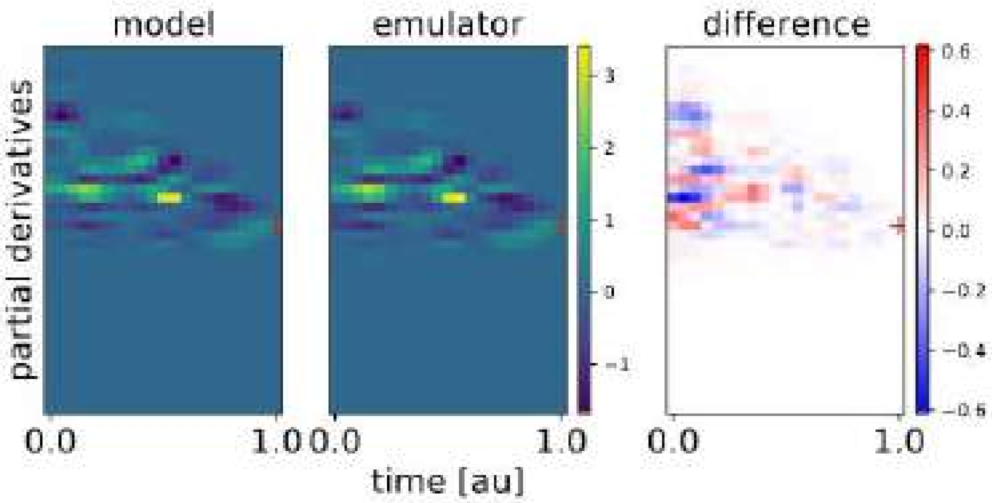


Accuracy of Estimated Input-Output Gradients

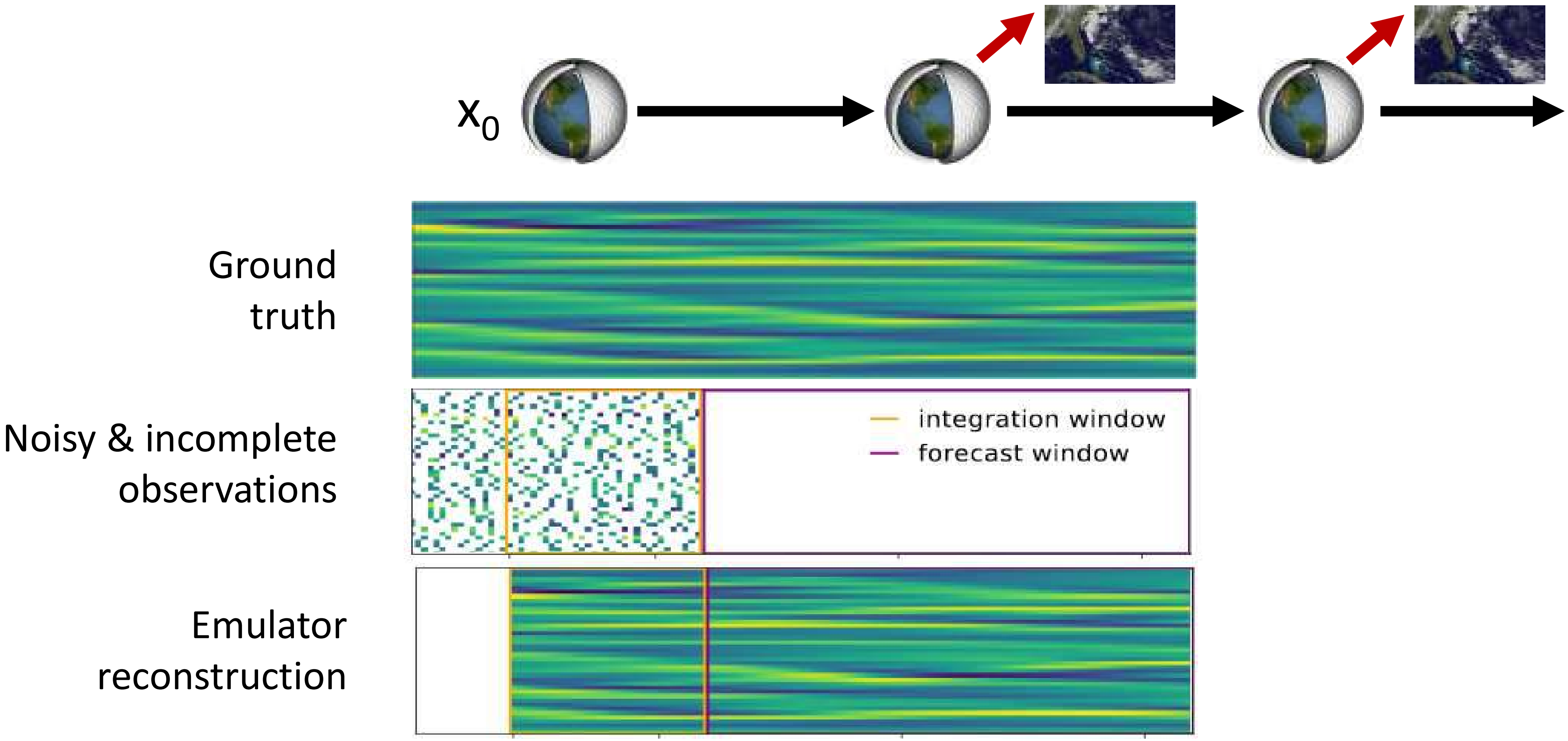
…for a single time step?



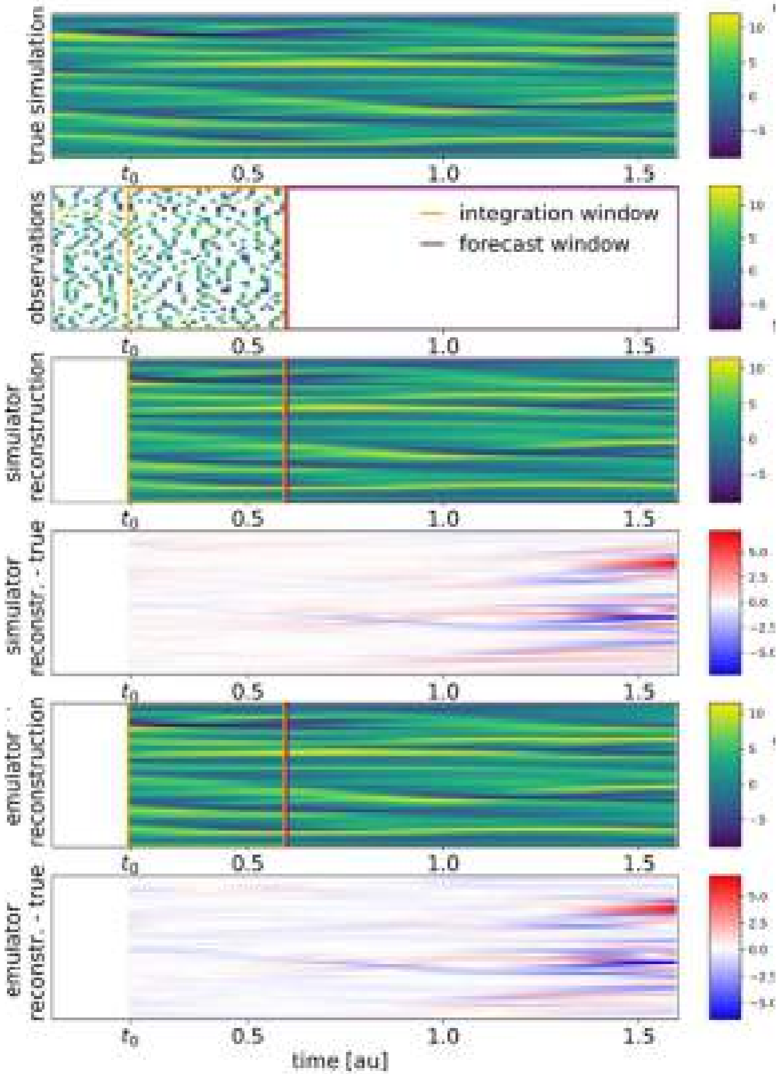
…for longer simulations?

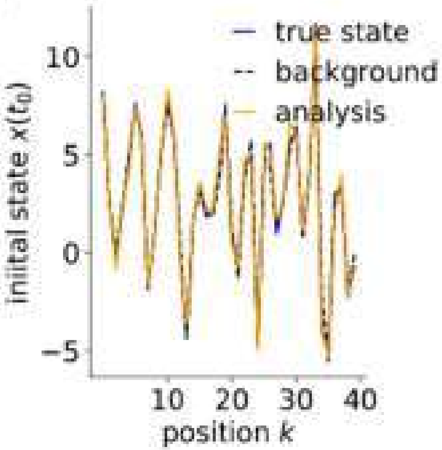


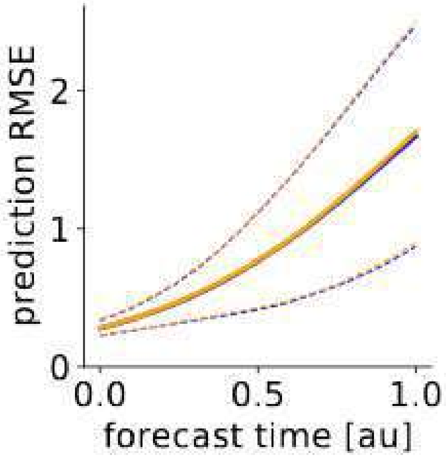
Data Assimilation for L96

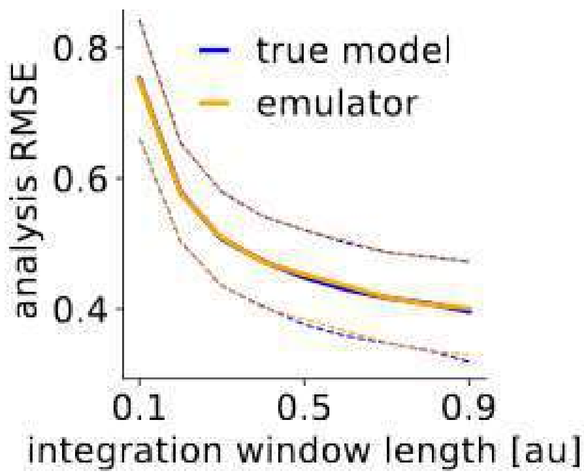


Data Assimiliation Results

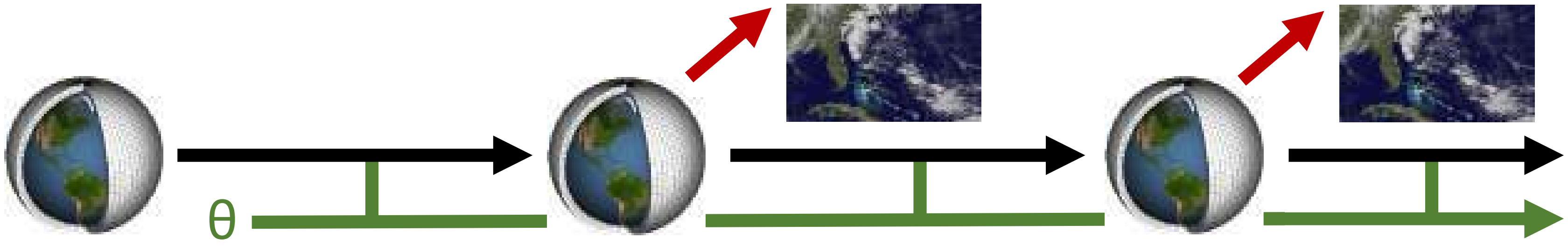






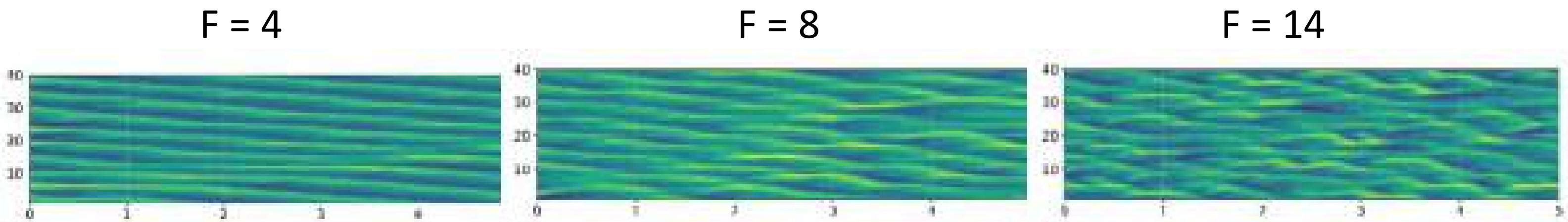


Task 2: Parameter Tuning

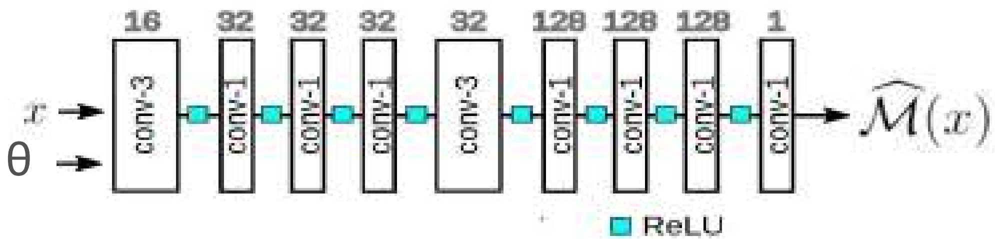


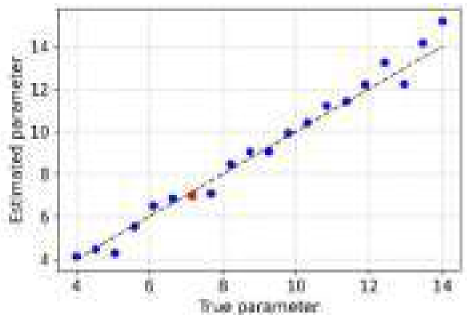
Simulator

$$\frac{dx_k}{dt} = -x_{k-1}\left(x_{k-2} - x_{k+1}\right) - x_k + F$$



Conditional emulator





Vadim Zinchenko

Task 3: Sub-grid-scale Parametrizations

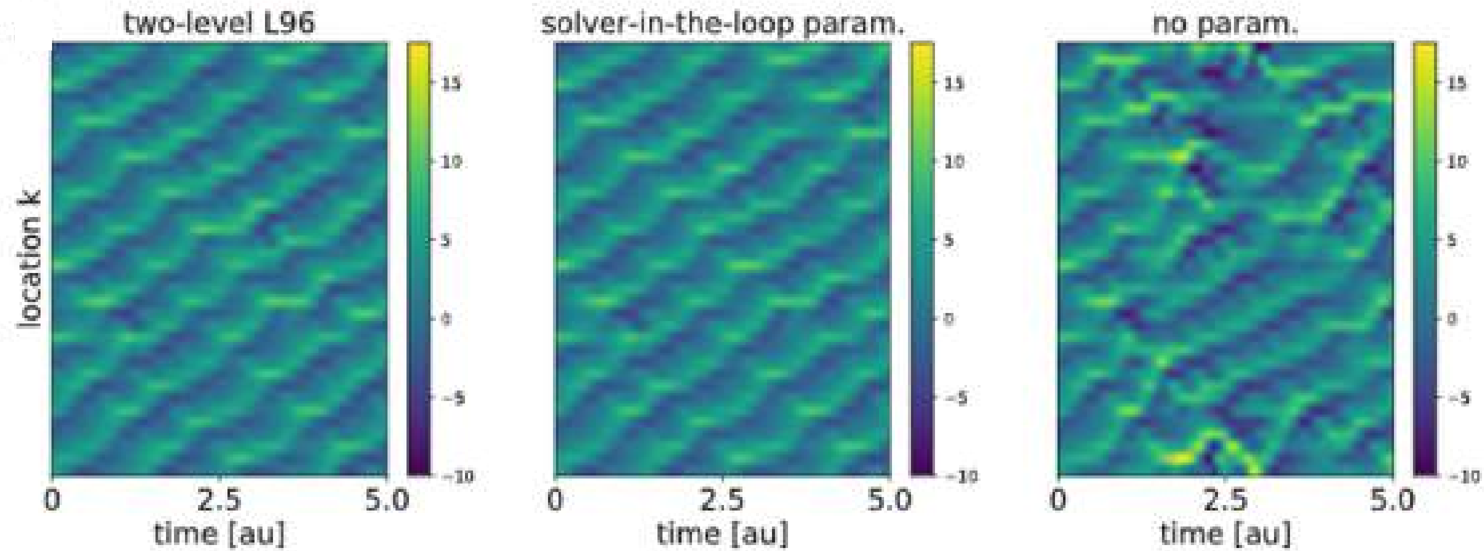
Fine-scale model

$$\frac{dx_k}{dt} = -x_{k-1}\left(x_{k-2} - x_{k+1}\right) - x_k + F - hc\mathbb{E}_j[z_{j,k}]$$

$$\frac{1}{c}\frac{dz_{j,k}}{dt} = -bz_{j+1,k}\left(z_{j+2,k} - z_{j-1,k}\right) - z_{j,k} + \frac{h}{J}x_k$$

Coarse-scale model with corrective term

$$\frac{dx_k}{dt} = -x_{k-1}\left(x_{k-2} - x_{k+1}\right) - x_k + F + \mathcal{B}_\psi(x_k)$$



Outline

1 Deep Differentiable Emulators

2 Hybrid Emulators

3 Progress in Emulation of NEMO

Complementary Advantages of ML and Simulation

Machine Learning

✓ Performant, efficient

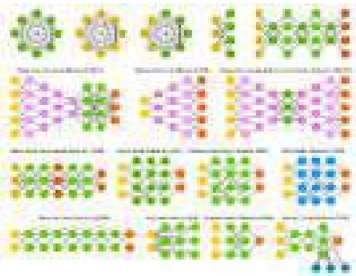
✗ Non-interpretable, poor generalization

Numerical Simulation

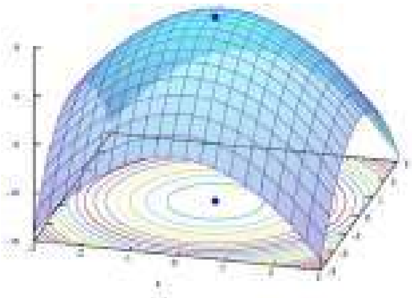
✓ Interpretable, physical, good generalization

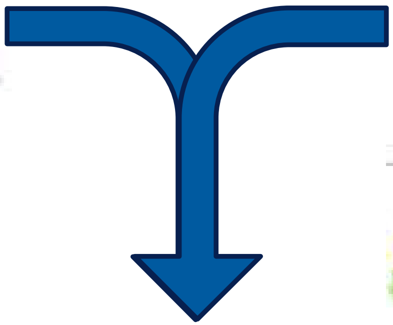
✗ Hard to fit data, difficult inverse problems

Architectures



Algorithms



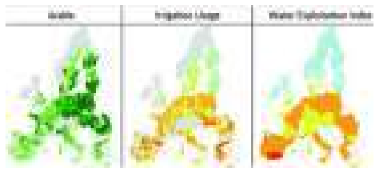


Ocean

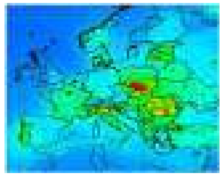
Hydrology

Atmosphere

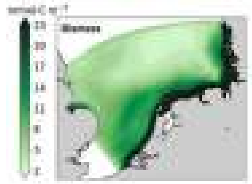
Impacts



Chemistry



Ecosystems



Hybrid Methods

Hybrid Methods I: Enforcing Conservation Laws

EDITO ModelLab hereon

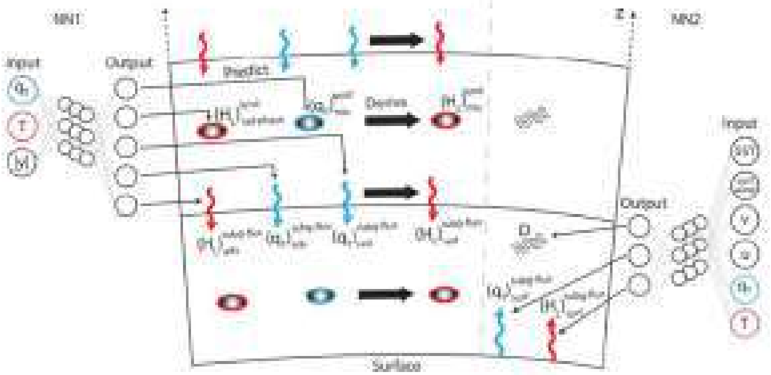
Use of neural networks for stable, accurate and physically consistent parameterization of subgrid atmospheric processes with good performance at reduced precision

Janni Yuval[1], Paul A. O'Gorman[1], and Chris N. Hill[1]

[1]Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, USA

Abstract

A promising approach to improve climate-model simulations is to replace traditional subgrid parameterizations based on simplified physical models by machine learning algorithms that are data-driven. However, neural networks (NNs) often lead to instabilities and climate drift when coupled to an atmospheric model. Here we learn an NN parameterization from a high-resolution atmospheric simulation in an idealized domain by coarse graining the model equations and output. The NN parameterization has a structure that ensures physical constraints are respected, and it leads to stable simulations that replicate the climate of the high-resolution simulation with similar accuracy to a successful random-forest parameterization while needing far less memory. We find that the simulations are stable for a variety of NN architectures and horizontal resolutions, and that an NN with substantially reduced numerical precision could decrease computational costs without affecting the quality of simulations.



Potential and Limitations of Machine Learning for Modeling Warm-Rain Cloud Microphysical Processes

Axel Seifert[1] and Stephan Rasp[2]

[1]Deutscher Wetterdienst, Offenbach, Germany, [2]TU München, Munich, Germany

Abstract The use of machine learning based on neural networks for cloud microphysical parameterizations is investigated. As an example, we use the warm-rain formation by collision-coalescence, that is, the parameterization of autoconversion, accretion, and self-collection of droplets in a two-moment framework. Benchmark solutions of the kinetic collection equations are performed using a Monte Carlo superdroplet algorithm. The superdroplet method provides reliable but noisy estimates of the warm-rain process rates. For each process rate, a neural network is trained using standard machine learning techniques. The resulting models make skillful predictions for the process rates when compared to the testing data. However, when solving the ordinary differential equations, the solutions are not as good as those of an established warm-rain parameterization. This deficiency can be seen as a limitation of the machine learning methods that are applied, but at the same time, it points toward a fundamental ill-posedness of the commonly used two-moment warm-rain schemes. More advanced machine learning methods that include a notion of time derivatives, therefore, have the potential to overcome these problems.

$$\frac{dL_c}{dt} = -AU - AC,$$

$$\frac{dL_r}{dt} = +AU + AC,$$

$$\frac{dN_c}{dt} = -2AU_N - AC_N - SC_c = -\frac{2}{x_*}AU - \frac{1}{\bar{x}_c}AC - SC_c,$$

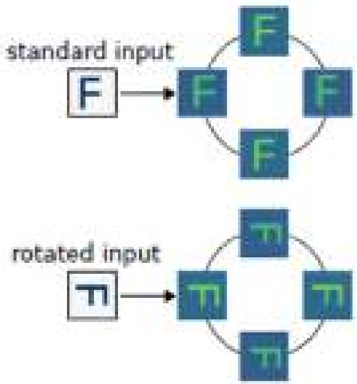
$$\frac{dN_r}{dt} = +AU_N + AC_N - SC_r = +\frac{1}{x_*}AU - SC_r,$$

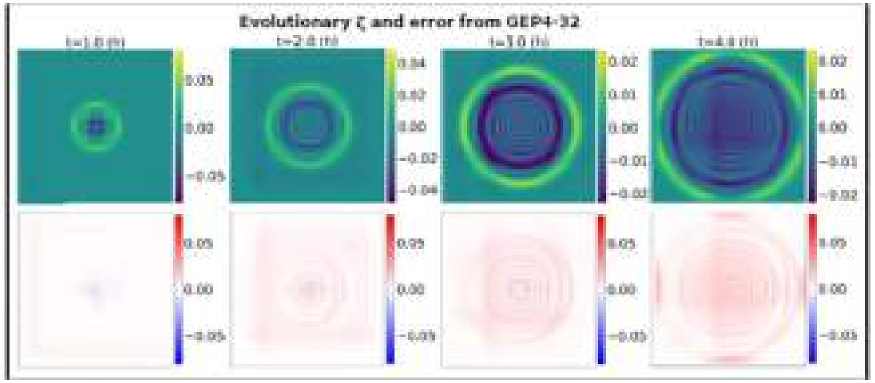
Hybrid Methods II: Exploiting PDE Symmetries

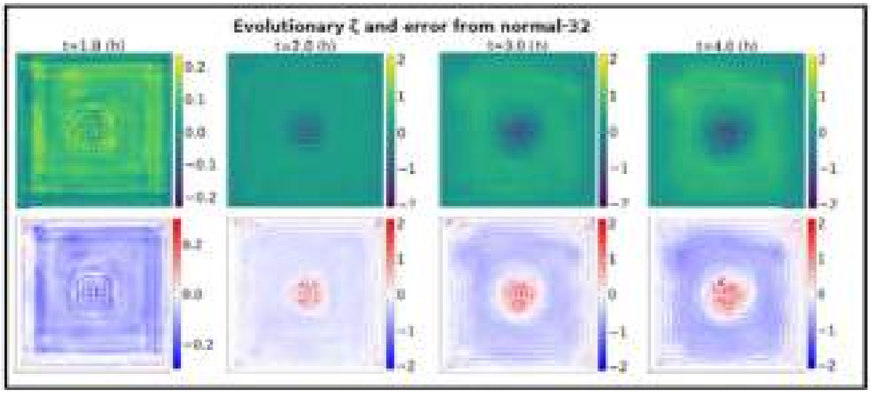
Specialized Convolutional Layers (Cohen & Welling, 2016)
2D Shallow water equations

Convolutional networks are translation invariant.

But what about other symmetries present in the PDEs we're solving?



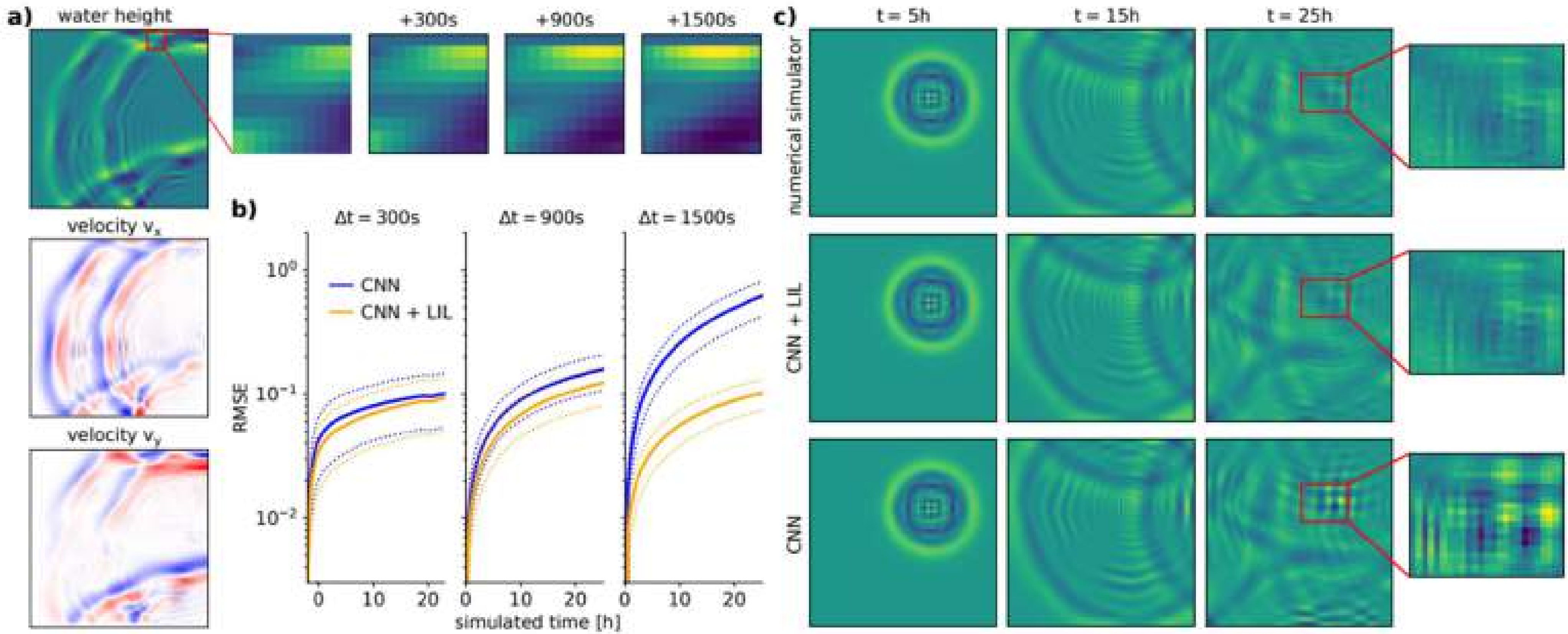




Yunfei Huang

Hybrid Emulators III: Simulation Components as Layers

EDITOModelLab hereon



Outline

1 Deep Differentiable Emulators

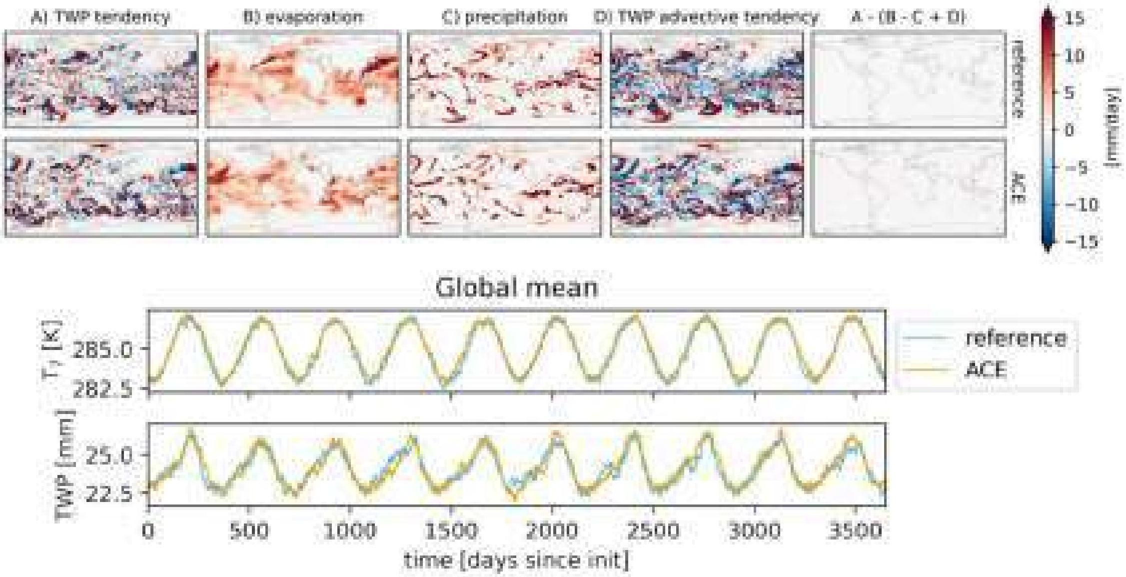
2 Hybrid Emulators

3 Progress in Emulation of NEMO

Emulating Larger Models on Longer Time Scales

EDITOModelLab hereon

AI2Climate Emulator
Watt-Meyer et al., 2023



Simulation: FV3GFS, Δx=100km, 64 levels, fixed SST climatology

Training data: 8 layers, 1^o grid, 6 fields every 6 hours

See also: ClimaX, AtmoRep, …

Lots of Progress so far:

- Long time scales (10 years)
- Large datasets
- Training at scale
- Physical + Geometric Consistency
- Useful evaluation metrics

But Many Gaps:

- Few results on ocean / coupled ESMs
- Reduced vertical resolution
- Many fields ignored (TKE, hydrometeors, …)
- Large and fixed time step doesn't allow data assimilation, parameter tuning or parametrization learning from observations

Simplified 2D NEMO Setup for Emulator Development

EDITOModelLab hereon

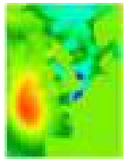
Initial goal:

emulate a 2D version of NEMO with simplified physics at native time/space resolution

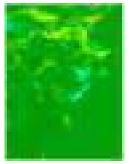
Prognostic fields

Boundary conditions

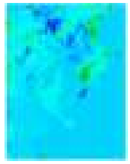
Sea surface height



Zonal velocity



Meridional velocity



x_n
system state
at time step n

$\frac{dx}{dt}$

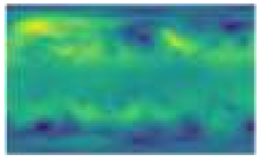
Leapfrog scheme

$$x_{n+1} = x_{n-1} + 2\Delta t \frac{dx}{dt}$$

Work in progress by Minh Nguyen, Marcel Ricker, Sebastian Grayek & Joanna Staneva @ Hereon

Forcing fields

Atmospheric pressure



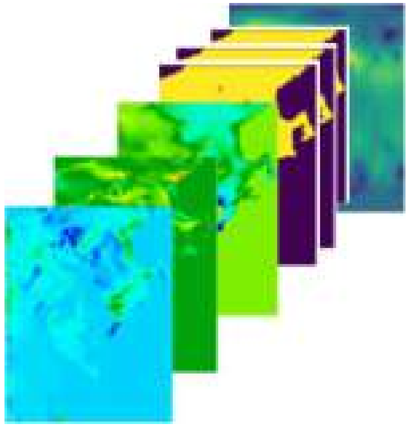
Tidal forcing

Work in progress

Learning Framework and Architecture

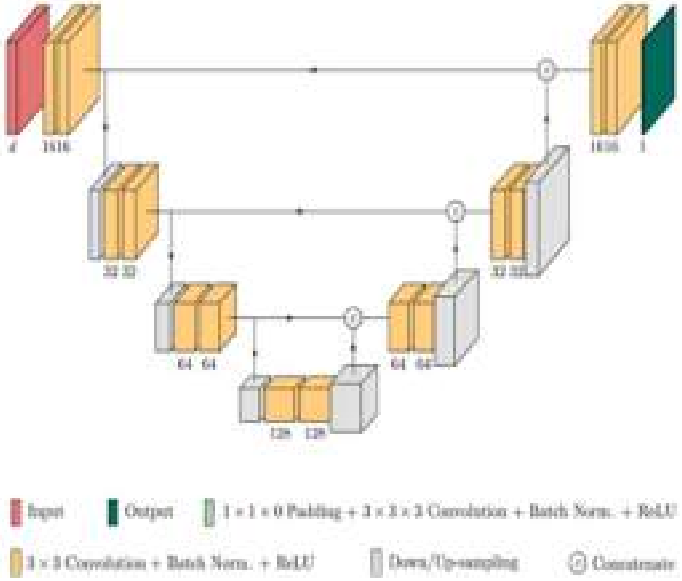
Input fields

x_n, forcing, BCs, masks, bathymetry



Baseline architecture

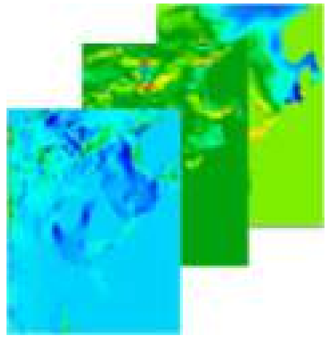
Convolutional U-net



Network Outputs

$$\frac{dx}{dt}$$

Time-stepped fields



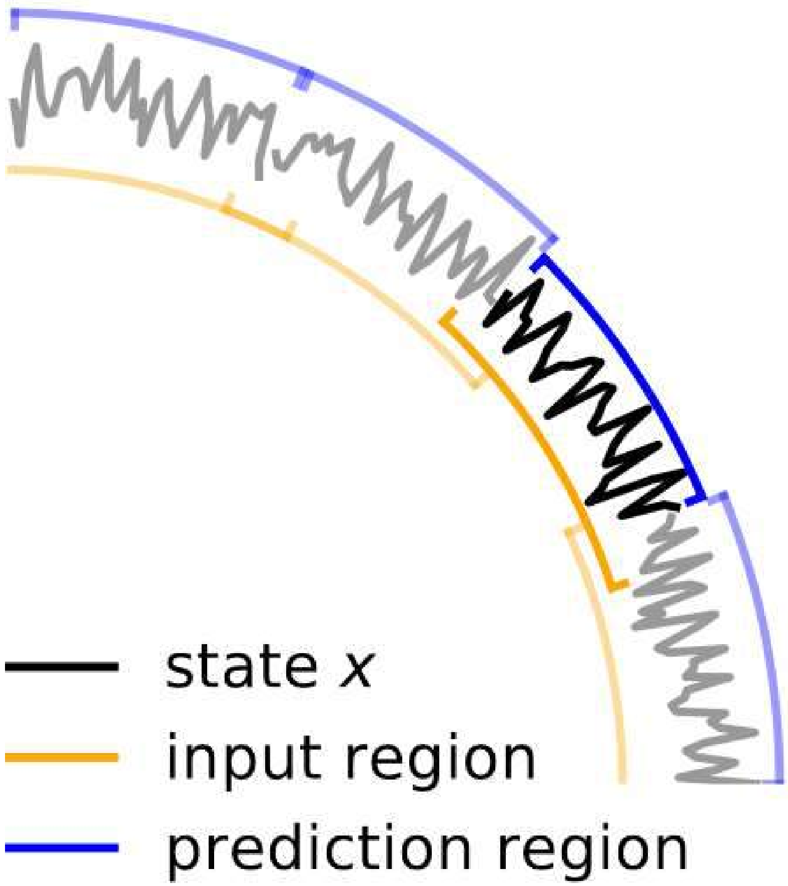
$$x_{n+1} = x_{n-1} + 2\Delta t \frac{dx}{dt}$$

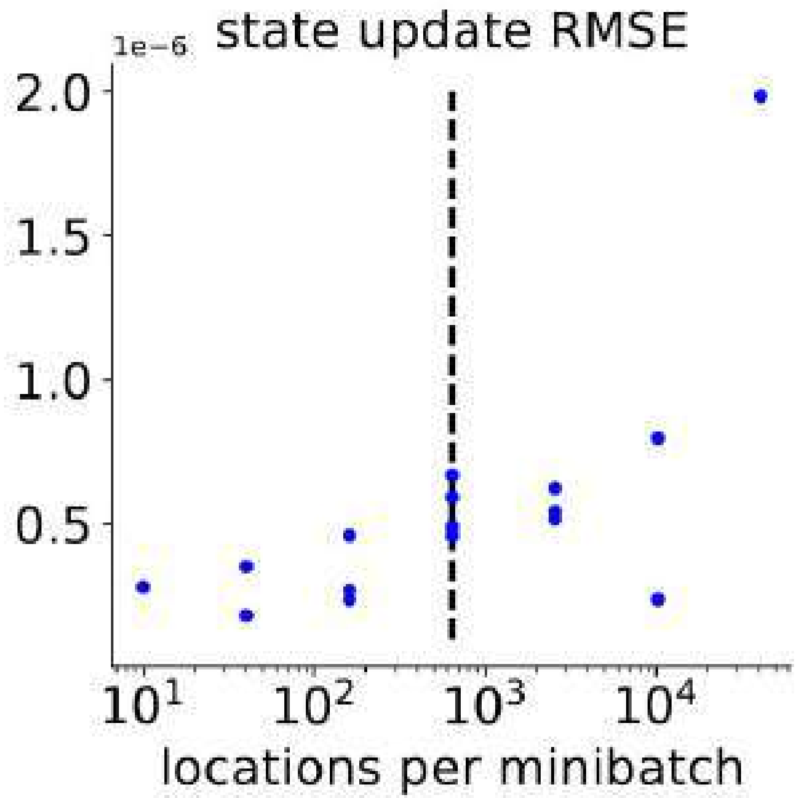
Summary + Next Steps

- Emulators can provide missing derivatives for solving inverse problems
- Accuracy can be improved by constrained hybrid models
- Initial progress with NEMO is proceeding with training data generated from a simplified 2D scheme
- Next steps:
    - optimize and evaluate 2D emulation scheme
    - incorporate tidal forcing
    - explore and optimize neural architecture
    - physical and geometric constraints
- Medium term:

- 3D NEMO with all relevant fields and physics
- Changing spatial or temporal resolution

Training on Partial System States





Objective Function for Emulator Training

EDITO ModelLab hereon

Objective function

Next system state

Emulator state update function

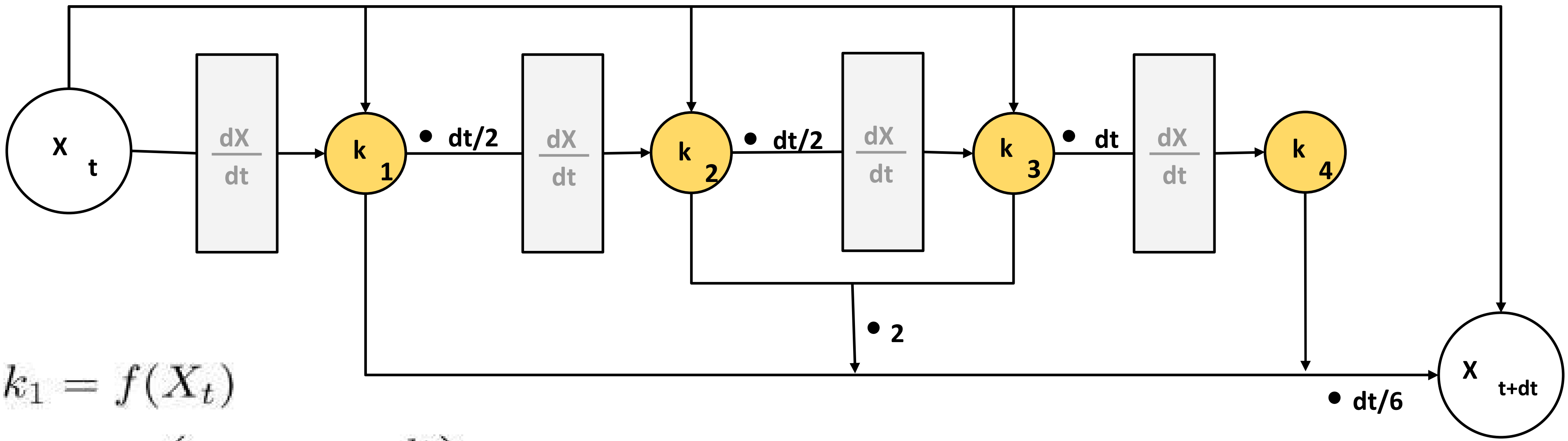
$$\mathcal{L}_{\mathrm{DYN}}(\phi) = \sum_n ||\mathbf{x}_{n+1} - \widehat{\mathcal{M}}_\phi(\mathbf{x}_n)||_2^2 = ||M(\mathbf{x}_n) - \widehat{\mathcal{M}}_\phi(\mathbf{x}_n)||_2^2$$

Neural network parameters

Time index

Simulator state update function

Runge-Kutta Integration



$$k_1 = f(X_t)$$

$$k_2 = f\left(X_t + k_1 \cdot \frac{dt}{2}\right)$$

$$k_3 = f\left(X_t + k_2 \cdot \frac{dt}{2}\right)$$

$$k_4 = f\left(X_t + k_3 \cdot dt\right)$$

$$X_{t+dt} = X_t + \frac{dt}{6}(k_1 + 2(k_2 + k_3) + k4)$$

WP 3 – Models for EDITO

WP3:

- Year 1 Achievements/Year 2 Plan, I Federico (CMCC) (25′)
- Example: Global Configuration of NEMO at 1/36, MOi (C Bricaud) (15′)
- Discussion (5′)

EDITOModelLab

European Digital Twin Ocean

WP3
Models for the Digital Twin of the Ocean

1st Year Achievement & 2nd Year Workplan

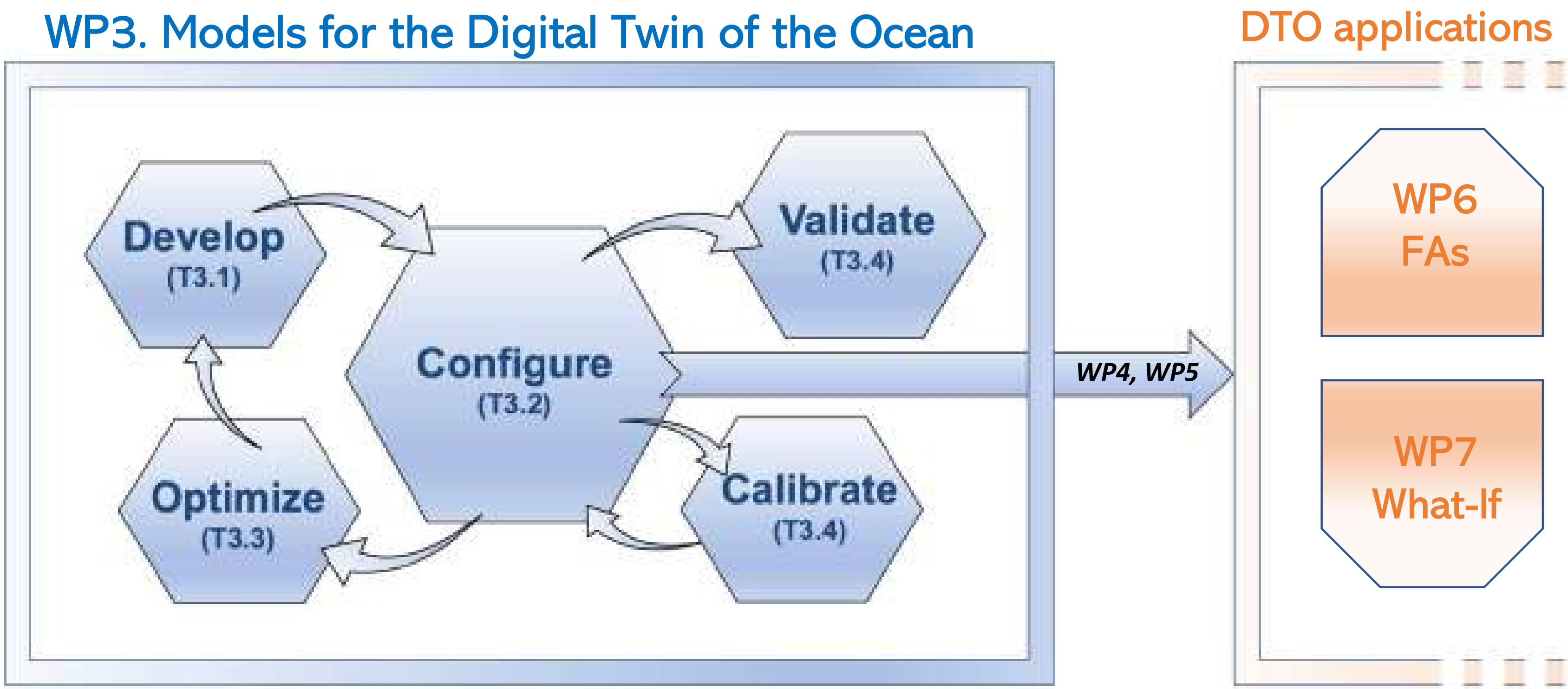
I. Federico (CMCC, lead)
J. She (DMI, co-lead)
and WP3 team

EDITO Model Lab – General Assembly
16-18 January 2024, Lecce, Italy

Overview – *Numerical models for the Digital Twin of the Ocean*

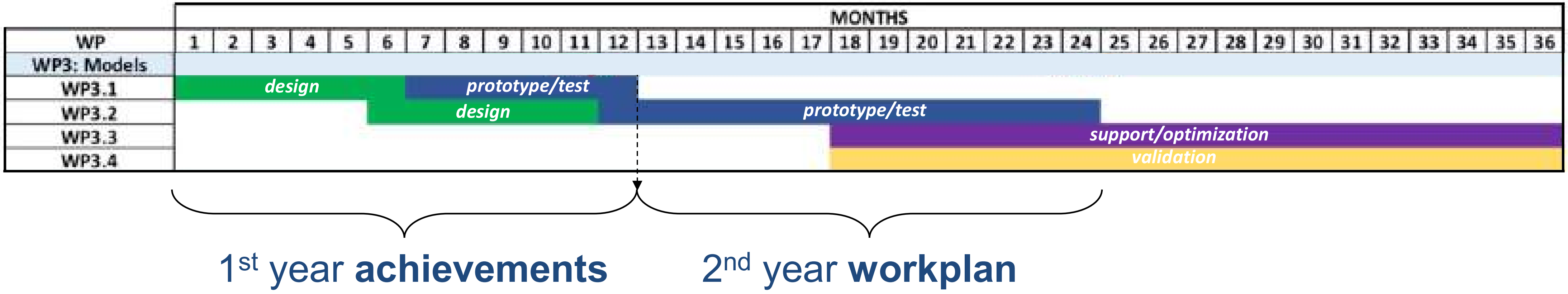
- **Improvement/Development** of next generation ocean models for DTO
- Ocean **configurations** for DTO models
- **Optimization** of DTO models for HPC and GPUs
- **Calibration/Validation** of models with satellite and in situ observations

<u>MAIN OBJECTIVE</u>: *consolidate **existing numerical models** for circulation and waves and develop the **next generation** of ocean model configurations*



Overview – *Numerical models for the Digital Twin of the Ocean*

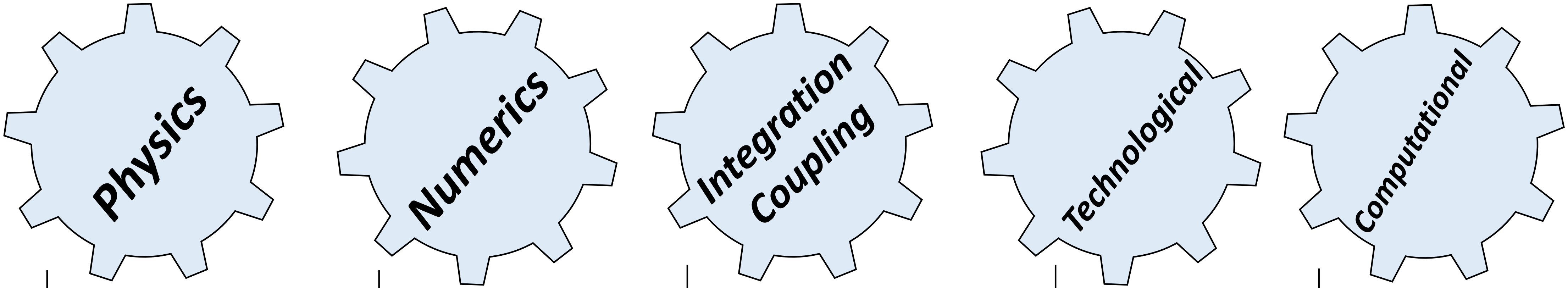
WP3.1 - Improvement/Development *of next generation ocean models for DTO*
WP3.2 - *Ocean* ***configurations*** *for DTO models*
WP3.3 - Optimization *of DTO models for HPC and GPUs*
WP3.4 - Calibration/Validation *of models with satellite and in situ observations*



EDITOModelLab

Improvement/Development of next generation ocean models for DTO

WP3.1 - The design phase of the model developments



Physics
- *Tidal representation at the global scale*
- *Sea-ice with unstructured model*
- *Wave parametrization and modelling*
- …

Numerics
- *New time-stepping (i.e. RK3)*
- *Finite elements for global scale*
- *Boundary conditions treatment*
- …

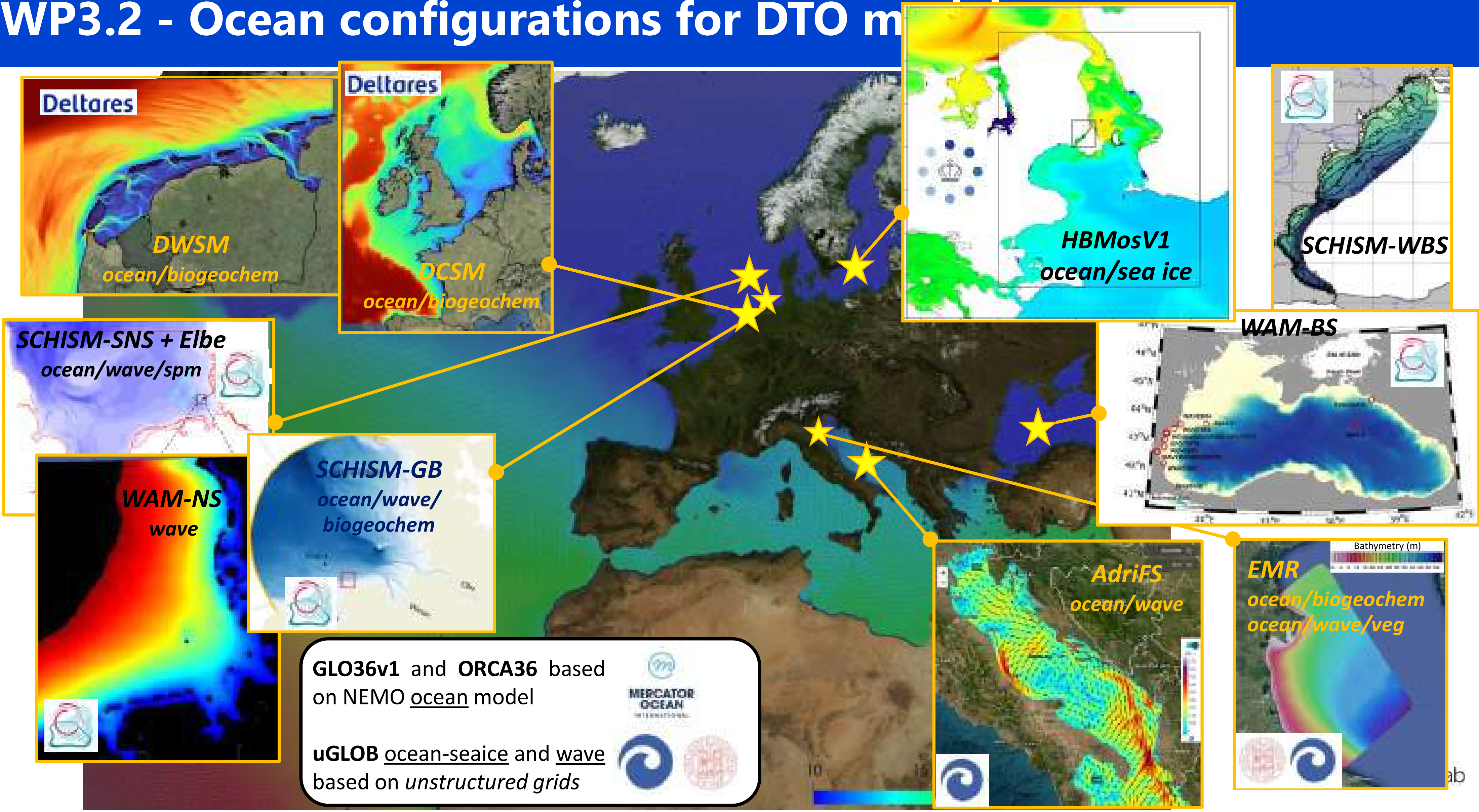
Integration Coupling
- *Current-wave interaction*
- *Coupling with biogeochem and ecological models*
- *Integrate vegetation module*
- …

Technological
- *Improve pre/post-proc for a user DTO*
- *Automatic mesh generation*
- *Model builder*
- …

Computational
- *CPU/GPU hybrid*
- *Mixed precision*
- *HPC for unstructured model*
- …

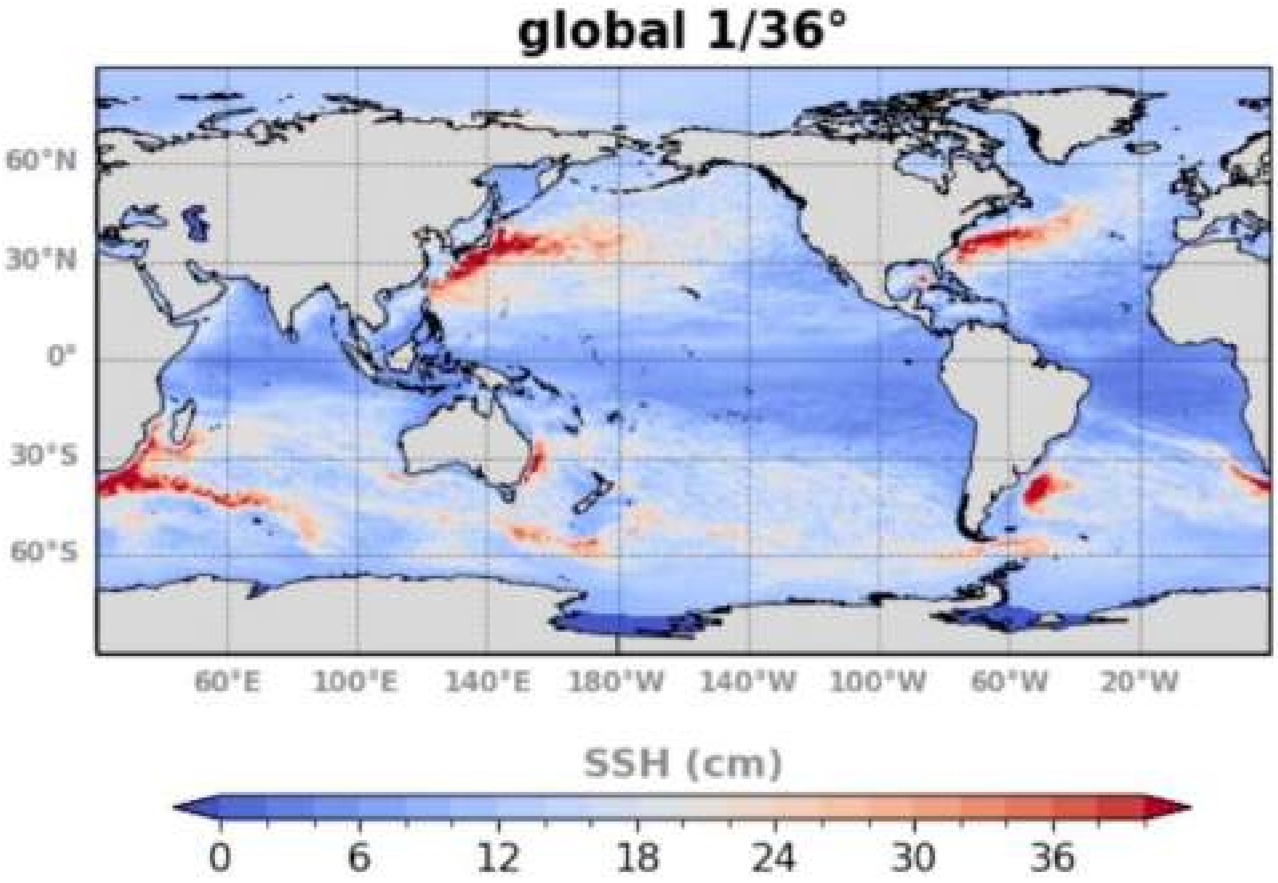
EDITOModelLab

WP3.2 - Ocean configurations for DTO m



WP3.2 - Ocean configurations for DTO models

ORCA36 – NEMO1/36



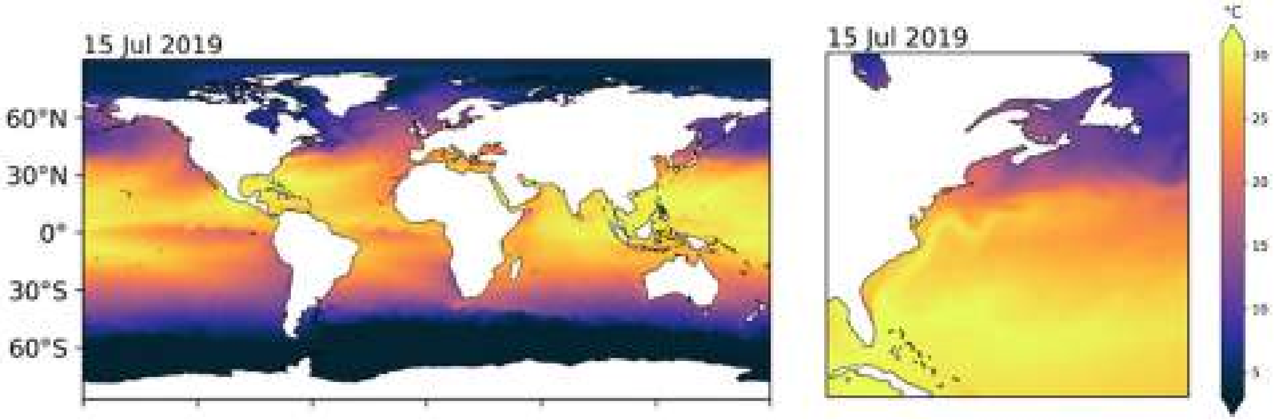
Example of Ocean Configuration presented by Clément Bricaud (MOi)

MERCATOR OCEAN INTERNATIONAL
EDITOModelLab

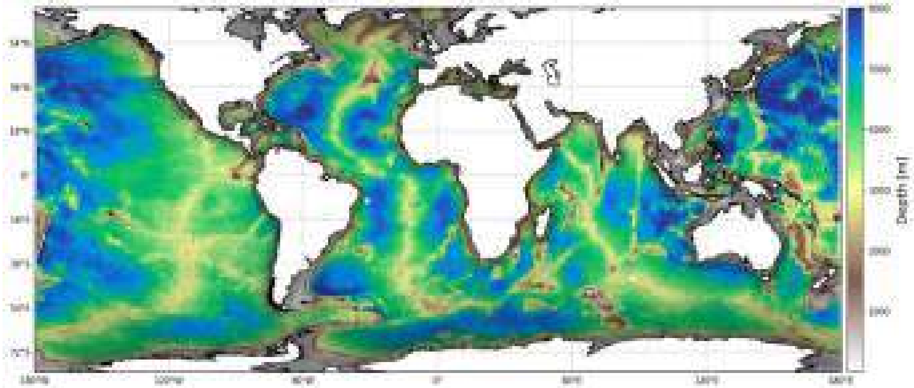
WP3.2 - Ocean configurations for DTO models

uGLOB – ocean/sea-ice

Unstructured-grid 3D baroclinic circulation modelling of seamless Global Coastal Ocean ensures continuity and mutual exchanges between the scales



Grid and bathymetry

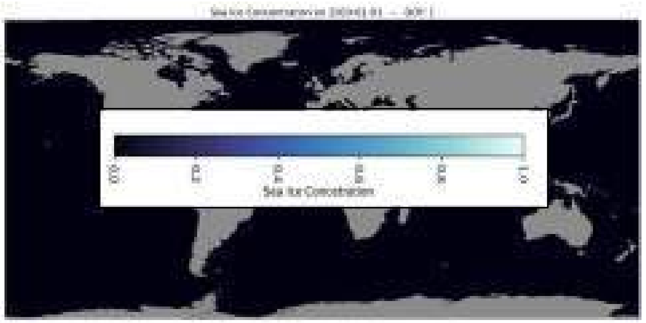


Steps of meshing principles of:

(i) quasi-Mercator mesh refinement approach, with resolution ranging from 25km to 6km

(ii) distance from the overall coasts.

Development of sea-ice component on unstructured grid



- Column physics (**thermodynamics, ice thickness distribution**, ridging and associated area/thickness changes) based on **Icepack v1.3.2**
- Modified EVP **mom. eq. solver**
- FCT **advection scheme**

Next (2nd year):

- Model developments on ocean (e.g. turbulence, rivers, tides) and sea-ice (e.g. advection) components
- Advance with validation

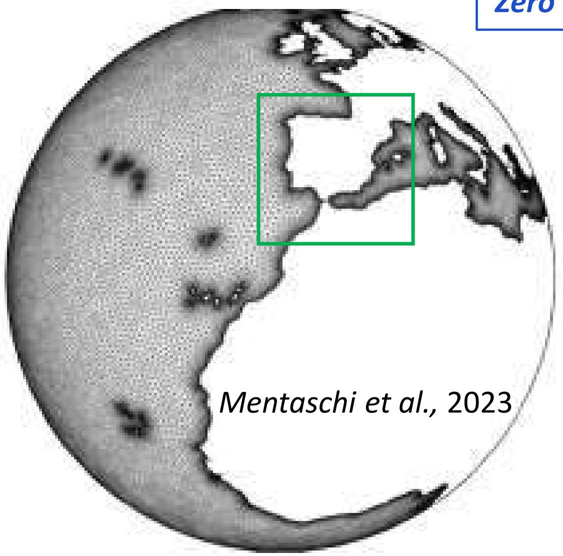
cmcc EDITOModelLab

WP3.2 - Ocean configurations for DTO models

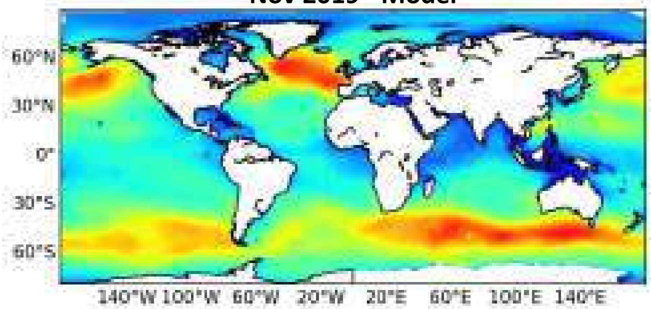
uGLOB - wave

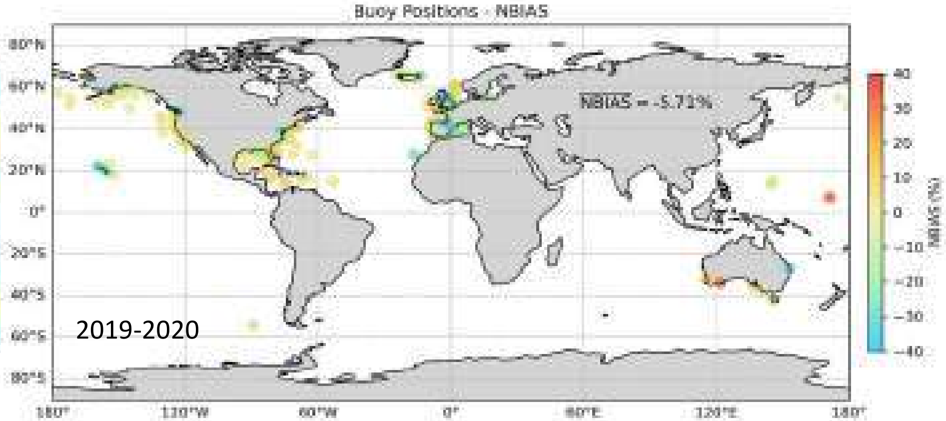
link with **FA-2** *on*
Zero carbon shipping

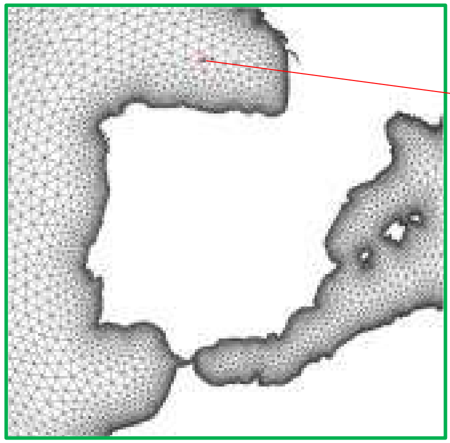
Unstructured-grid WW3 modelling of seamless Global Coastal Ocean ensures continuity and mutual exchanges between the scales, from 1/2° to 2-4km

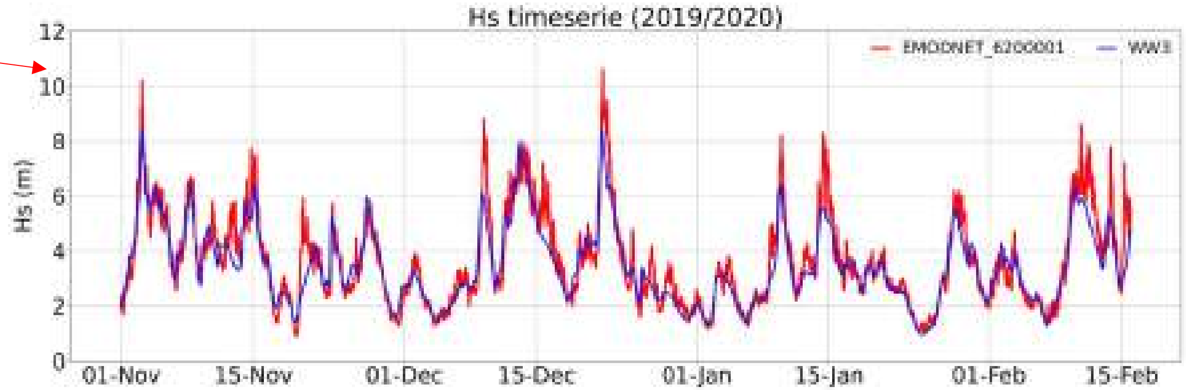


Nov 2019 - Model









Next **(2nd year):**

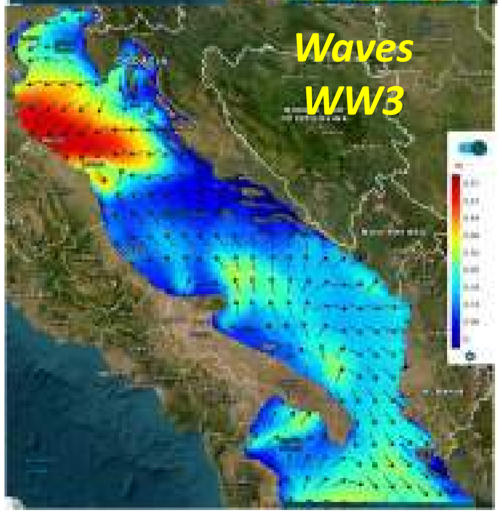
- Validation with satellite
- Event-based validation (e.g. waves induced by hurricanes)
- Sensitivity to atm forcing (ERA5 and ECWMF-IFS)

cmcc
EDITOModelLab

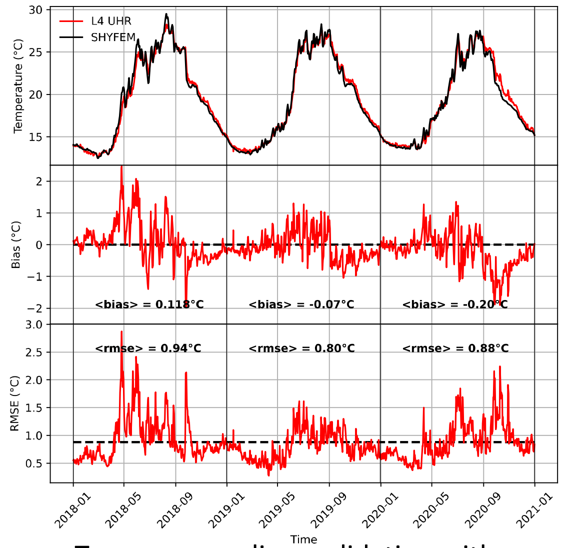
WP3.2 - Ocean configurations for DTO models

AdriFs ➢ **Unstructured resolution from 2km to 300m**

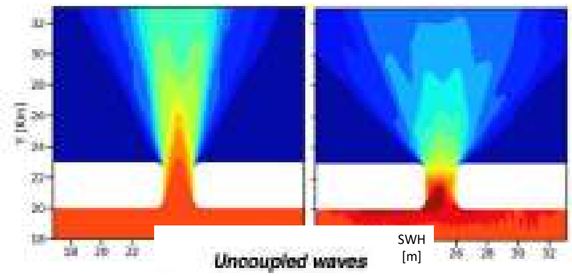
link with ***FA-1*** *on* ***MPA for biodiversity***



Validation with satellite and in-situ observations



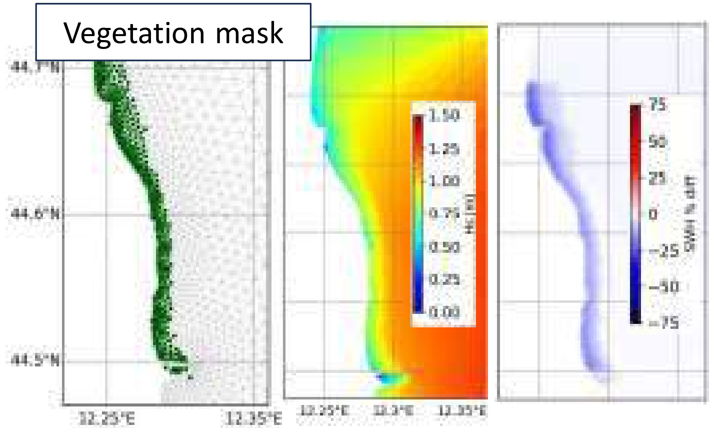
Two-way coupling: validation with tidal inlet testcase



NEXT (2nd year): AdriFs in coupled mode

VEGetation module for the Emilia Romagna domain in Northern Adriatic Sea

link with ***WiS-1*** *on* ***Nature-based Solutions***

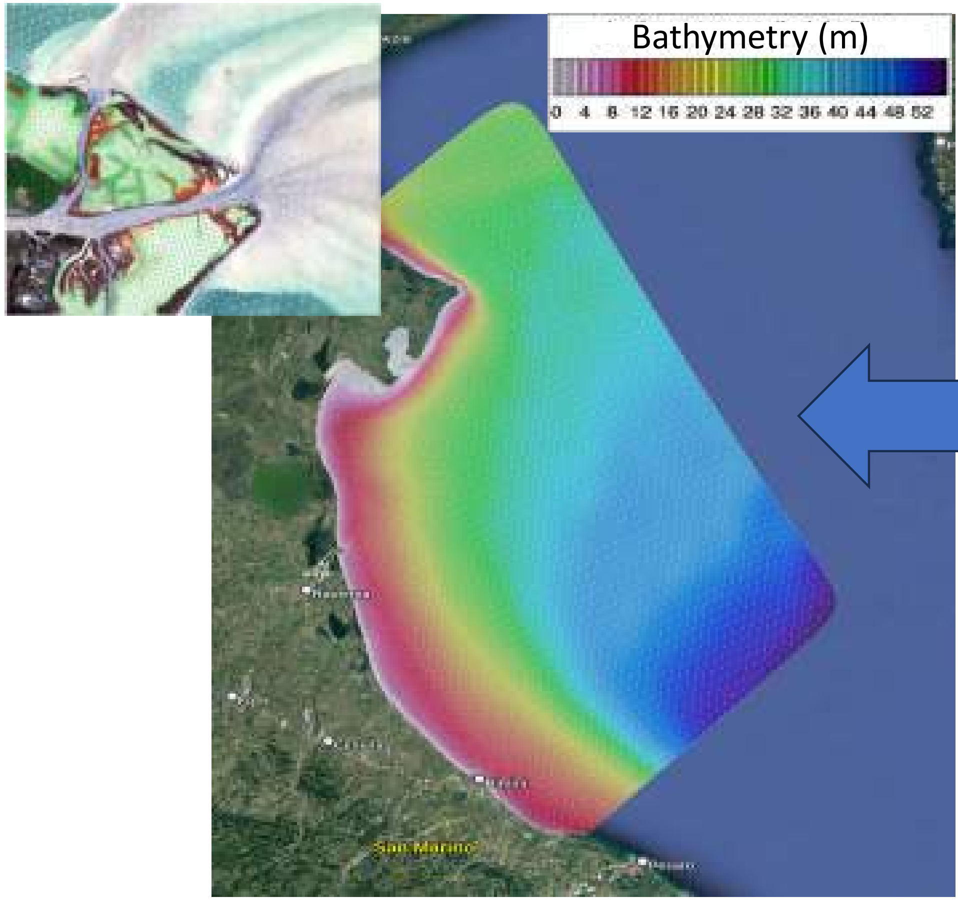


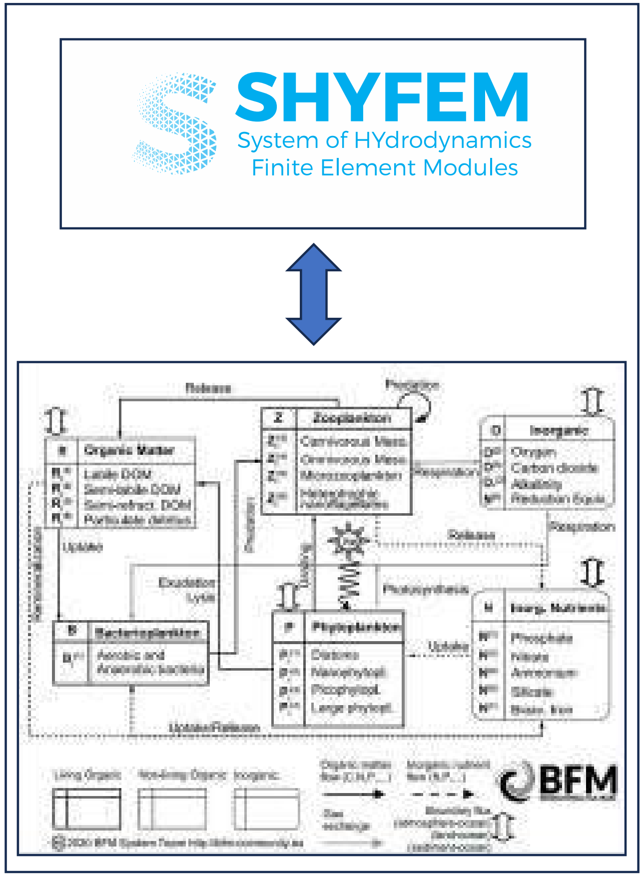
Advancement with vegetation modelling including flexibility of seagrass plants

cmcc EDITOModelLab

WP3.2 - Ocean configurations for DTO models

Coupling between the circulation model SHYFEM-MPI and biogeochemistry model BFM for the Emilia Romagna domain in Northern Adriatic Sea in Italy





Idealized and realistic testcases are used to verify and test the coupling procedures.

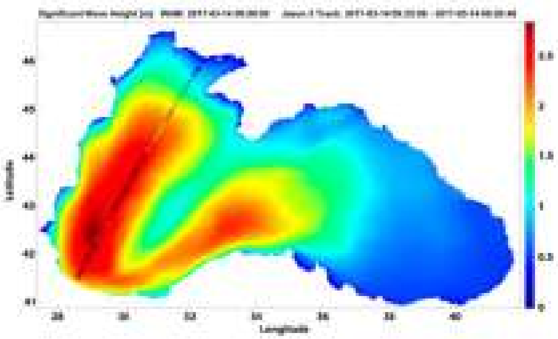
Next* (2nd year)*:

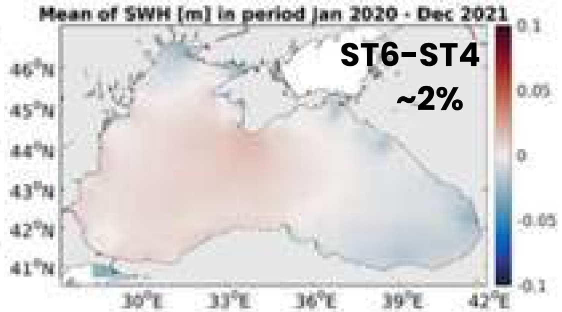
- Finalization of the coupling
- Calibration and validation of the EMR config

EDITOModelLab

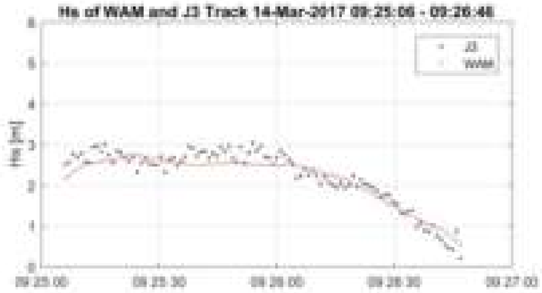
WP3.2 - Ocean configurations for DTO models

WAM – Black Sea





Sensitivity to ST4 and ST6 source term



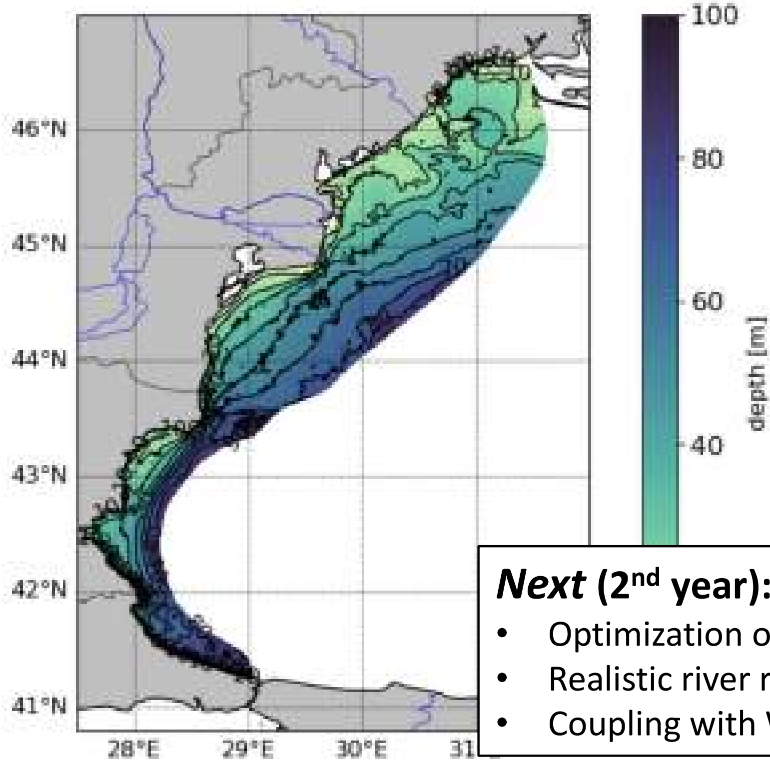
Along-track satellite comparison for a wave extreme event

Next **(2nd year):**

- inclusion of Sea of Azov
- Inclusion of Marmara Sea
- Second forecast cycle
- Tests of new assimilation methods

SCHISM – coastal Western Black Sea

Horizontal resolution from 3 km to 100m



Next **(2nd year):**

- Optimization of grid
- Realistic river run-off
- Coupling with WWM

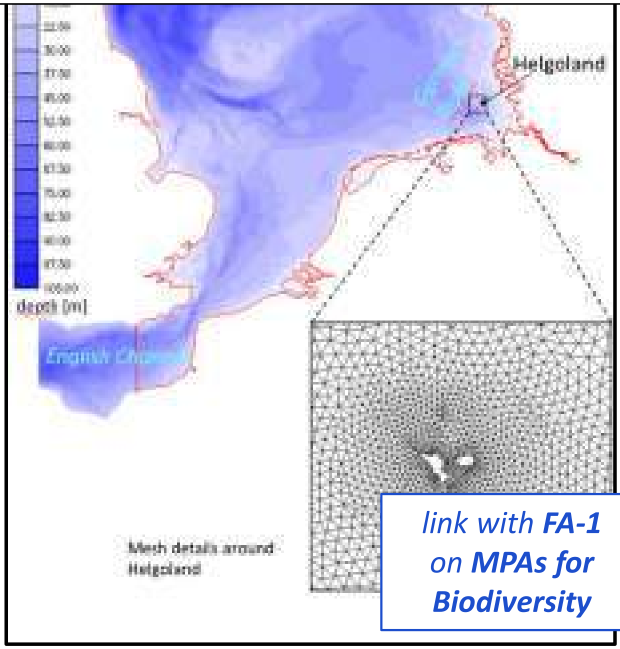
link with ***WiS-2***
on ***Marine plastic for Zero pollution***

hereon EDITOModelLab

WP3.2 - Ocean configurations for DTO models

SCHISM : Southern North Sea + Elbe (ECOSMO)

- Coupled **hydrodynamic-biogeochemical**
- Resolution from 5km (SNS) to 30m (estuary)

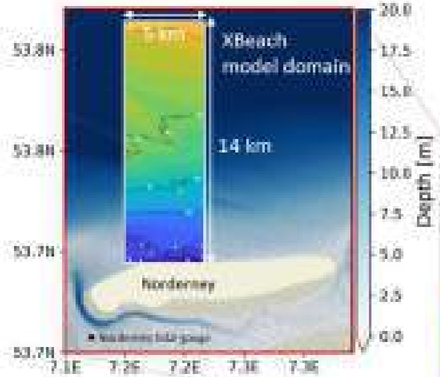


*link with **FA-1** on **MPAs for Biodiversity***

Next **(2nd year):**

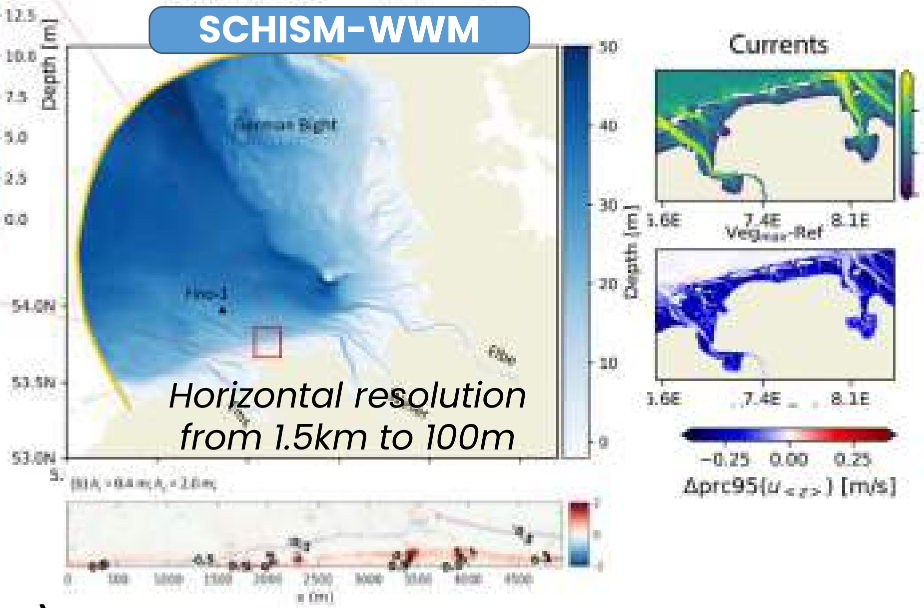
- Inclusion of Weser estuaries to the numerical mesh
- Advancements with biogeochemical developments
- Work on turbulence-sediment-bgc parameterisation

SCHISM – German Bight



*link with **WiS-1** on **Nature-based solution** and **WiS-2** on **Marine plastic for Zero pollution***

Developments for vegetation VEG module
Bathymetry change due to storm surge



Horizontal resolution from 1.5km to 100m

Next **(2nd year):**

- Containerization with Singularity
- Additional X-Beach subdomain for erosion assessment WiS

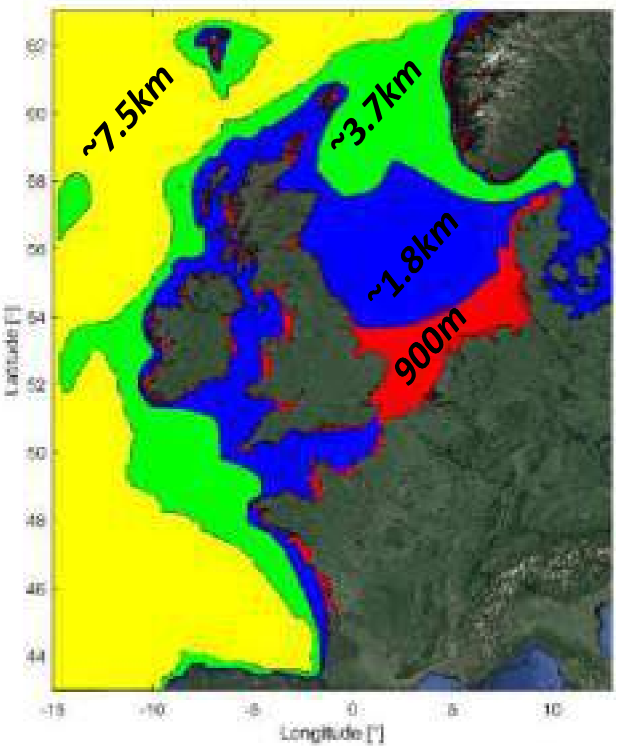
hereon EDITOModelLab

WP3.2 - Ocean configurations for DTO models

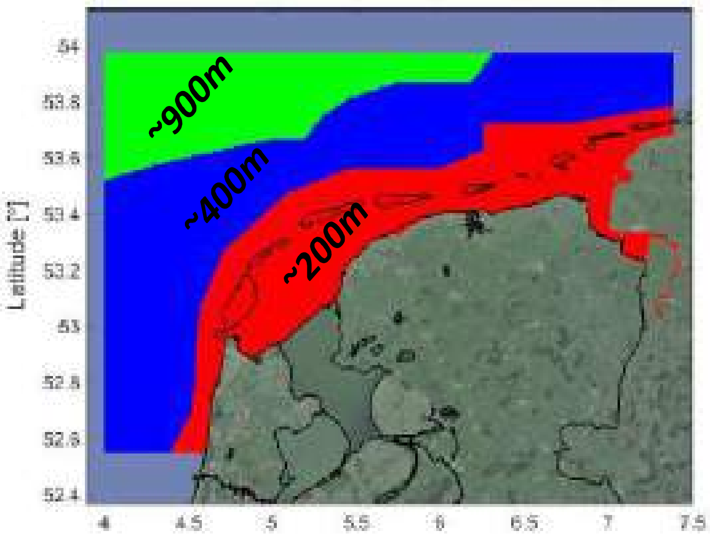
Delft3D-FM including water quality and morphology modules

link with **FA-1** *on* ***MPA for biodiversity*** *and*
WiS-3 *on* ***Aquaculture for Zero carbon***

Dutch Continental Shelf Model (DCSM)



Dutch Wadden Sea Model (DWSM)



- ➢ **Optimization** of post-processing of hydrodynamic-; morphologic- and wave model outputs, using **D-EcoImpact**.
- ➢ Improved interoperability of **pre-/post-processing** by generalizing formats with **HydroLib**.

Next* (2nd year)*:

- D-EcoImpact: interoperability, API, GUI, AI-based rules.
- Water Quality: higher resolution (100m), shellfish representation, BMI interface

- ➢ Bathymetries from Dutch governmental data, combined with EMODnet
- ➢ DW Sea Model nested in either CMEMS or in DCSM *(higher resolution)*

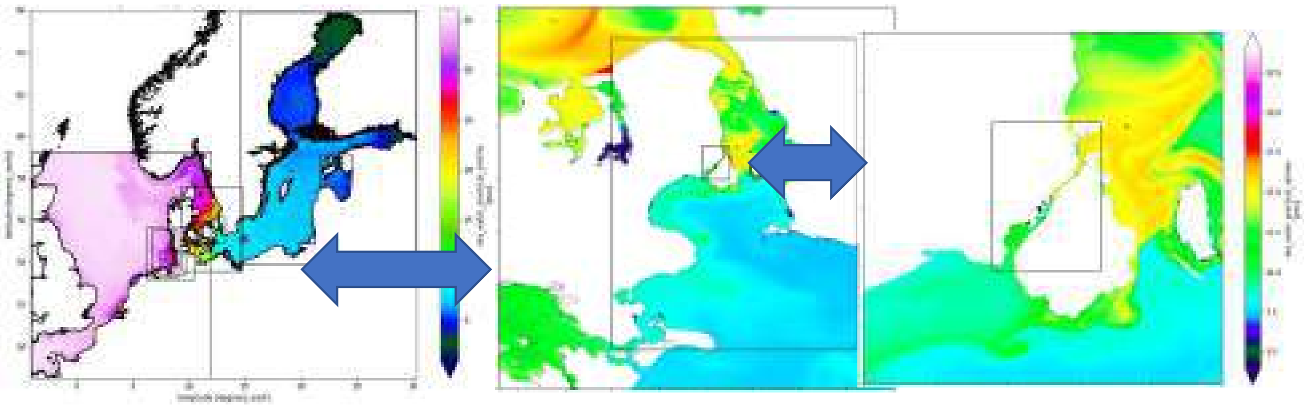
Deltares EDITOModelLab

WP3.2 - Ocean configurations for DTO models

*link with **WiS-1** on **Nature-based solution** and **WiS-2** on **Marine plastic for Zero pollution***

***HBMos:** a two-way nested on-demand model for any subdomain of Baltic-North Sea (downscaling up to 37m resolution)*

Example for Copenhagen area



Background configuration:
North Sea – Danish wat. – Baltic Sea:
5.5km – 1.8km – 900m resolution

Examples on on-demand configuration:

- Øresund: 180m; Copenhagen: 37m
- OLAMUR Offshore Farms in German Bight, W. Baltic and Estonia: 180m
- Latvia Ports (12 sub-domains): 37m
- On-demand setup for extreme storm surges 180m-37m

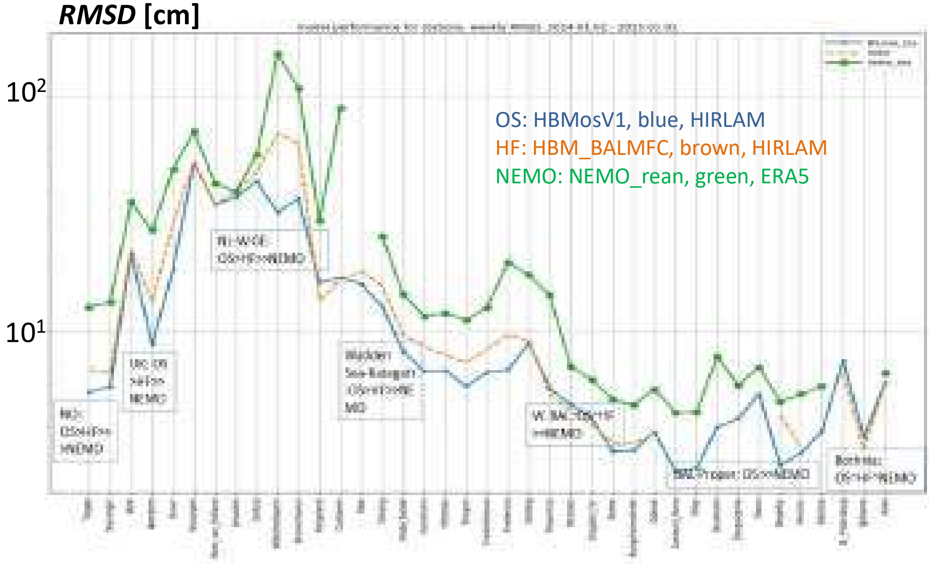
Baltic-North Sea setup:

- EMODnet bathymetry
- OpenStreetMap coastline
- River discharge from eHype
- HIRLAM/HARMONIE forcing
- LBC: tides, T/S and surge
- Implement MP module in HBMos and develop MP resuspension

***Next* (2nd year):**

- ➢ Finalize R&D on HBMos-MP module
- ➢ EuroHPC Tests (optimization?)
- ➢ HBMos-WAM coupling (optional)
- ➢ More validations (incl. Satellite SST)

***RMSD* [cm]**



Danmarks Meteorologiske Institut

Overview on T3.1/T3.2: Model developments and Ocean Configurations (M1-M24)

1st Year Achievements:

- Finalization of the **design phase** of **Development** of Next Generation Ocean Models for DTO (T3.1)
- Ocean **configurations** (T3.2) and implementations of global and regional-coastal models for DTO in advanced stage - to be linked with the different **FAs and WiSs** (WP6 + WP7)

2nd Year Workplan:

- Configurations already mature and well-established for **integration into VOML** and support for **FAs and WiSs**
- Finalization of all the model developments and **Ocean Configurations**

2nd year Workplan

T3.3: Optimisation of DTO models for HPC and GPUs (M18-M36)

CINECA

➢T3.3.1: Optimisation of Model efficiency

➢ NEMO ORCA configurations

As preliminary work a **Mixed-precision version** of ORCA1 with ICE is created (~30% improvement in performance)

BSC

- Validating ORCA12 is in progress
- Create and start validating ORCA36 mixed-precision configuration
- Extend **GPU porting** to entire ICE (icedyn_adv_pra) module
- Assessing overall performance

➢ Unstructured-grid models

cmcc

- Improvement of **I/O** management via **XIOS** under testing
- Optimization of **domain decomposition partitioning** for unstructured grids
- Optimization of **sparse matrix solver**

EDITOModelLab

2nd year Workplan

T3.3: Optimisation of DTO models for HPC and GPUs (M18-M36)

➢T3.3.2: Evaluation of model scalability and performance

CINECA

- Definition and use of suitable **computational metrics** (PoP metrics, performance portability metrics - from literature, speed-up, efficiency....perf./Watt…)
- **Assessment campaign** (TBD) based on top of the previously defined computational metrics and optimised models. This includes:
  - EuroHPC hardware selection
  - Model configurations from Task T3.2
  - Assessment campaign (in strict cooperation with PoP CoE?)

2nd year Workplan

T3.4: Validation/calibration of models with satellite and in situ observations (M18-M36)

1. Design of the validation method (M18)

- Define ocean configurations to be validated: T3.4 should focus on key ocean configurations
- Define validation period and extreme events:
  - A common 1-year period should be used as much as possible, as this allows model intercomparison
  - Ideally a recent year is preferred which can be compared with CMEMS forecast
  - Events-based: storm surge, marine heatwaves, inflow events
- Define validation parameters: T, S, sea level, currents, ice, SWH, wave period
- Define validation metrics: ideally CMEMS validation metrics can be used.

2. Validation implementation (M24)

- Input dataset preparation (CMEMS datasets?)
- One-year simulation
- General validation
- Event-based validation
- Intercomparison (between EDITO models, and between EDITO and CMEMS models - link with T4.4)

3. Reporting and publication (M30)

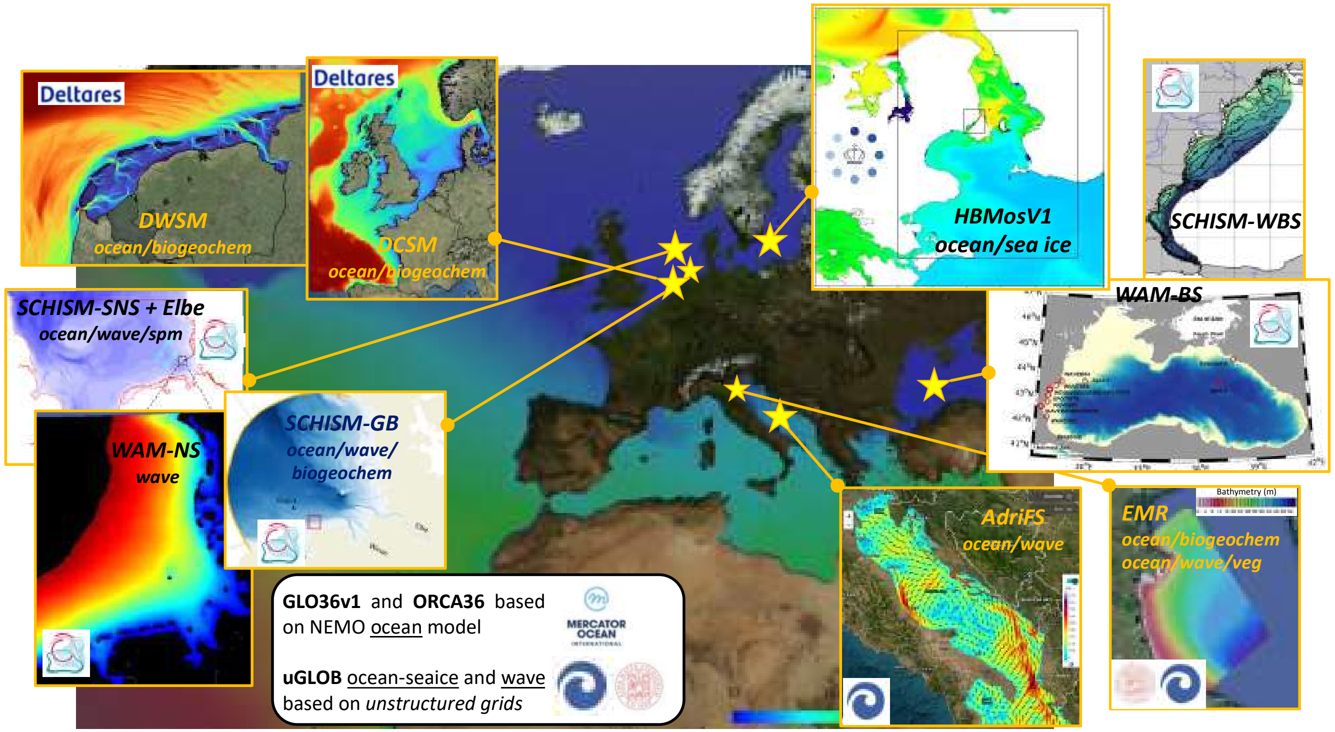
Danmarks Meteorologiske Institut

EDITOModelLab

2nd year Workplan

T3.4: Validation/calibration of models with satellite and in situ observations (M18-M36)

Ocean configurations to be validated



PARTNER(S) INVOLVED	NAME OF THE OCEAN CONFIGURATION	GEOGRAPHICAL REGION	MODEL(S)
MOI	GLO36V1	Global	NEMO
MOI	ORCA36 free runs	Global	NEMO
CMCC/UNIBO	uGLOBocean	Global	SHYFEM-MPI/Seaice
CMCC/UNIBO	uGLOBwave	Global	WW3
CMCC	AdriFS	Adriatic Sea	SHYFEM-MPI/WW3
UNIBO	ERM-biogeo	Northern Adriatic Sea	SHYFEM-MPI
UNIBO/CMCC	ERM-veg	Northern Adriatic Sea	SHYFEM-MPI/WW3
DMI	HBMosV1	Baltic/North Sea	HBM
Deltares	DCSM (Dutch Continental Shelf Model)	North Sea	Delft3D-FM
Deltares	DWSM (Dutch Wadden Sea Model)	Wadden Sea	Delft3D-FM
Hereon	SCHISM-GB	German Bight	SCHISM/WWM/SED3D
Hereon	SCHISM-SNS + Elbe	southern North Sea + Elbe estuary	SCHISM
Hereon	WAM-NSW	North Sea	WAM
Hereon	WAM-BS	Black Sea	WAM
Hereon	SCHISM-WBS	Western Black Sea	SCHISM/WAM

2nd year Workplan

T3.4: Validation/calibration of models with satellite and in situ observations (M18-M36)

Example of event-based validation (KPIs)

General validation metrics

Class 1 metric: climatology and variability

Name of product	Levels [m]
T-climatology	5, 20, 30, 50, 100, 150, 200, 300, 400, 500, 600, 700, 800, 900, 1000, 1200, 1400, 2000, 3000, 4000
S-climatology	
UV-climatology	
SSH-climatology	
T-standard deviation	
S-standard deviation	
UV-standard deviation	
SSH-standard deviation	

Class 3 metric: time series

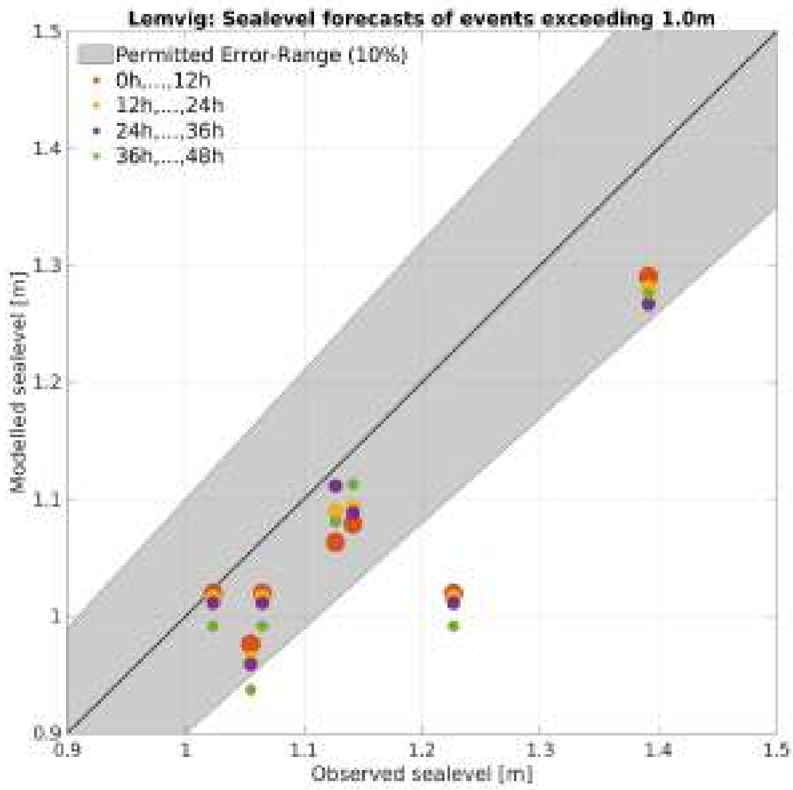
Name of product	Location
BAL TS-1	Buoy station Platform code: xxx [Lat xxx°N; Lon xxx°W]
BAL coastal SST-1	station Platform code: xxx [Lat xxx°N; Lon xxx°W]
BAL SSH-1	Tide gauge station Platform code: xxx [Lat xxx°N; Lon xxx°W]
NWS TS-1	Buoy station Platform code: xxx [Lat xxx°N; Lon xxx°W]
NWS SSH-1	Tide gauge station Platform code: xxx [Lat xxx°N; Lon xxx°W]
NWS SST-1	station Platform code: xxx [Lat xxx°N; Lon xxx°W]
MED TS-1	Buoy station Platform code: xxx [Lat xxx°N; Lon xxx°W]
MED coastal SST-1	station Platform code: xxx [Lat xxx°N; Lon xxx°W]
MED SSH-1	Tide gauge station Platform code: xxx [Lat xxx°N; Lon xxx°W]
GLO TS-1	Buoy station Platform code: xxx [Lat xxx°N; Lon xxx°W]
GLO SSH-1	Tide gauge station Platform code: xxx [Lat xxx°N; Lon xxx°W]

Class 2 metric: vertical sections of T and S

Name of product	Area	Latitude	Longitude
Section 1	Baltic	xxx°N	xxx°W – xxx°E
Section 2	North Sea	xxx°N	xxx°W – xxx°E

Class 4 metric: gridded error features (horizontal+vertical)

Name of product	Observations
BAL-H-SST	Satellite
BAL-V-TS	Mooring, ICES
BAL-H-TS	ICES, Argo
BAL-H-SSH	Satellite/tide dauge
NWS-H-SST	Satellite
....	



EDITOModelLab

Conclusions

- EDITO is contributing to the **development (T3.1) of several state-of-art models** (NEMO, SHYFEM, WW3, SCHISM, WAM, Delft3D, HBM, etc.)
- Ocean **configurations (T3.2)** and implementations of global and regional-coastal models for DTO in advanced stage - to be linked with the different **FAs and WiSs** (WP6 + WP7)
- HPC and GPU **optimization** of models and assessment of **performances (T3.3)**
- Common and **standardized** approach for multi-model (general and event-based) **validation (T3.4)**

EDITOModelLab

European Digital Twin Ocean

cmcc Centro Euro-Mediterraneo sui Cambiamenti Climatici

Danmarks Meteorologiske Institut

MERCATOR OCEAN INTERNATIONAL

ALMA MATER STUDIORUM UNIVERSITÀ DI BOLOGNA

hereon

BSC

SOCIB

Deltares

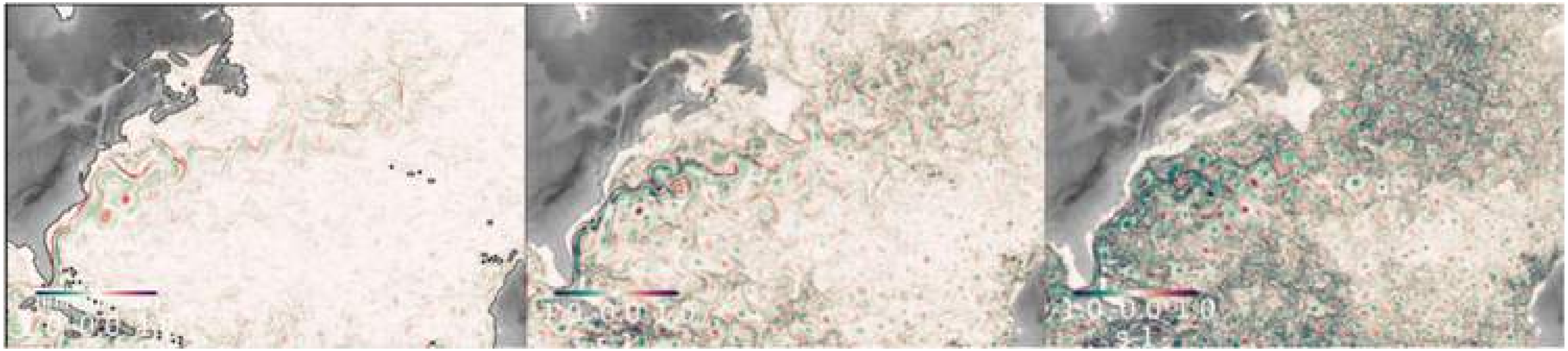
CINECA

Thanks

WP 3 – Models for EDITO

WP3/example:
The global 1/36° configuration based on NEMO OGCM

Clément Bricaud, Jérôme Chanut, Romain Bourdalle Badie, Mercator Ocean International



1/4° | 1/12° | 1/36°

EDITOModelLab

WP 3 – Models for EDITO

Plan:

- Global 1/36°: context and objectives
- Model development and validation
- Near real-time demonstrator

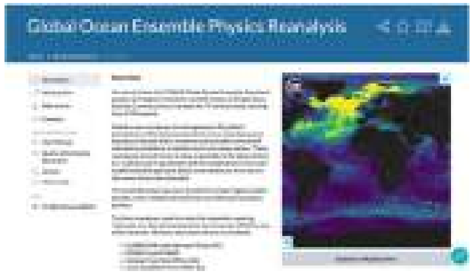
WP 3 – Models for EDITO

Plan:

- Global 1/36°: context and objectives
- Model development and validation
- Near real-time demonstrator

Global 1/36° : context and objectives

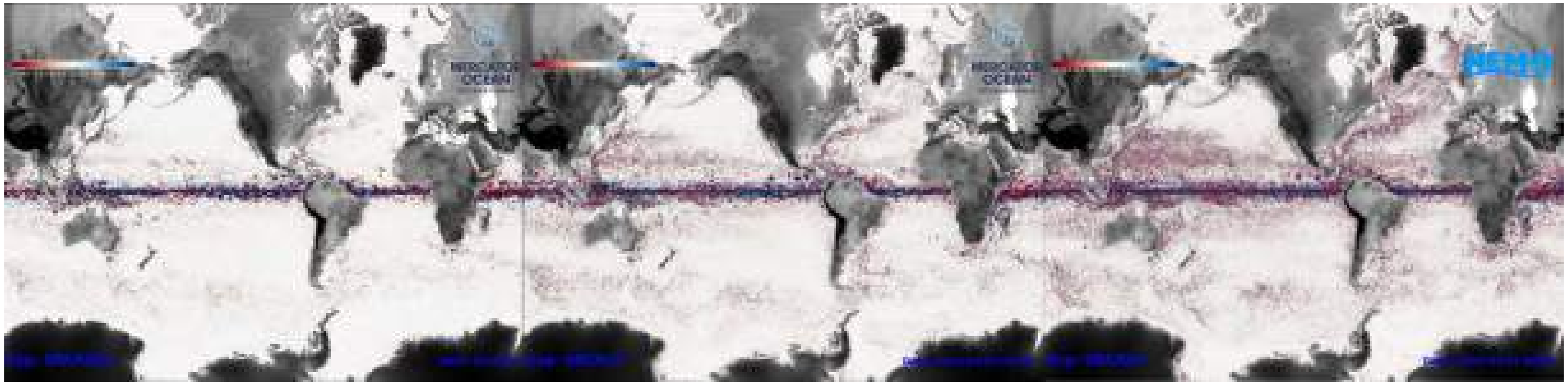
Present CMEMS/MOI global configurations:



Global ¼° (20-25 km)
=>Reanalysis
=>Seasonal forecast

Global 1/12° (6-9 km)
=>10-days Forecasting
=>Reanalysis

Global 1/36° (2-3 km)
=>10-days Forecasting



EDITOModelLab

Global 1/36° : context and objectives

Configuration name	Horizontal resolution (degree)	Horizontal resolution (km)	Zonal dimension	Meridional dimension	Baroclinic time-step (s)
ORCA025	1/4	20-25	1440	1205	1080.
ORCA12	1/12	6-9	4320	3615	360.
ORCA36	1/36	2-3	12960	10842	120.

- New global 1/36° configuration (ORCA36): model configuration for future Copernicus Marine Service and Mercator Ocean International global forecasting, based on NEMO OGCM.

- Developped during EU H2020 IMMERSE project

- Add finer scales processes and improve impact of fine scales processes over large scales processes

- 1/36° resolution: ~ 2 km

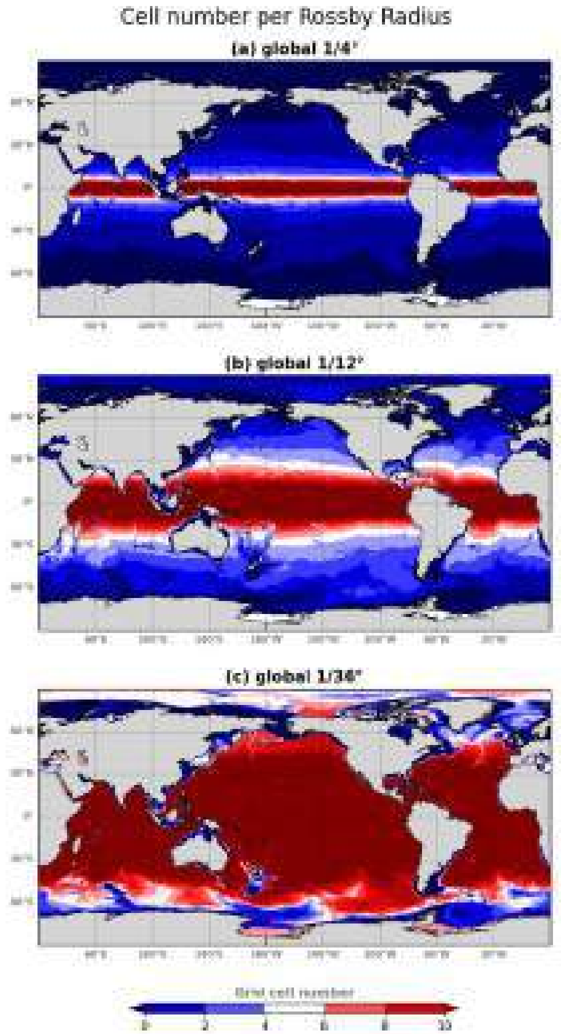
Resolve the **1st Rossby radius at the global scale** (away from continental shelves)

- Why including tides ?

Most of the energy transferred from external to **internal tides** resolved
Broad impact on energy content from meso to sub-mesoscales
Produce realistic internal tides fields and prepare upcoming observing systems (SWOT)
Better modelling/understanding of deep mixing (impacts MOC)

EDITOModelLab

Global 1/36° : context and objectives



Global 1/36° : Impact of resolution on waves resolution

Configuration	30°S / 30°N	80°S / 30°S and 30°N / 80°N	80°S / 90°S and 80°N / 90°N
ORCA025	2-10	0-1	0
ORCA12	4-10	1-4	0-1
ORCA36	10	6-10	3-6

Number of grid cells to resolve the first Rosby deformation radius

A minimum of 2 grid cell per Rossby radius to resolve a wave on a discrete grid (Hallberg, 2013)

Global ¼°: eddy-permitting

Global 1/12°: eddy-rich

Global 1/36°: eddy resolving
+ able to represent a part of the sub-mesoscale activity: sub-mesoscale permitting.

EDITOModelLab

WP 3 – Models for EDITO

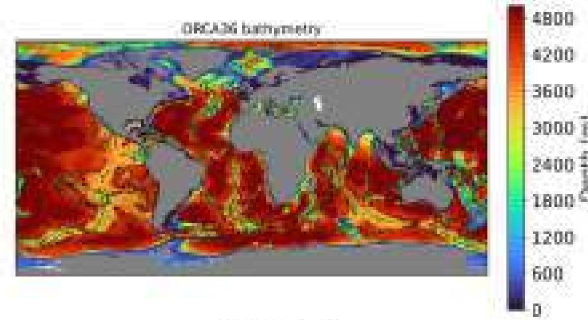
Plan:

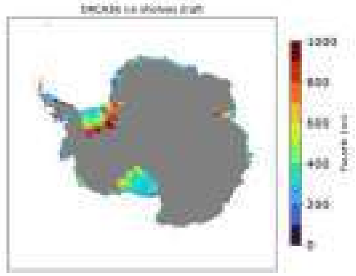
- Global 1/36°: context and objectives
- Model development and validation
- Near real-time demonstrator

Model configuration and main settings

Configuration:

Horizontal grid : tripolar ORCA grid (12960 * 10850 points)
Vertical grid: 75 Z-levels, 1 meter at surface
Domain Include Antarctic Ice Shelves (explicit resolution)
Bathymetry: GEBCO 2019 (GEBCO, 2019) and Bedmachine Antarctica 2
Antarctic ice caps: Bedmachine Antarctica 2





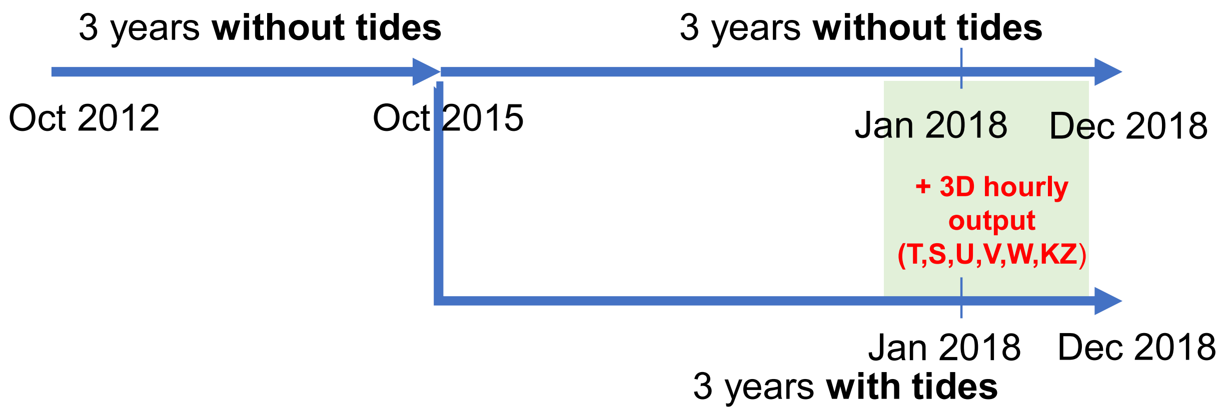
Code:

NEMO 4.2 release (including sea-ice SI3 model)

Numerical settings:

Non-linear free surface (Quasi-eulerian Coordinates formulation)
Forcing: ECMWF bulk formulae + Atmospheric pressure gradient.
Tracers transport: FCT advection scheme 4th order on horizontal and vertical + Explicite diffusion with iso-neutral operator
Dynamic: Advection: flux form - 3rd order UBS + No explicit viscosity
Vertical physic: Vertical mixing: k-epsilon vertical mixing (GLS) + adaptive-implicit vertical advection (Shchepetkin 2015)

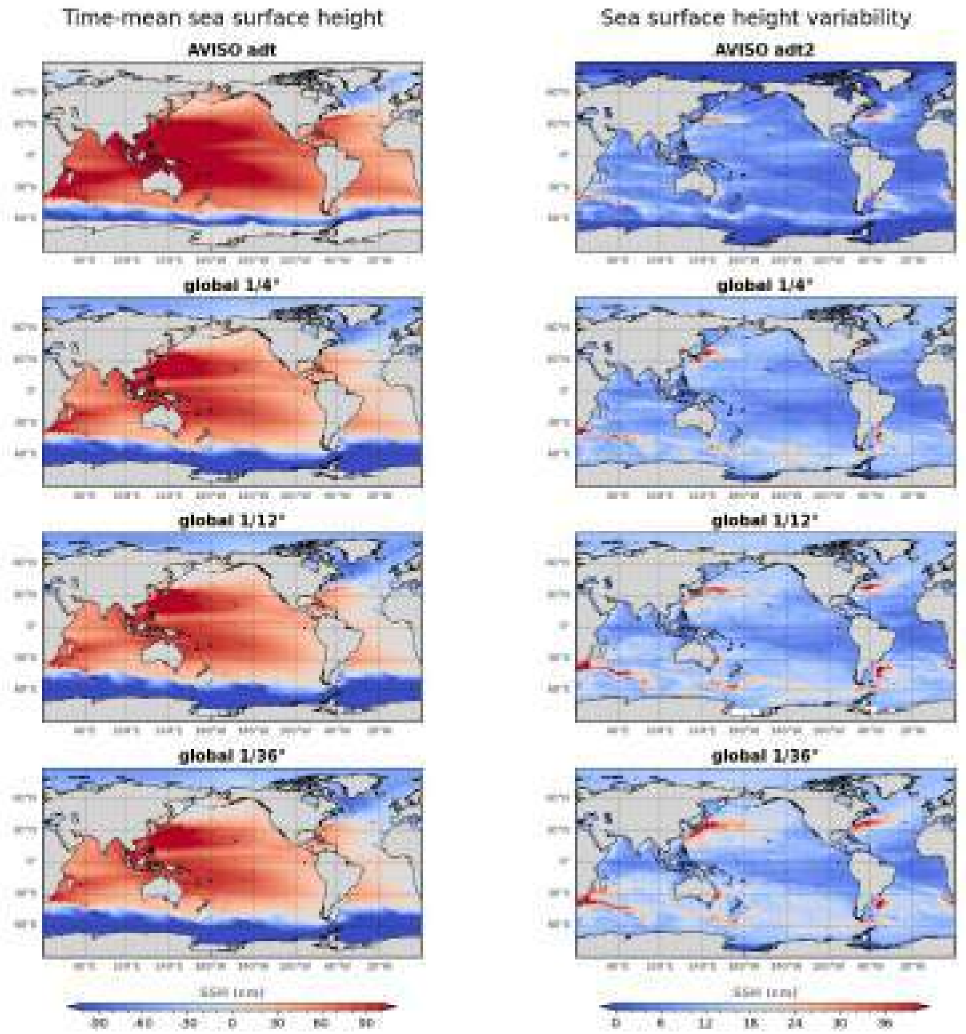
2022: production of multi-year hincasts



- A portfolio of simulations at **1/4°, 1/12° and 1/36°**. **Without** and **with tidal** forcing
- Atmospheric forcing from ECMWF/IFS real time system 8 km/1 hours
- Initial conditions: T&S from WOA13 climatology ; sea-ice form CMEMS/Mercator ¼° reanalysis GLORYS2V4.
- Tidal forcing: O1, K1, M2, S2, N2 + Self Attraction Loading
- Run on ECMWF/ATOS computer: 25600 cores for NEMO, 100 XIOS servers (1 per node), 2 months per day
- 3D daily average + 2D hourly, the last years with also 3D hourly outputs

EDITOModelLab

Sea Surface Height time-mean and variability



Period: 2016-2018

All the models are able to reproduce the circulation estimated by AVISO

Model SSH mean weaker in the open Ocean
Model SSH variability globally greater than AVISO for all the models.

western boundary currents are more energetics in ORCA12 and ORCA36

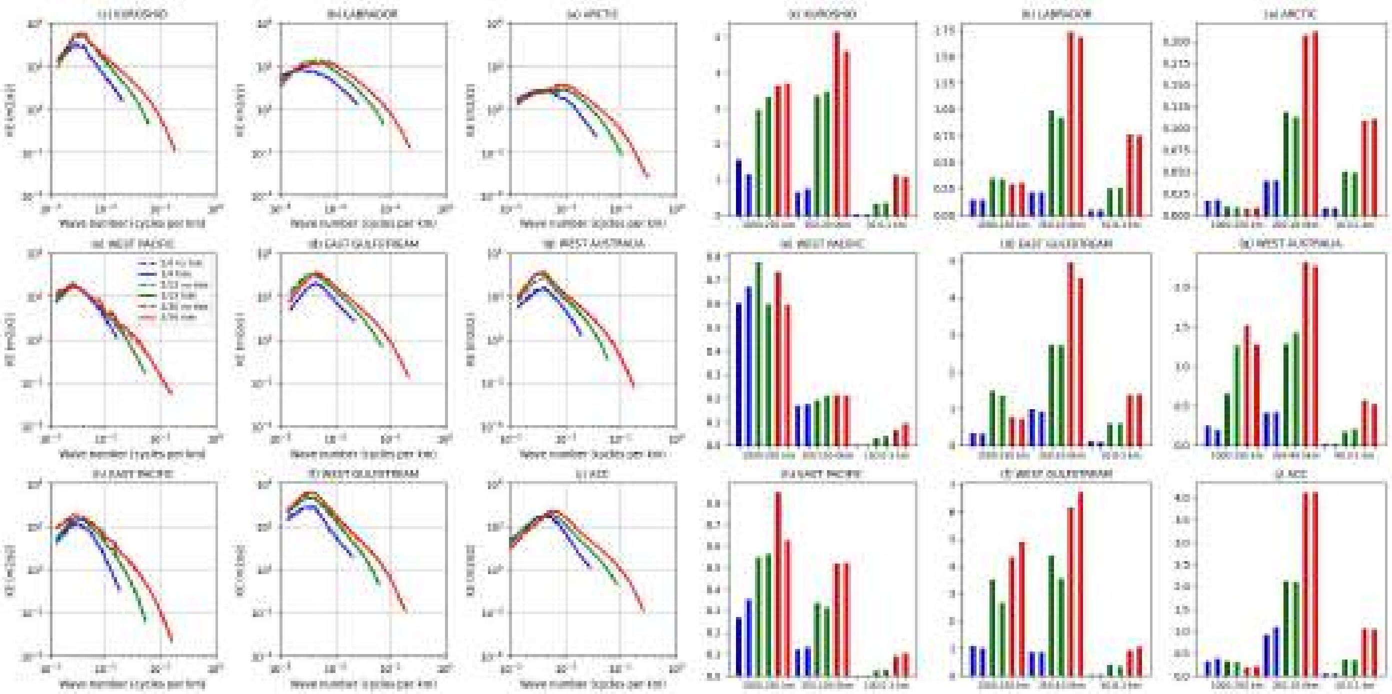
Kuroshio and Gulf Stream pathways are more diffuse in ORCA36
better penetration in the open Ocean.

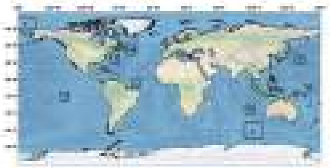
In ORCA12 and ORCA36:
better location of the Gulf Stream separation
retroflection is visible in ORCA12 and ORCA36.

North Atlantic current direction:
In ORCA025: North-East direction
ORCA12 and ORCA36 : Eastward direction

EDITOModelLab

Surface Kinetic energy spatial spectra





dashed lines : no tidal forcing
solid lines: with tidal forcing

hashed boxes : no tidal forcing

3 bands:

the large scales : from 1000 to 250 km-

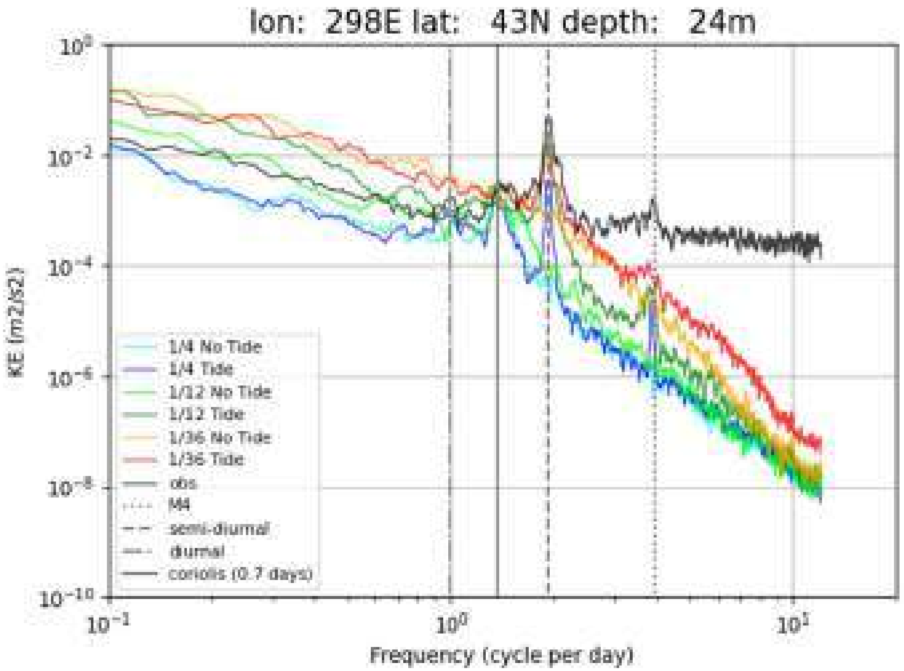
the mesoscales: from 250 km to the local first baroclinic Rossby radius of deformation)

the sub-mesoscales (from the first baroclinic Rossby radius of deformation to 1 km).

freq < 10−2 cyc/km, ORCA12 and ORCA36 are close and ORCA025 is weaker in most of the boxes.
freq > 10−2 cyc/km, the 3 configurations well differ.
freq > 10−1 cyc/km, only ORCA36 is able to produce SKE.

ORCA025 is not able to represent all the mesoscale
ORCA12 can not represent the finest mesoscale processes and can not simulate sub-mesoscale phenomena.
ORCA36 is able to represent all the mesoscale processes and can simulate the largest sub-mesoscale processes.

Kinetic energy time spectra



As in Luecke 2020:
compare model spectra to observations (GMACMD database)

Non-tidal and tidal solutions at ¼°, 1/12° and 1/36° resolutions are compared to observations.

- The KE content increases at all scales with the model resolution.

- Models with a higher resolution and tidal forcing are closer to observations.

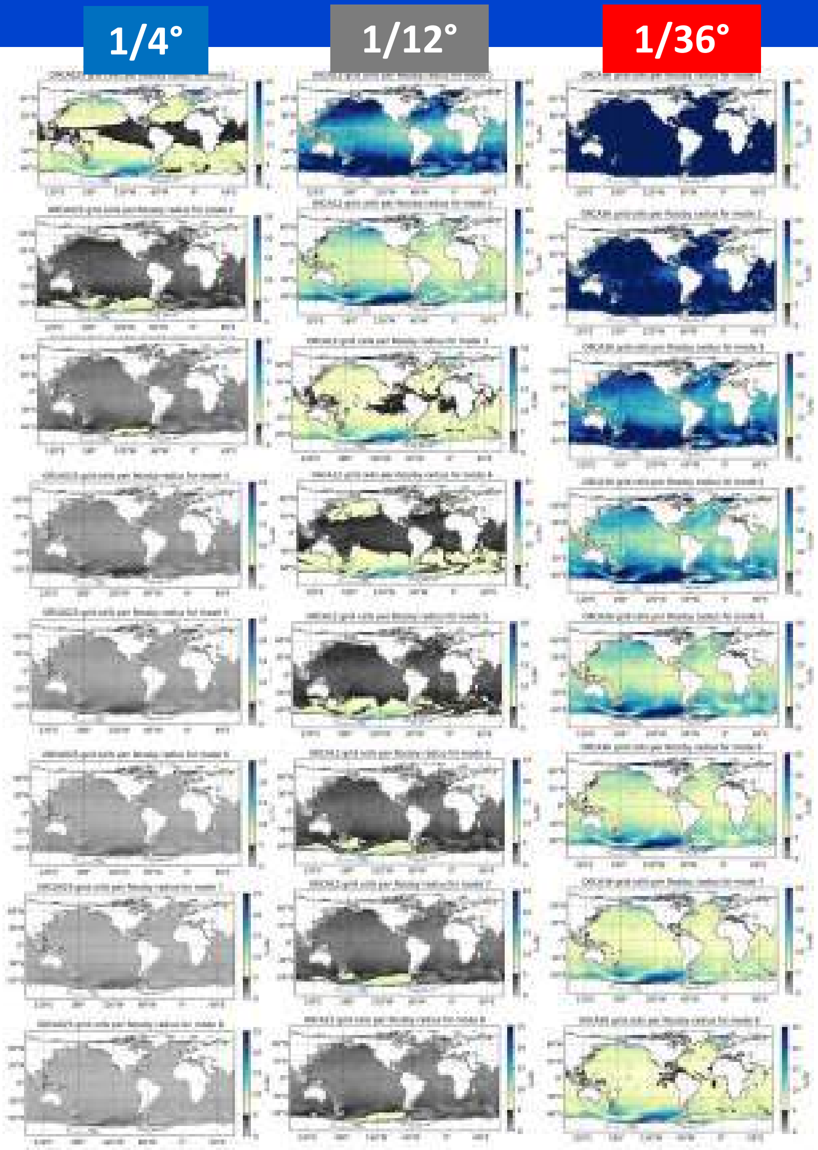
- Impact of tidal forcing at coriolis, semi-diurnal and M4 frequencies:
Tidal-forced models well reproduce the hint of energy, also present in the observations).

- Impact of tidal forcing at f > cyc/day
no major impact on ORCA025
Change for ORCA12 and ORCA36

- Impact of tidal forcing at f > M4
more energetic for ORCA36

EDITOModelLab

Baroclinic modes resolved



Based on the theory for linear internal waves leads to resolving the Sturm-Liouville problem

Mode n = 0 : barotropic mode
Modes n ≥ 1 : baroclinic modes

To determine the number of modes that can be resolved, comparison between:

- the size of the horizontal resolution: $\Delta x = \max(dx, dy)$
- the M2 wavelength of the mode: $\lambda_n = \frac{2\pi c_n}{\sqrt{\omega^2 - f^2}}$

We consider that the mode is resolved if $\lambda_n/\Delta x > 5$.

Grey/black. : $\lambda_n/\Delta x < 5$. => mode not resolved
Yellow/green/blue: $\lambda_n/\Delta x > 5$ => mode resolved

ORCA025 does not resolve any modes
ORCA12 resolves 2 baroclinic modes
ORCA36 resolves 7 baroclinic modes.

EDITOModelLab

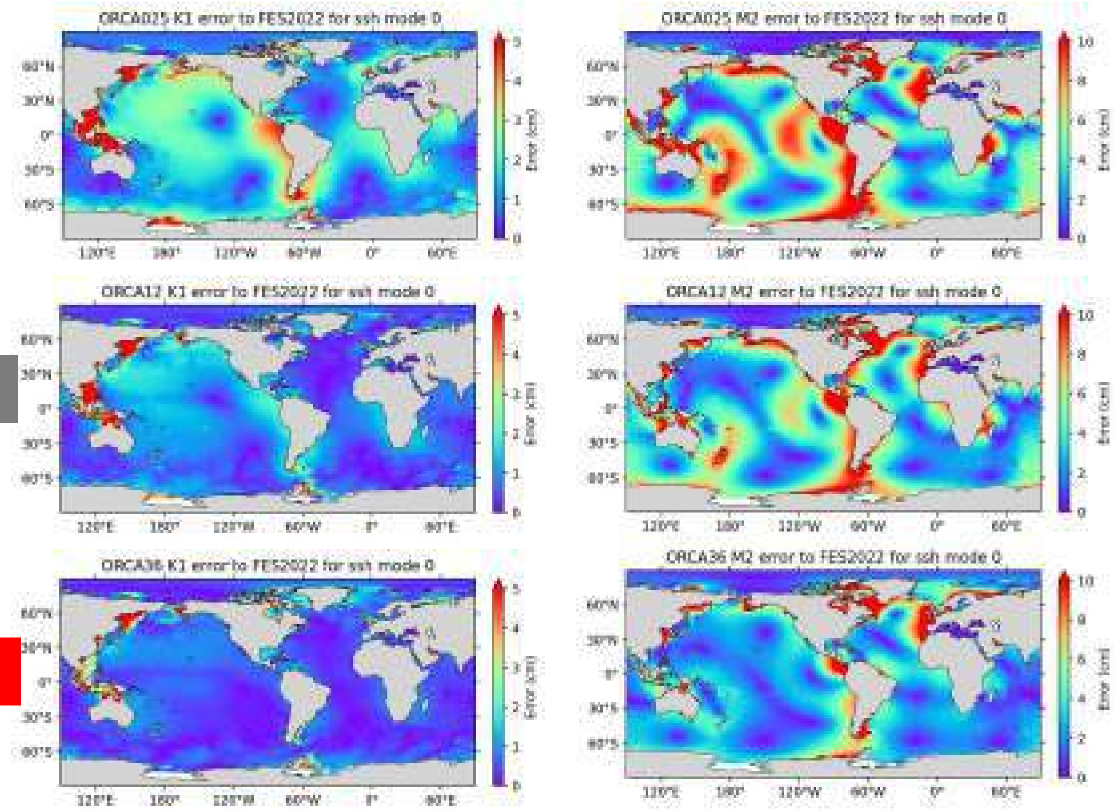
Barotropic SSH: comparison to altimetry

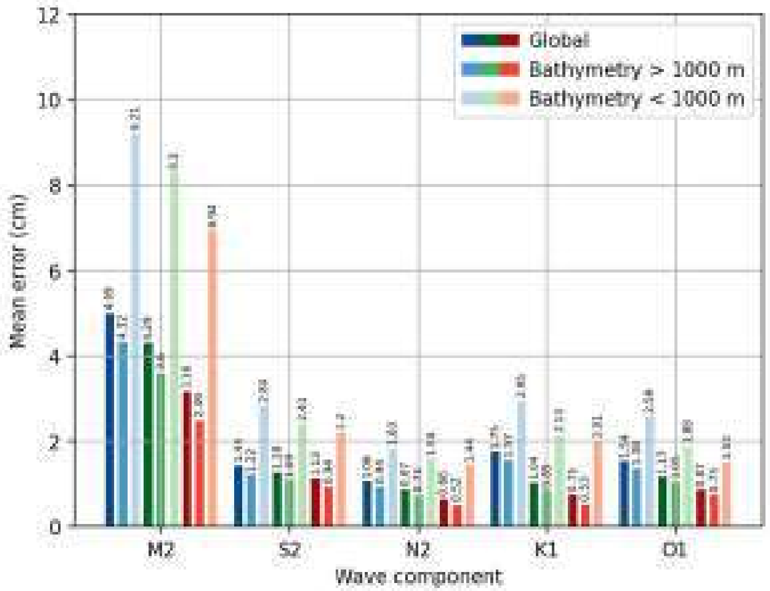
K1 | M2

1/4°

1/12°

1/36°

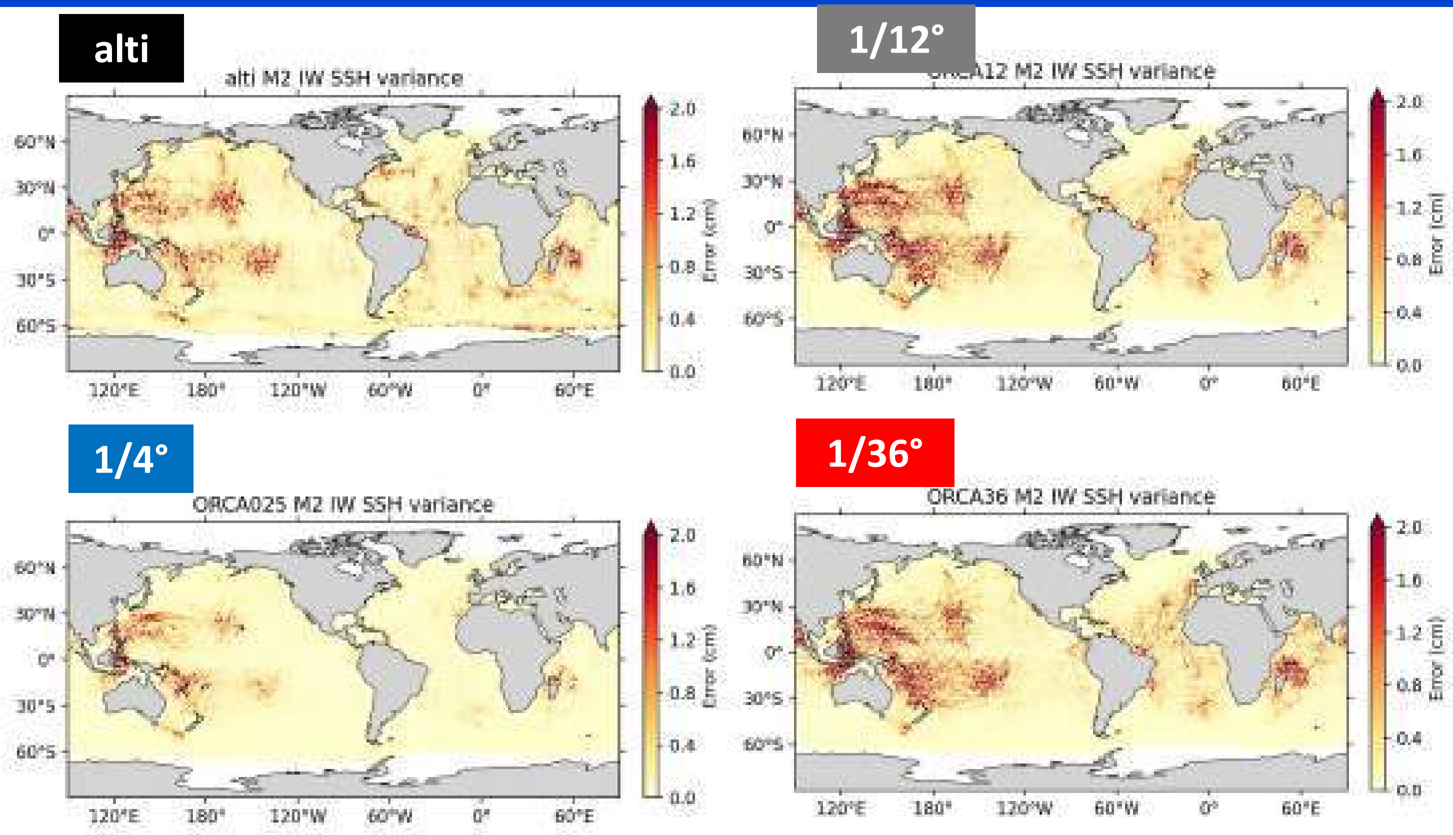




Compare model to FES2022
Model = SSH mode 0

EDITOModelLab

M2 Baroclinic SSH: comparison to altimetry



Internal tide extraction:

- Altimetry: SLA – FES , then 50-400 km filtering

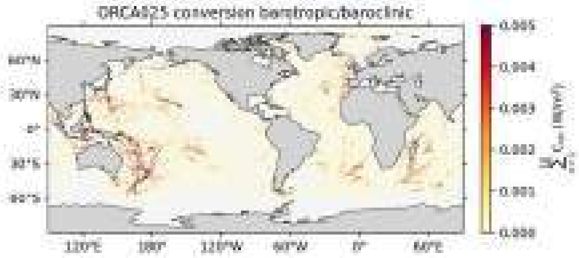
- Model: sum of mode 1-10

M2: large increase of variance with resolution

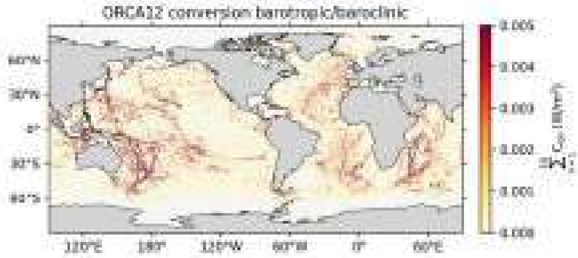
Baroclinic to barotropic conversion

M2 baroclinic to barotropic conversion

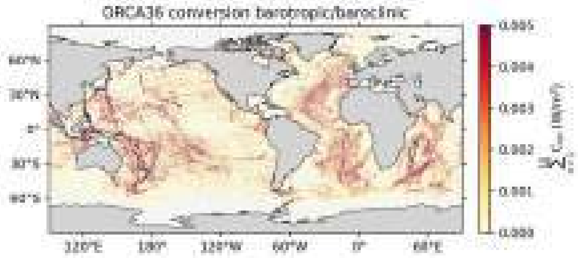
1/4°



1/12°



1/36°



resolution	M2	K1	O1	N2	Q1	S2	Total
1/36°	633	66	40	26	0	97	862
1/12°	421	57	35	17	0	64	594
1/4°	74	33	25	3	0	11	146

Barotropic to baroclinic conversion (GW)

EDITOModelLab

Model improvements

2023:

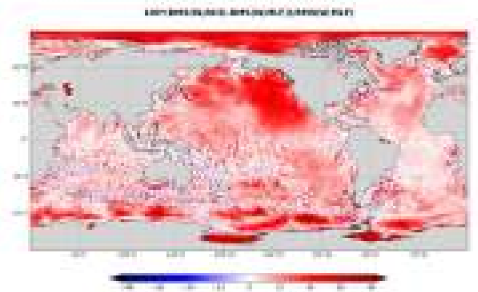
- Use the new 2 level time-steping scheme based on Runge Kuta 3rd order scheme

Replace the former scheme based on a leap-frog + asselin filter (= Modified Leap Frog = MLF)

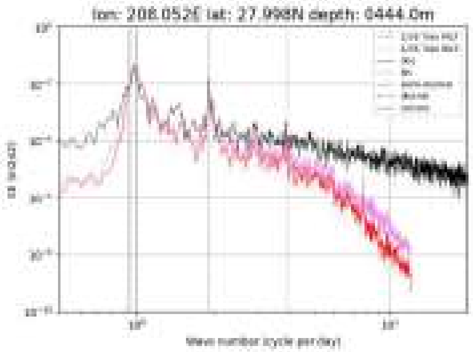
RK3 costs 50% more than MLF per time step :
But: RK3 has an extended stability: Time step value multiplied by 2.5
=> RK3 + rdt=300s: 30 % gain compared to MLF + rdt=120s

Vertical velocities RMS

Ratio: 100*(RK3-MLF)/MLF



3 months KE time PSP



=> more variability in W with RK3 => less dissipative compare to MLF

=> more energy at mesoscale and fine scales

=> more energy at sub diurnal frequencies

EDITOModelLab

Model outputs: transfer on the EU public DTO platform

One year of ORCA36 (hourly 2D and daily 3D) : 90 Tb

One year of ORCA36 (hourly 2D and daily 3D + hourly 3D) : 790 Tb…

a first dataset will be available in 2024:

Sea Surface Heigh, tempereture and horizontal velocities

(2.3Tb per variable per year)

EDITOModelLab

Model improvements

2023:

Task 3.1 Improvement of next generation ocean models for DTO
Task 3.4 Validation/calibration of models with satellite and in situ observations

- Use the new 2 level time-steping scheme based on Runge Kuta 3rd order scheme
- evaluation of resolution increase
- evaluation of tides impact and IW

2024:

Task 3.1 Improvement of next generation ocean models for DTO

- Switch to the last release of NEMO

Task 3.2 Ocean configurations for DTO models

- Test NEMO/ORCA36 on EuroHPC computers (especially BSC and CINECA)
- Test NEMO/ORCA36 on CPU/GPU hybrid nodes (porting with PSYCLONE)
- Test and validation of ORCA36 with mixed-precision)

WP 3 – Models for EDITO

Plan:

- Global 1/36°: context and objectives
- Model development and validation
- Near real-time demonstrator

Near real-time demonstrator

Near real-time demonstrator based on spectral nudging GLO36V1: system design

- Model:

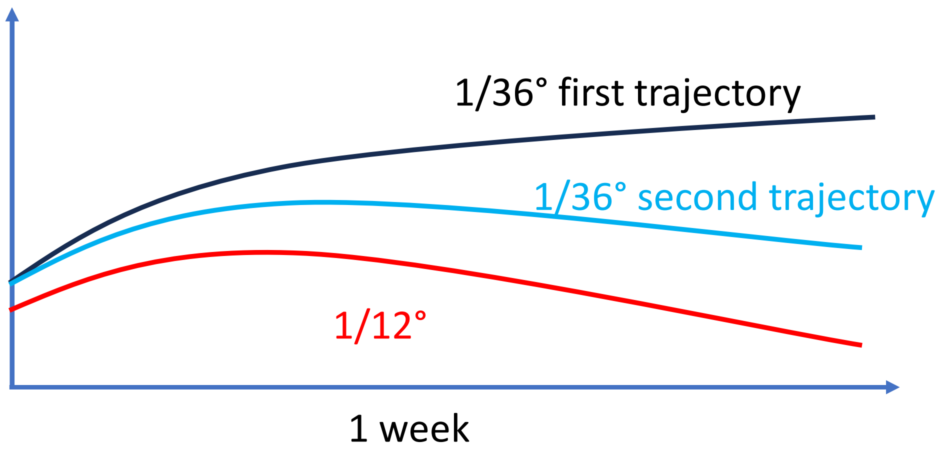
- global 1/36°, based on ORCA grid and NEMO 4.2
- Domain including Include Antarctic Ice Shelves (explicit resolution)
- Forced by ECMWF/IFS sytem (8 km resolution, 1 hour frequency)
- Tidal forcing: O1, K1, M2, S2, N2 + Self Attraction Loading
- Initial condition: T,S,U,V, sea ice from CMEMS/MOI global 1/12° real-time system

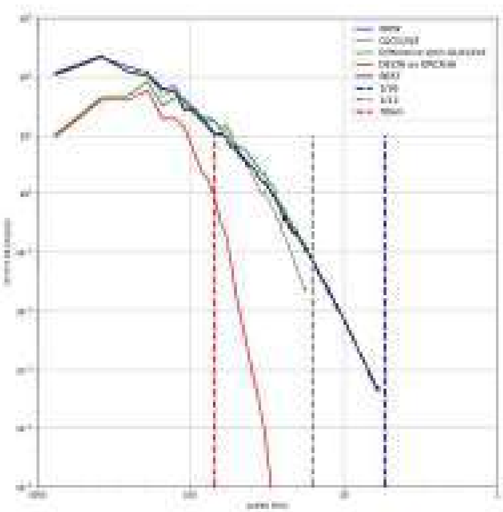
- Nudging:

- Toward CMEMS/MOI global 1/12° real-time system (for Temperature ,Salinity ,horizontal velocities and sea ice concentration).
- After a first trajectory: the increment is based on the weekly difference between the global 1/36° and global 1/12° systems, low-pass filtered (70 km) and tapered along the coast.
- During the second trajectory: the increment is injected in NEMO with NEMO IAU.

- Control:

- Mercator Observation operator (NOOBS, written in python) is implemented.





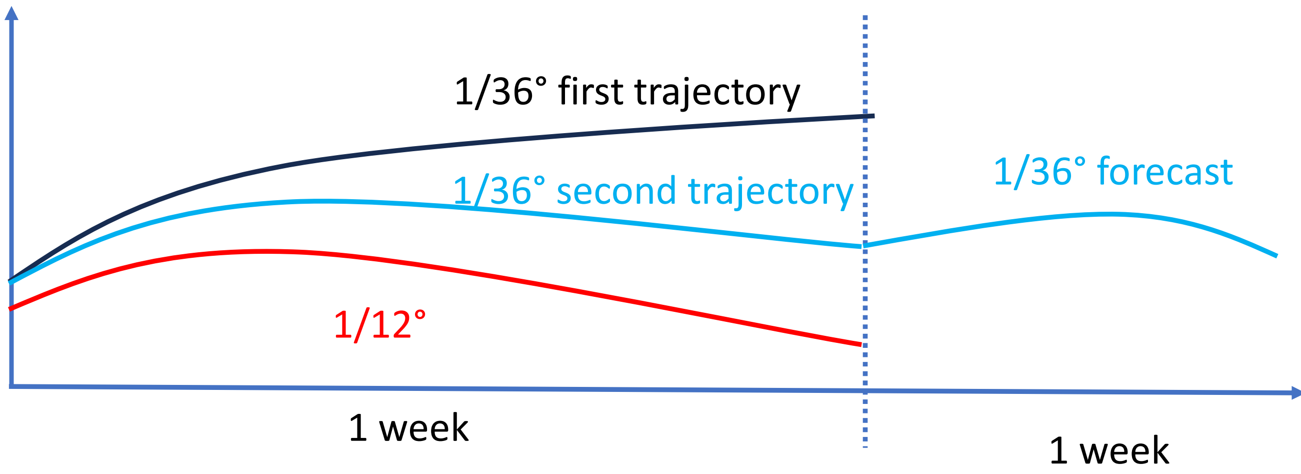
Temperature spectral analysis

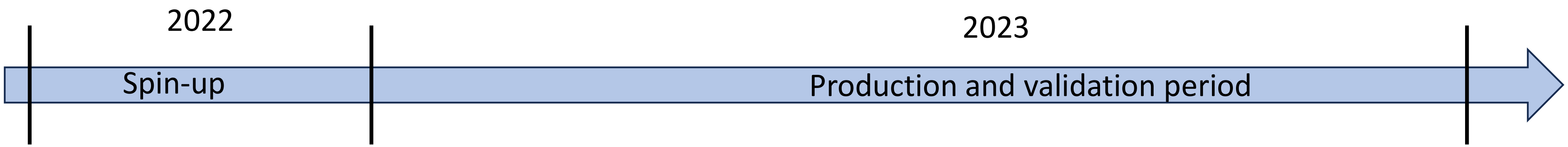
Near real-time demonstrator

<u>Near real-time demonstrator based on spectral nudging GLO36V1: scenario</u>

3 months of spinup

One year prodcution, including reforecast





01/10/2022
Initialisation from the global 1/12° real time system

EDITOModelLab

Near real-time demonstrator

<u>2023:</u>

Task 3.1 Improvement of next generation ocean models for DTO

- Implementation of spectral nudging in global 1/36°

Task 3.4 Validation/calibration of models with satellite and in situ observations

- Implementation of offline obervations operator and comparison with the present MOI/CMEMS global 1/12° NRT sytem

<u>Plans for the second year (2024)</u>

Task 3.1 Improvement of next generation ocean models for DTO

- Finalize tests of spectral nudging

Task 4.4 Simulations and quantification of the benefit of DTO models

- Produce the one year hindcast and forecast

Task 3.4 Validation/calibration of models with satellite and in situ observations

- Validation of the forecasts

Task 4.4 Simulations and quantification of the benefit of DTO models

- Push model outputs on the Marine Data Store, to be available on EDITO-infra platform
  a first data dataset will be pushed on the Marine Data Store and referenced on the EDITO-INFRA catalogue
  Provide informations (sytem description and quality) on a public github ?

Conclusion and perspectives

- **A global 1/36° configuration exists**, implemented in NEMO 4.2

A multi year hindcast has been performed, with its twin global ¼° and 1/12° configurations
Without and with tidal forcing

Increasing resolution leads to an improvement in term energy of energy

Improved representation of barotropic tide thanks to resolution (and Antarctic cavities in the domain)
7 baroclinic modes resolved for ORCA36, 2 baroclinic modes resolved for ORCA12

Some diagnostics has been designed to highlight benefices of resolutions and tidal forcing

- **a NRT demonstrator has been designed, developed and tested in 2023.**

It is designed and implemented

It will be run in 2024.

Model output will be accessible through EDITO-INFRA

EDITOModelLab

BACK AT 2:30 PM

Achievements and next steps

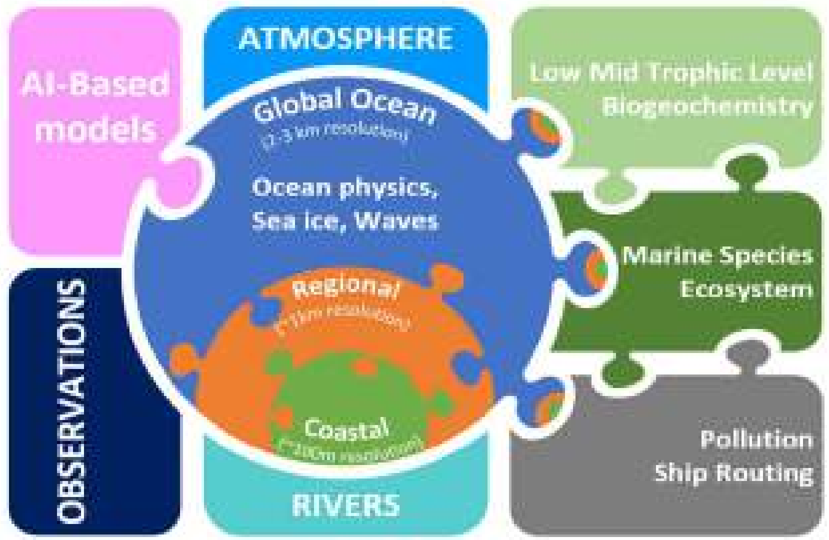
Core Model Suite and Virtual Ocean Model Lab (WP4 -WP5)

Moderator: F Cultrera (Cineca), Y Drillet (MOi)

WP4 | Objectives

Lead MOi, co lead DELTARES

Objectives (linked to EDITO-Model Lab objectives No 1, 2, 3 and 4):
Design and integrate the model components to **build EDITO core model suite**, based on the next generation of models that will be developed, maintained and made available in EDITO-Model Lab. The EDITO core model suite that will be integrated in this WP4 will be based on available, optimised and validated models and on DDEs combined with classical model approaches to build **hybrid models**, other **models** and **tools** (as validation tools) will be integrated in the core model suite.



EDITOModelLab

WP4 | Structure

Done

T4.1 Design the integration path for the core model suite (Lead: Deltares | Partners: Hereon, MOi, IMT, CMCC)

Co-design

Started

T4.2 Development of the DTO core model suite (Lead: MOi | Partners: Hereon, Deltares, DMI, BSC, IMT, CNRS, CMCC)

Model development (with VOML support)

ST 4.2.1 Ocean hybrid model integration

ST 4.2.2 Connected model components for Focus Application

ST 4.2.3 Super Resolution

T4.3 Integration of the core models suite (Lead: BSC | Partners: CINECA, Hereon, Deltares, CMCC, DMI, MOi)

Integration on Backend

To Do

T4.4 Simulations and quantification of the benefit of DTO models (Lead: DMI | Partners: Hereon, MOi, Deltares, CMCC)

Qualification

T4.5 Optimization of the workflow of the DTO model and Technical Support (Lead: CINECA| Partners: BSC)

Optimisation

EDITOModelLab

WP4 | EDITO core model suite (achievements)

Task 4.1

➔ **Joint task with T5.1, tight collaboration with other WPs (2,3,5,6,7)**

- Updated TRL objectives for model components (WP3) and Emulators (WP2)
- Defined planning of co-design phase (Year 1)
- Summary of data (input/output) from WP6 & 7 included in DMP (D1.1)

- Codesign phase achieved

Milestone 2-Workshop for co-design of the VOML (Co-Design Technical meeting in Toulouse, 19-20 October 2023) (WP5)
Milestone7-CO-DESIGN (Co-Design Review in Delft, 22-23 November 2023) (WP1)

- Contribution to Technical Architecture Document deliverable (D1.2)

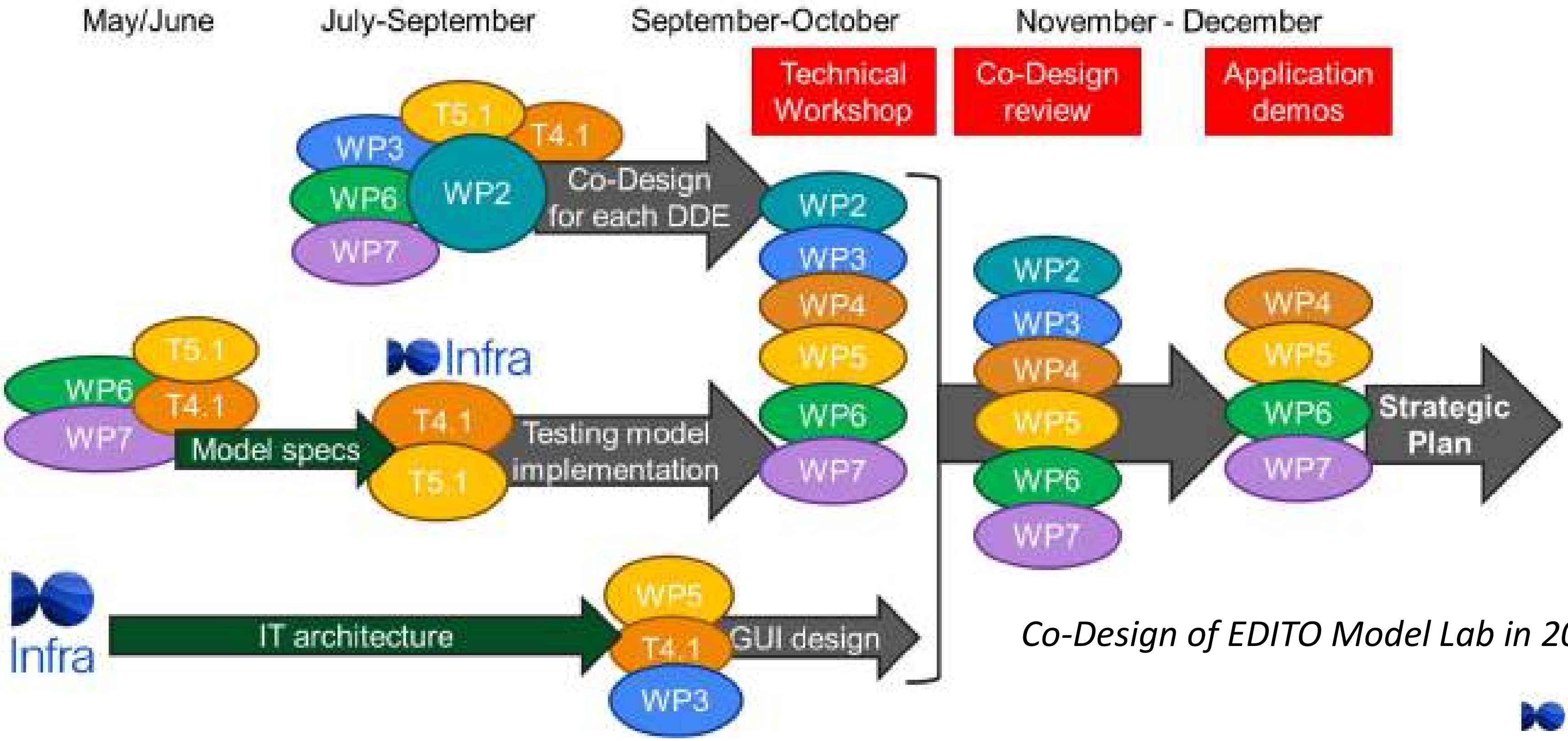
Data summary table – extract from DMP (D1.1)

Related WP, - Focus Application (FA), What-If Scenario (WiS)	Planned usage/ Required Inputs	Planned usage/ Required Outputs	Planned physical processes	Core models / Secondary models	Stakeholders	Description of data	Source	Format	Storage location/ Protocole
NEAR Real-Time data									
WP6 **FA1** **Marine Protected Areas for biodiversity**	Natural and lateral boundary conditions: - Bathymetry (EMODnet) - Meteorology (ERA5) - Atmospheric N2 deposition (EMEP-data) - Global Ocean observation (CMEMS), for hindcast and short term forecast - River time series of 1) discharge volume, 2) water conditions & 3) nutrient/oxygen/carbon concentration (E-hype model / ICGEMO measurements, used in OSPAR, or National governmental data) Specific for FA 1: - Designated MPA in the region - Maritime activity: shipping, fishing, construction, etc. - Pollution	Variables: - Biodiversity target variables to be derived from ECOPotential - Biomass of marine species - Reproduction/mortality rates of species - Particle tracking (possible add-on) Water quality (nutrients, oxygen, pH or H+), pelagic and benthic functionals types (e.g. phytoplankton, zooplankton, seagrass) Resolution: - Spatial: 800 meters - depth: coastal (20 layers in first 100 meter) - Temporal: daily timestep D	In general: - Hydrodynamics - Biogeochemistry - Ecology - Sediment uptake -Pelagic/benthic Ecological processes: None, the project will model the physical habitat factors	Delft3D-FM / Deco Impact	Intermediate users	Scale: Regional/ Coastal Demo sites: -North Sea: Dutch Continental Shelf Model -MPA in Puglia (CMCC), Italy	EDITO Model Lab	Output file formats: NetCDF (unstructured) Output file size estimation: For daily timeseries and weekly maps	Marine Datalake

EDITOModelLab

WP4 achievements: task4.1 co-designing the integration path

In 2023 task4.1 was completed. Over iterative co-design steps, components were developed and showcased, resulting in a clear vision on how to integrate them in 2024.



Co-Design of EDITO Model Lab in 2023

EDITOModelLab

WP 4 | EDITO core model suite (achievements)

Tasks 4.2 and 4.3

→ **Preliminary testings and integrations on the platform**

- → **Active collaboration with EDITO-infra project team**
- → **Technical tests with WP5 (VOML) and other WPs for testing systems/workflow components**

- Progress on interfaces with the EDITO-Infra virtual environment (Datalab)

Testing integration of software (code repositories and containerized images) as « services » and «process » in EDITO Infra environment

- Interfacing with HPC ressources

Connexion through Autosubmit to BSC MN4 verified, ongoing with CINECA

EDITOModelLab

WP4 | Towards Beta version of Core Model Suite (MS8)

Tasks 4.2 and 4.3

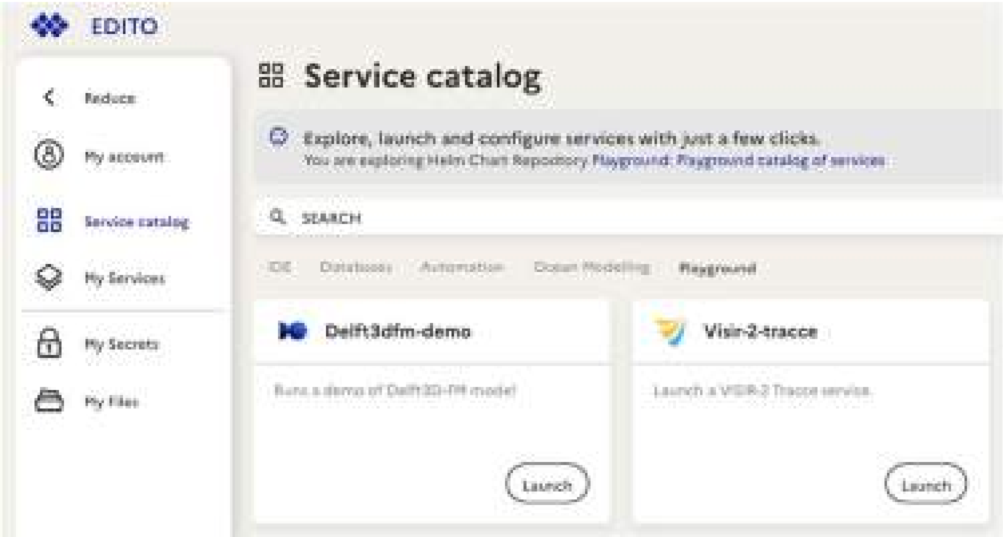
→ **First attempts to deploy software on platform led to a refined integration path**

- MA-8 <u>due Month 14</u> (February)

Test Integration (deploy and run) of a 1st set of models (NEMO, Deltf3d-fm and VISIR-2) on cloud platform

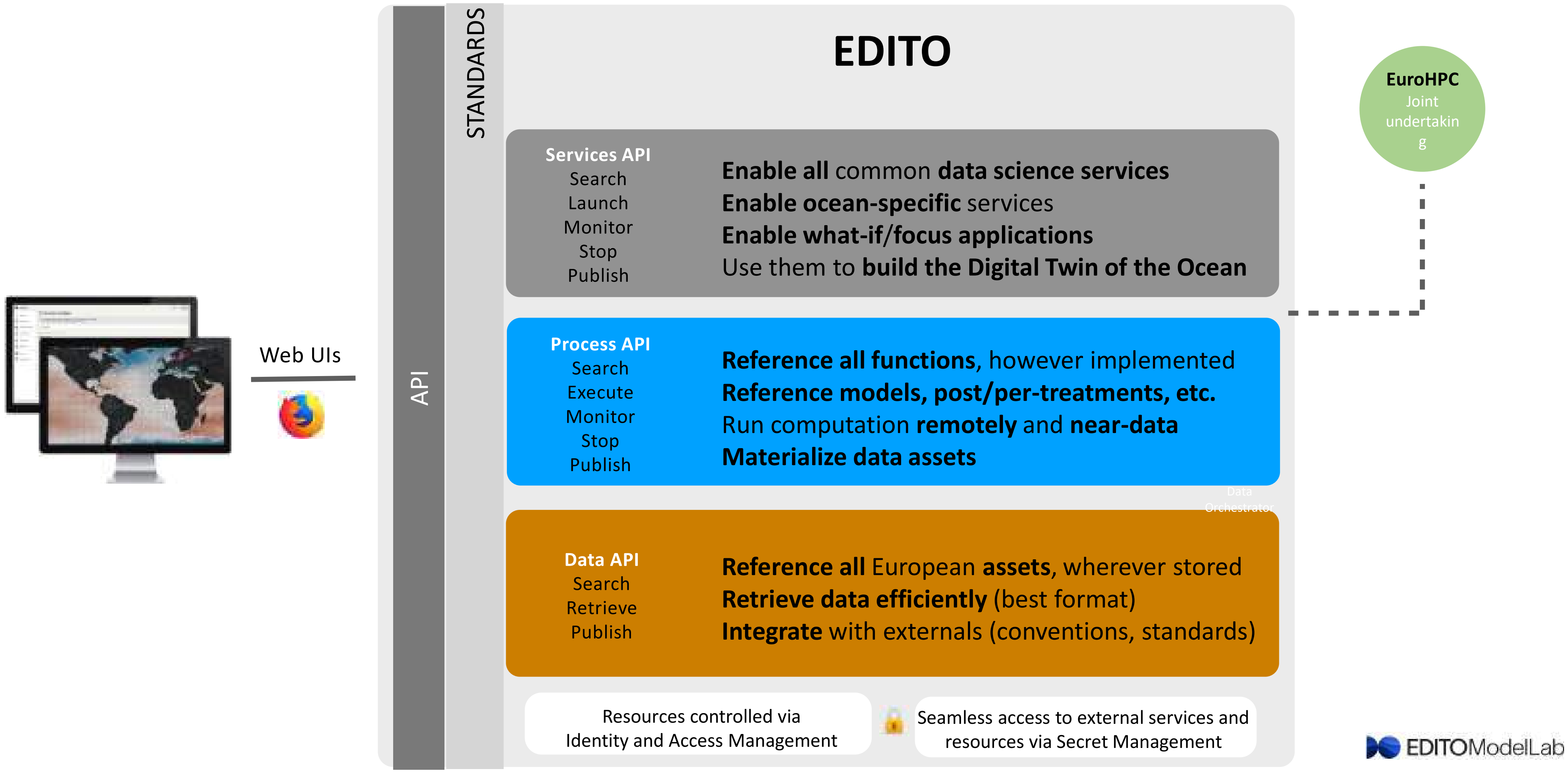
Step-wise demonstration of end-to-end application workflows led to significant progress on compatibilty and interoperability

Fast hands-on from developers on platform and high level of standardization (clean soft repos, containers), allowed rapid deployement and demonstration within platform environment

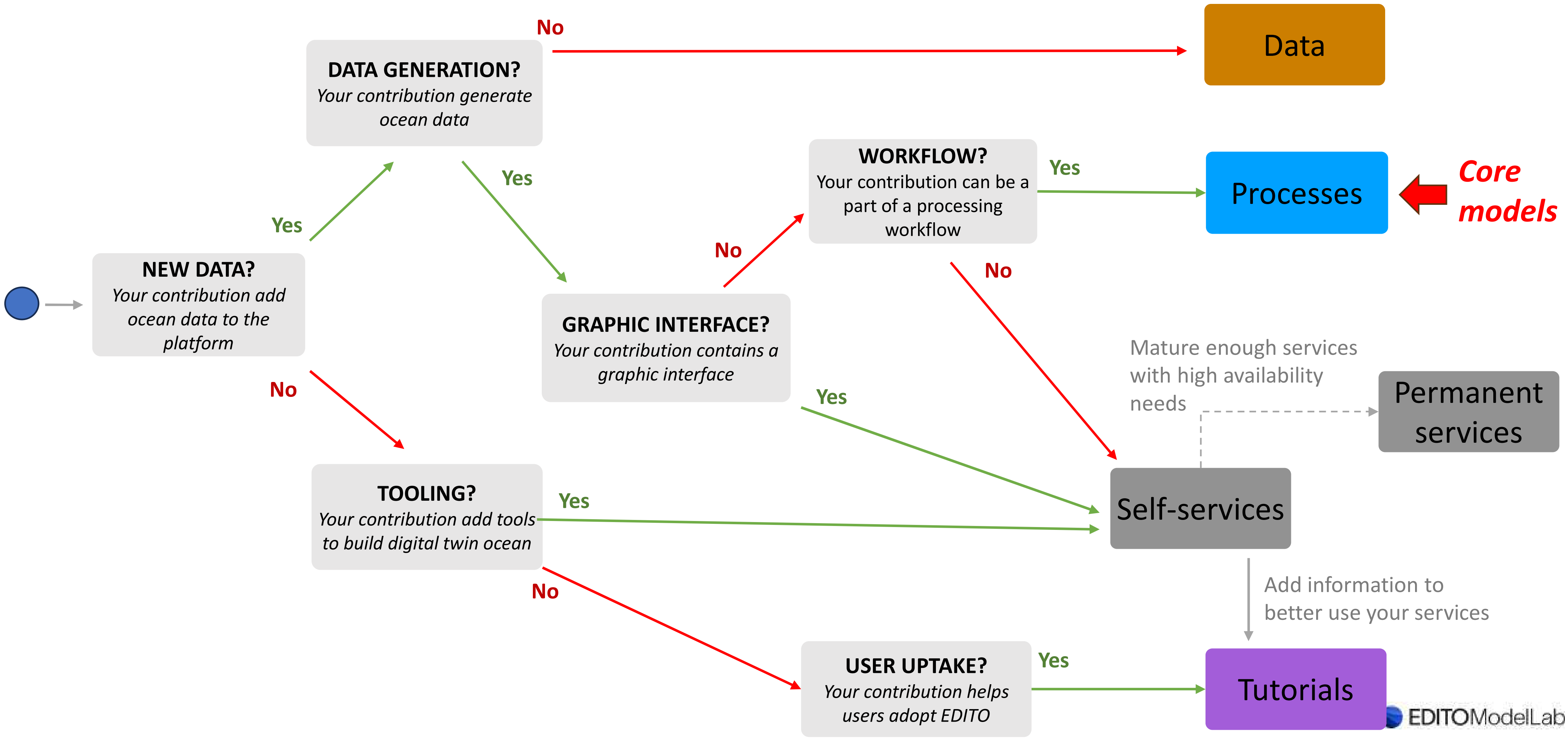


Datalab snapshot on “Playground” section

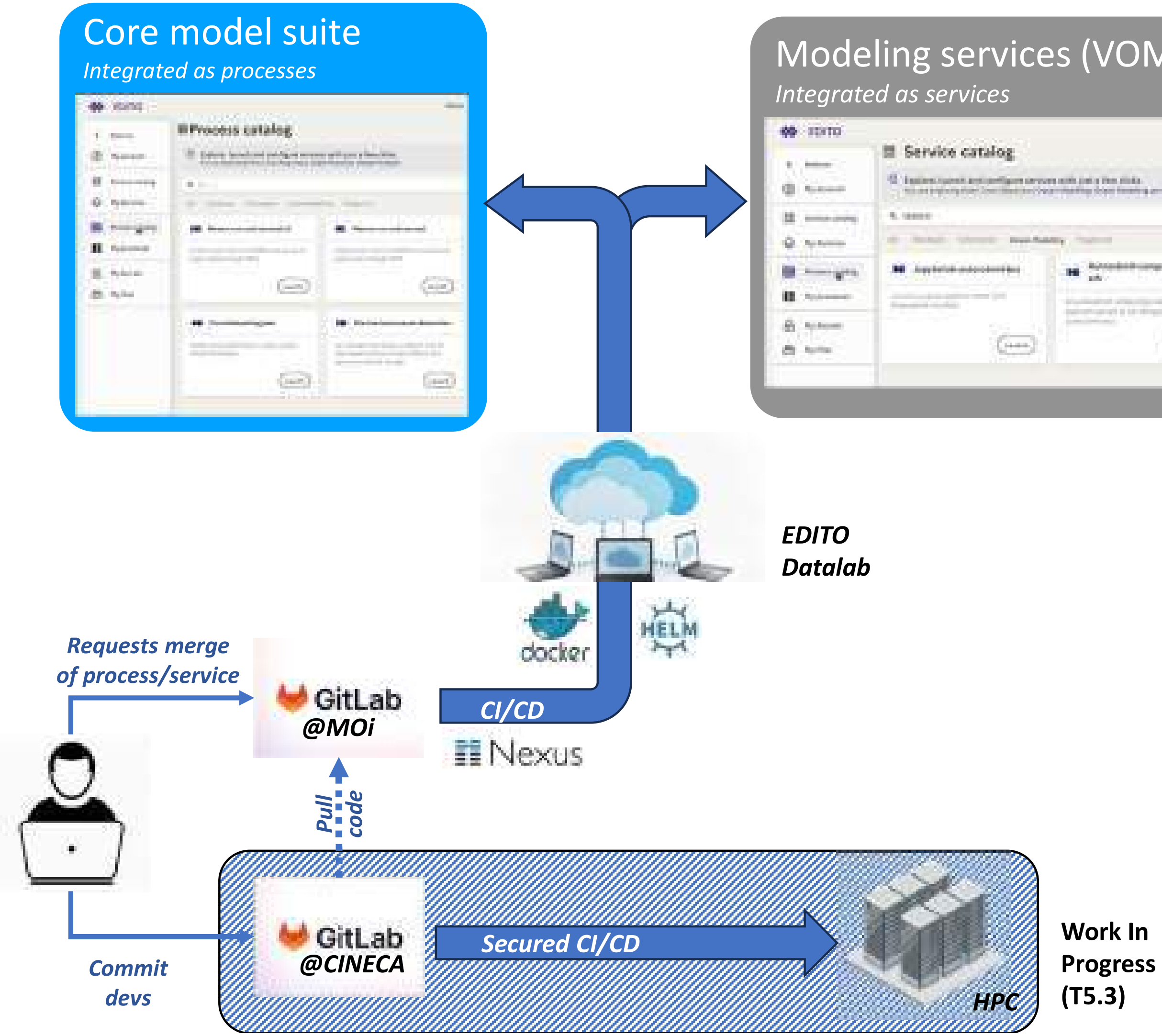
EDITO interoperability design criteria



How to contribute to EDITO ?



WP4 | Towards Beta version of Core Model Suite (MS8)



- Model suite will be presented as part of Process Catalog (dedicated tab)
- Models are integrated as process (within helm charts) and automatically deployed on the plaftorm by a CI fron Moi's gitlab
- For testing/dev purpose, developers can directly associate EDITO code repo to Datalab IDEs (eg. Vscode/JupyterHub)
- Whether a partner would need support for hosting code or images, please contact MOi.

EDITOModelLab

WP4 | EDITO core model suite (goals)

Task 4.1

- Strategic Plan – started, delivery extended to February 2024

Task 4.2

- Milestone 8-Beta version of Core Model Suite due Month 14:
    - Identify best candidates for the beta-version,
    - Make codes and configurations available from platform.
- D4.1 Core model suite code (M24)

Task 4.3

- Start integration of code model suite (from beta version)

- ***Some strategic challenges ahead:***
    - *HPC integrations to start,*
    - *cross-platform data management,*
    - *describe and document code model suite,*
    - *interoperability with UIs,*
    - *interoperability with WP6/7 applications.*

EDITOModelLab

WP4 Next steps: integration

Integration will be achieved on multiple levels in 2024:

1. Components to be ***complementary to and compatible with each other***. Achieved by co-operation among the partners of EDITO Model Lab (models and AI emulators) and by standardization of data and model output formats, interfaces, APIs, and protocols.

2. *Components to be* ***integrated on the EDITO platform*** and to be able to run seamlessly on HPC and cloud. Achieved by co-operation between EDITO Infra and EDITO Model Lab, and by bridging the gap between IT infrastructure development and scientific application of ocean models.

3. EDITO Platform and tools to become ***relevant for the target community***. Achieved by engagement with, training of and collaboration with intermediate (Focus Applications) as well as end-users (What-if Scenarios) outside of the EDITO projects.

WP5 | Structure

T5.1 Co-design of virtual environment (Lead: **MOi** | Partners: Deltares, CINECA, BSC, CMCC, UniBO) — **Co-design**

T5.2 Back-end architecture (Lead: **BSC** | Partners: CINECA, CMCC, MOi) — **Back-end**

T5.3 Virtual Ocean Model Lab for co-development (Lead: **CINECA** | Partners: BSC, CMCC, UniBO, DMI, MOi) — **VOML**

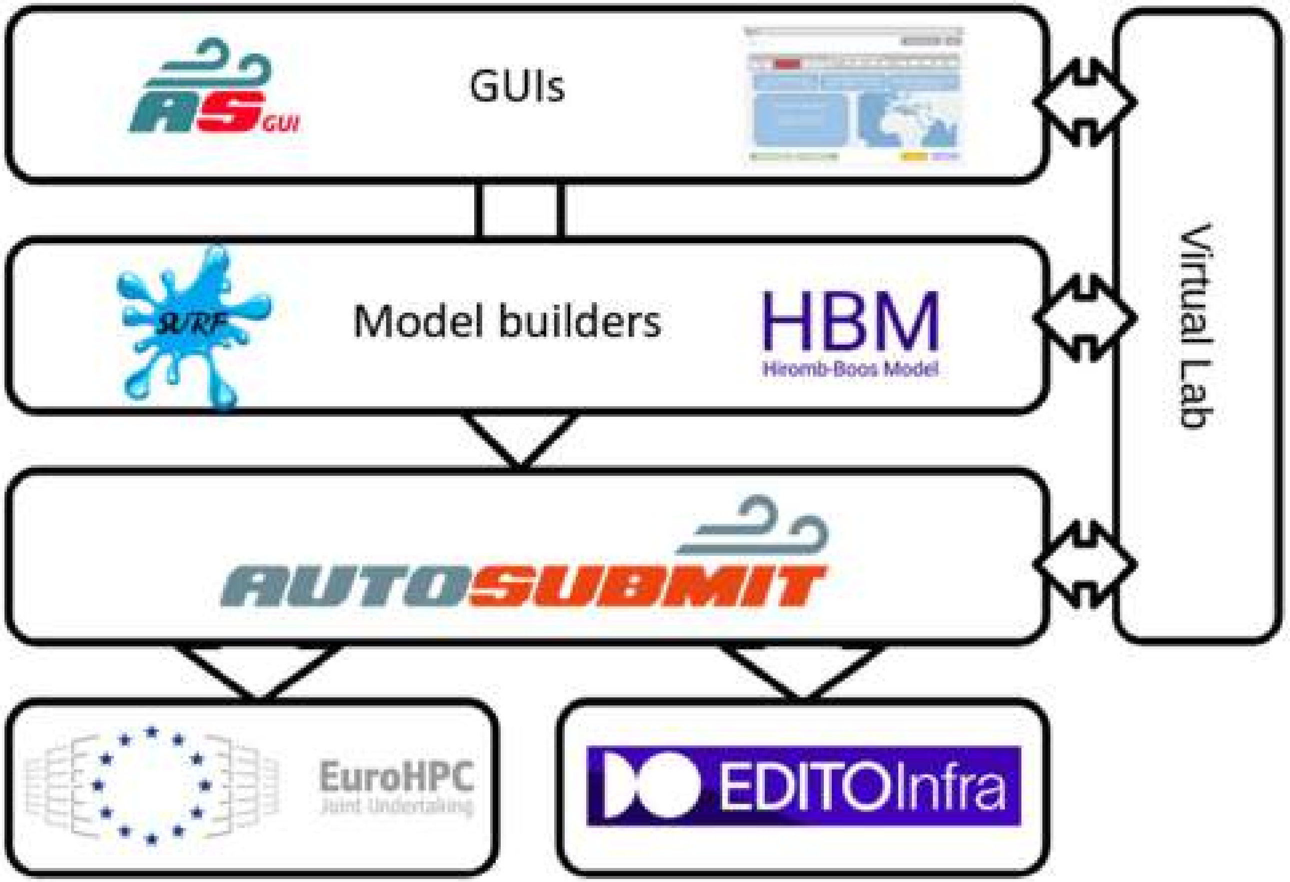
- **ST 5.3.1 Collaborative development and testing interactive framework**
- **ST 5.3.2 Relocatable Ocean modelling platform**

T5.4 User interfaces for on demand model (Lead: **CMCC** | Partners: BSC, CINECA, DMI, UniBO, Hereon) — **User interfaces**

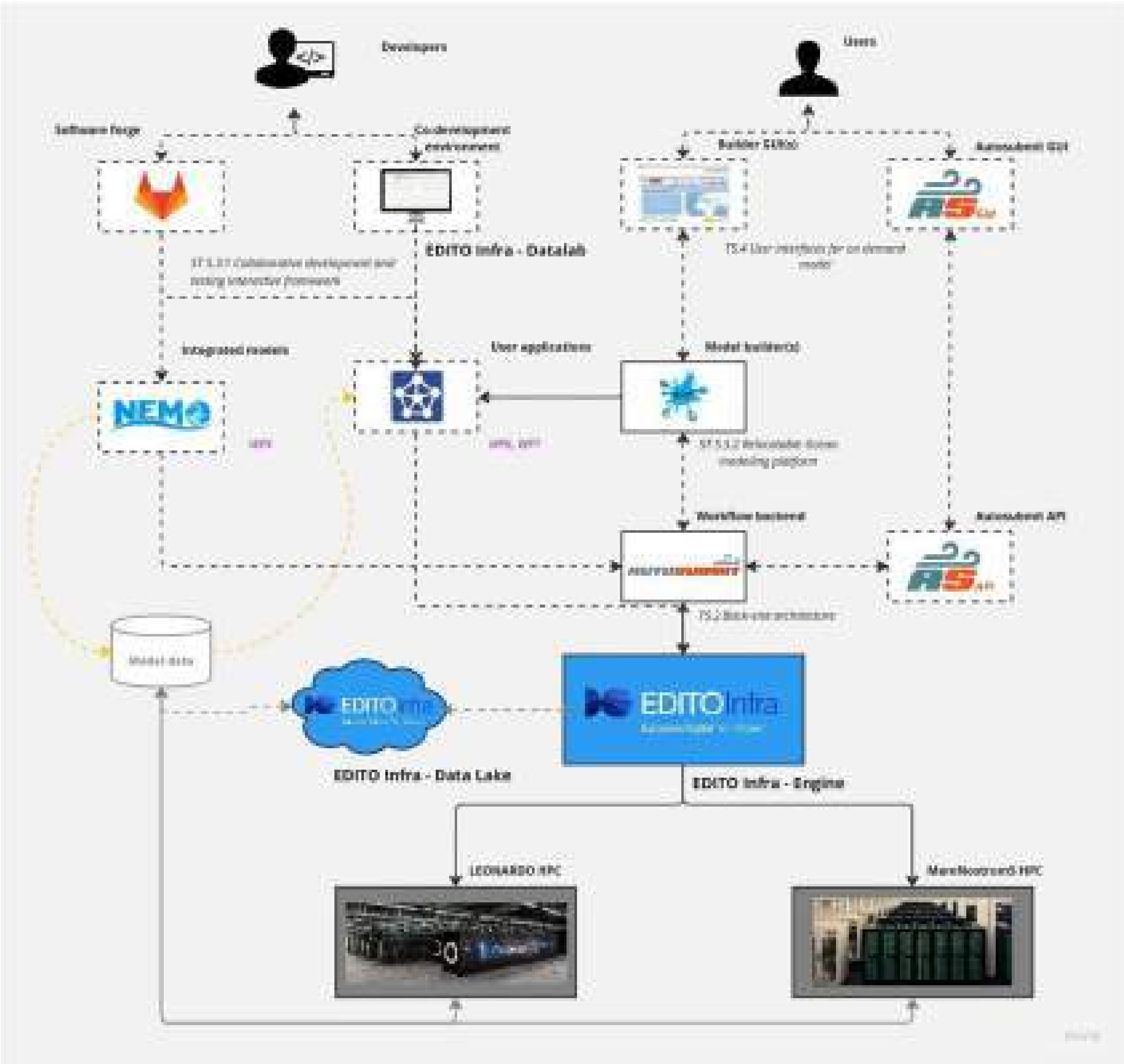
- **ST 5.4.1 Front-End Application Model**
- **ST 5.4.2 SURF-GUI**
- **ST 5.4.3 DMI-GUI**

T5.5 Testing and validation of the Virtual Ocean Model Lab (Lead: **SOCIB** | Partners: Deltares, MOi, BSC, CINECA, Hereon) — **Testing and validation**

WP5 | WP5 & VOML architecture



WP5 | VOML architecture



[Open the diagram in Miro](#)

[Deliverable: D5.1.EDITO Model Lab technical architecture](#)

[News: What is the virtual ocean model lab?](#)

EDITOModelLab

WP5 | Integration progress

- HPC - backend → As soon as HPCs are available
- EDITO Infra - backend → Integrated
- Backend - Model builders → Ongoing
- Backend - GUI → Ongoing
- Model builders - GUI → Ongoing
- GUI - GUI → To be explored

WP5 | First year accomplishments

Task 5.2 Back-end architecture (Lead: BSC) [M1-M24]

Autosubmit 4 deployed at EDITO-Infra

- We created a **Docker image** for **Autosubmit4** to be deployed at EDITO-Infra
- Autosubmit4 was **integrated** with the help of **EDITO-Infra** team
- We held a **demonstration** of cloud and HPC workflows orchestrated from cloud in the EDITO VOML review technical meeting

Autosubmit API interoperable with Autosubmit 4

- Autosubmit API provides information from Autosubmit workflows by answering user requests
- **Autosubmit API**, compatible with Autosubmit3, was **upgraded** to be interoperable with Autosubmit4
- We have a version **ready to be deployed** at EDITO-Infra

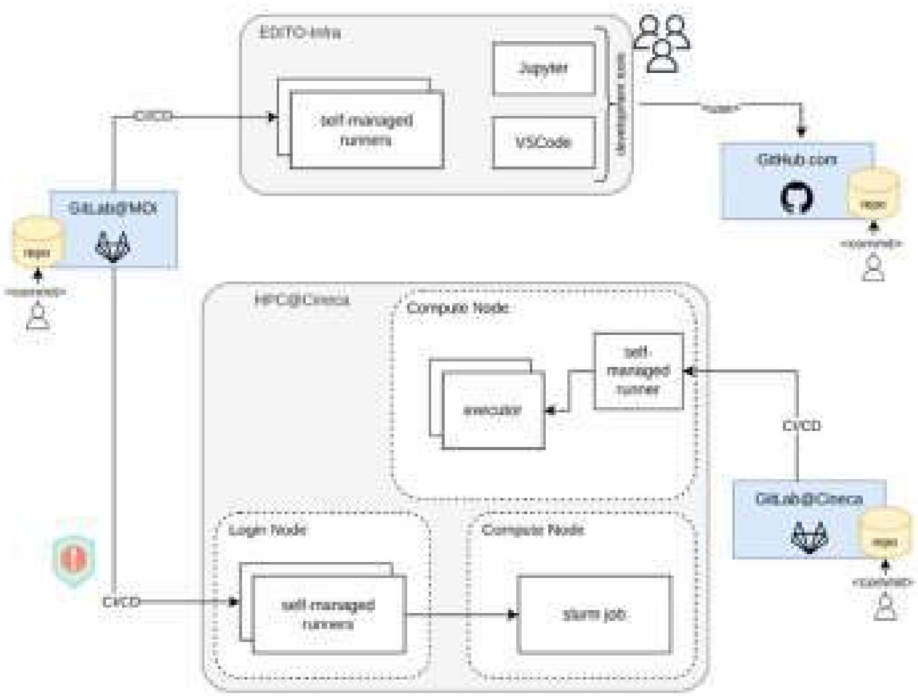
EDITOModelLab

WP5 | First year accomplishments

Task 5.3 VOML for co-development (Lead: CINECA) [M1-M24]

Collaborative development and testing interactive framework

- **Analysis** of the **state-of the-art** of reusable running instances of **GitLab** including the one available for EDITO-Infra and the other from HPC side
- Study for a solution to **enable CI/CD runners** for **automatic integration** and **deployment** in different compute infra
- **IDE tools available** on **EDITO Infra**, such as VSCode, Jupyter Notebooks



Relocatable Ocean modelling platform

- Code review and **re-engineering** to **Python**
- **Containerization** of **SURF platform**. In progress using Docker and Singularity

EDITOModelLab

WP5 | First year accomplishments

Task 5.4 User interfaces for on demand model (Lead: CMCC) [M1-M24]

Autosubmit-GUI

- Improvement in the **GUI portability**. Quick and easy installation and test.

Vanilla demo: https://autosubmitgui.bsc.es/presentation/

SURF-GUI

- A list of **Software Requirements Specification** have been prepared
- Creation of the SURF-GUI **wireframe** completed

HBM-GUI

- Started the **development** of the HBM GUI using Python 3

WP5 | First year accomplishments

Task 5.5 Testing and validation of VOML (Lead: SOCIB). [M18-M36]

Definition of workplan for testing and validation

- **Project scientist hired**, with dedication to this task

WP5 | 2nd year plan

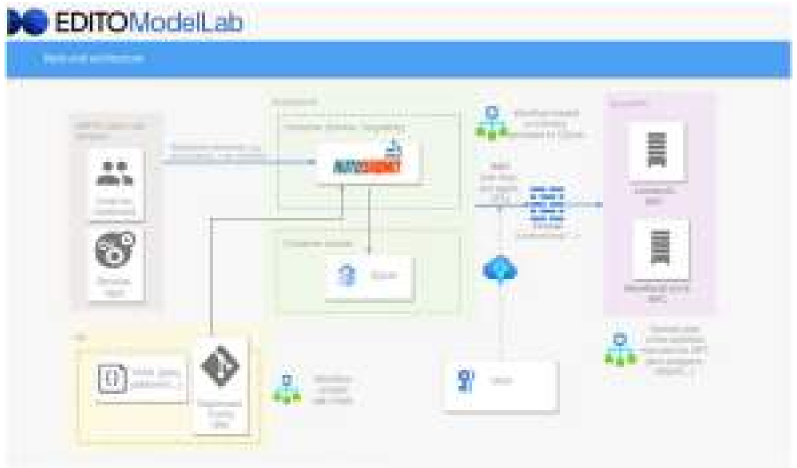
Task 5.2 Back-end architecture (Lead: BSC) [M1-M24]

Refine the Autosubmit 4 deployment at EDITO-Infra

- Work on Autosubmit's **DDBB persistency** and **shared usage**
- Work with EDITO-Infra team on **optimizing** the **handling** of the HPC **security**

Integrate Autosubmit API in EDITO-Infra

- Create a Docker **container** for **Autosubmit API**
- **Deploy** and **test** Autosubmit API in **EDITO-Infra**
- **Develop write-mode endpoints** in Autosubmit API implementing the necessary logic in Autosubmit and Autosubmit API



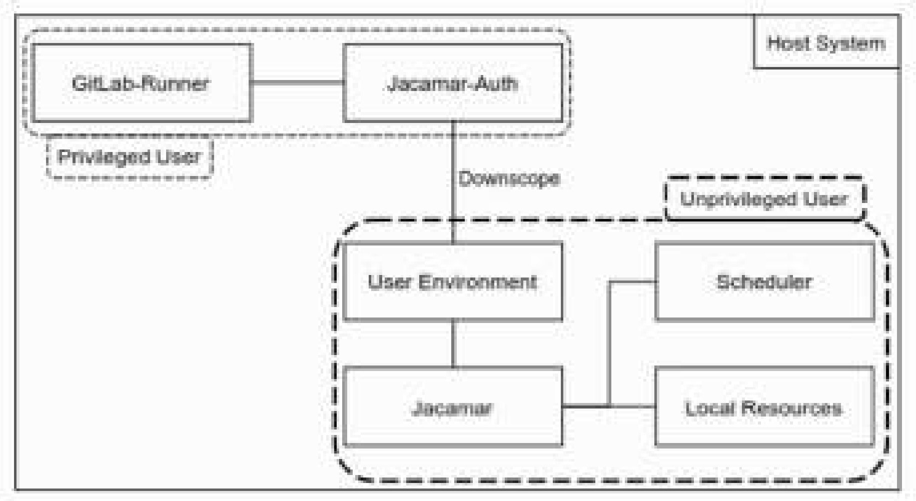
EDITOModelLab

WP5 | 2nd year plan

Task 5.3 VOML for co-development (Lead: CINECA) [M1-M24]

Collaborative development and testing interactive framework

- **Instantiation** of **Gitlab Runners** using Jacamar CI on HPC infra
- Authorization and downscoping
- Enabling CI/CD pipelines on EDITO infra and HPC



Relocatable Ocean modelling platform

- **Porting** of the runexp.py script **as Autosubmit pipeline** configuration
- Enabling **CI/CD** pipeline on **SURF** components
- **Deployment** of **different component** in the proper compute infra (both cloud and HPC)

EDITOModelLab

WP5 | 2nd year plan

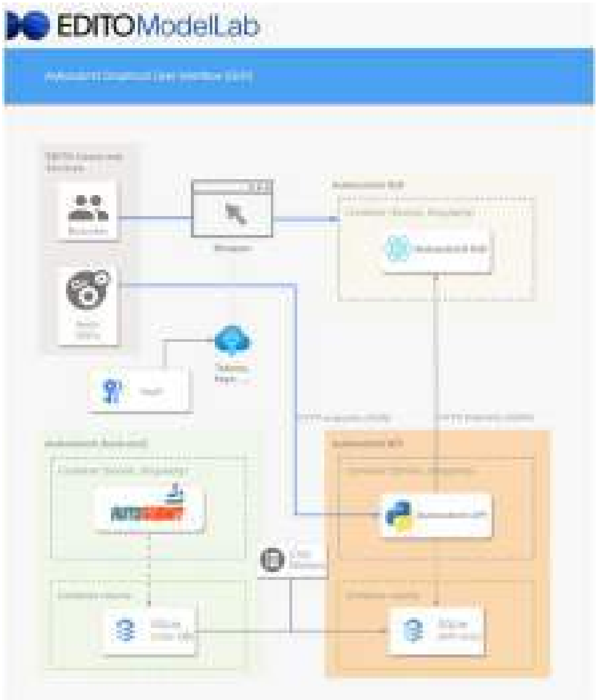
Task 5.4 User interfaces for on demand model (Lead: CMCC) [M1-M24]

Autosubmit GUI

- **Upgrade Autosubmit GUI** to use the new **write-mode endpoints** in Autosubmit API.
- **Deploy** Autosubmit GUI in **EDITO-Infra**.

SURF-GUI

- Create the **SURF-GUI Mockup** which will include more **visual** and **interactive** elements
- **Integrate** the **Autosubmit API/GUI** within the SURF-GUI
- Develop the **SURF-GUI prototype**
- **Deploy** the SURF-GUI prototype in the **EDITO-Infra**



WP5 | 2nd year plan

Task 5.5 Testing and validation of VOML (Lead: SOCIB). [M18-M36]

Definition of workplan for testing and validation

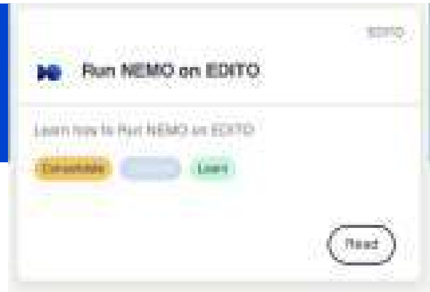
- **Compilation** of **user database**
- Define **calendar** for **testing** and **validation** of **VOML**
- Internal **testing and validation**
- Development of **tutorials** to be shared with **external users**

WP4-WP5 | Examples (live demos)

WP4 & WP5 Examples

- Autosubmit integration in EDITO (live demo)
- NEMO demonstration in EDITO (live demo)

WP4-WP5 | Example #2 NEMO Demonstration

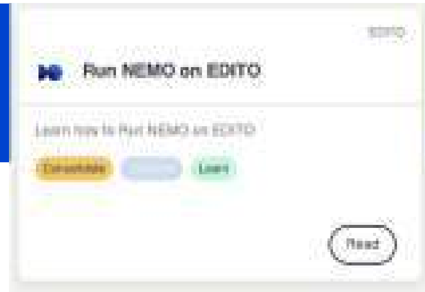


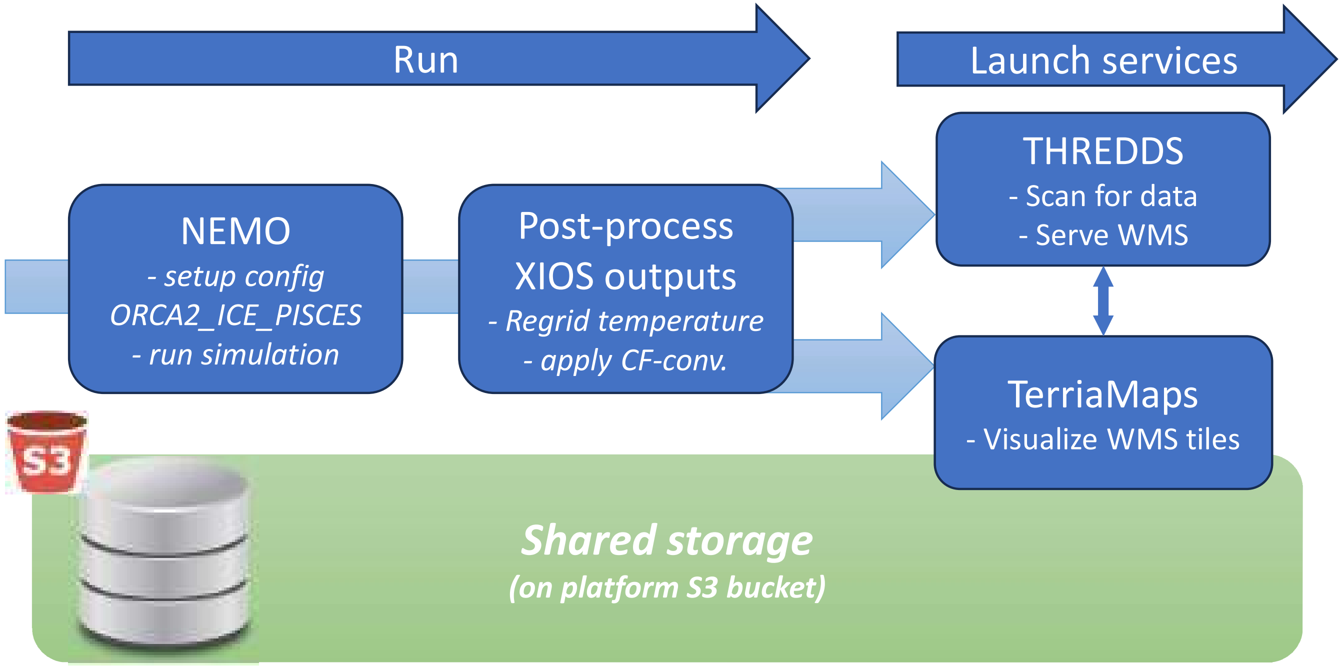
- **Run NEMO reference simulation ORCA2_ICE_PISCES**
  - global ocean with a 2°x2° ORCA2 grid and 31 vertical levels (z-coordinates, 10 levels in top 100m).
  - NEMO-OCE, NEMO-SI3, NEMO-TOP + XIOS
  - Climatological forcings

- **Integration path:**
  1. Gitlab repository, clonable from platform's VSCode IDE (self-service)
  2. Merge request to integrate docker images of scripts as processes on platform (helm charts)

EDITOModelLab

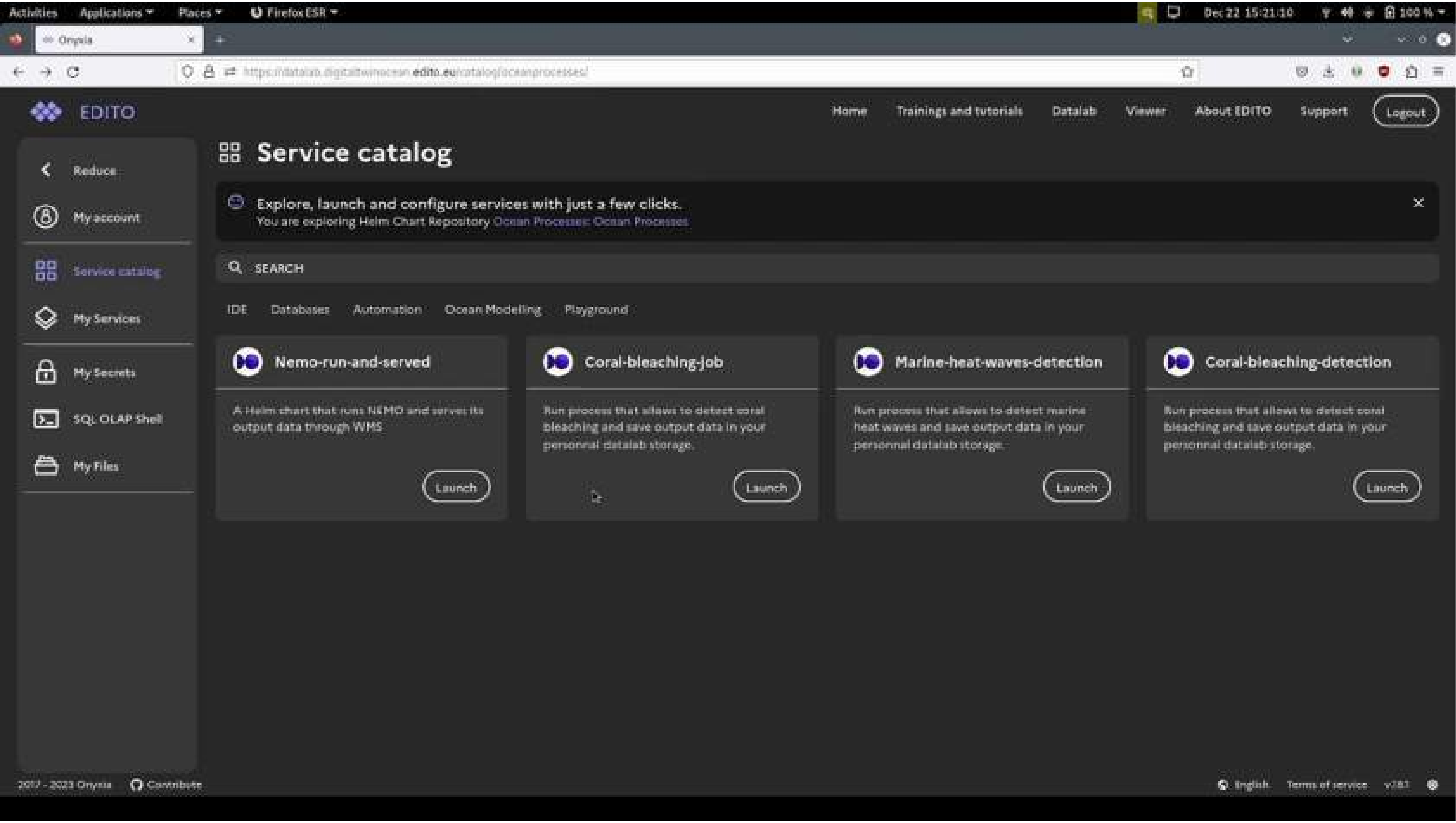
WP4 & WP5 | Example #2 NEMO Demonstration

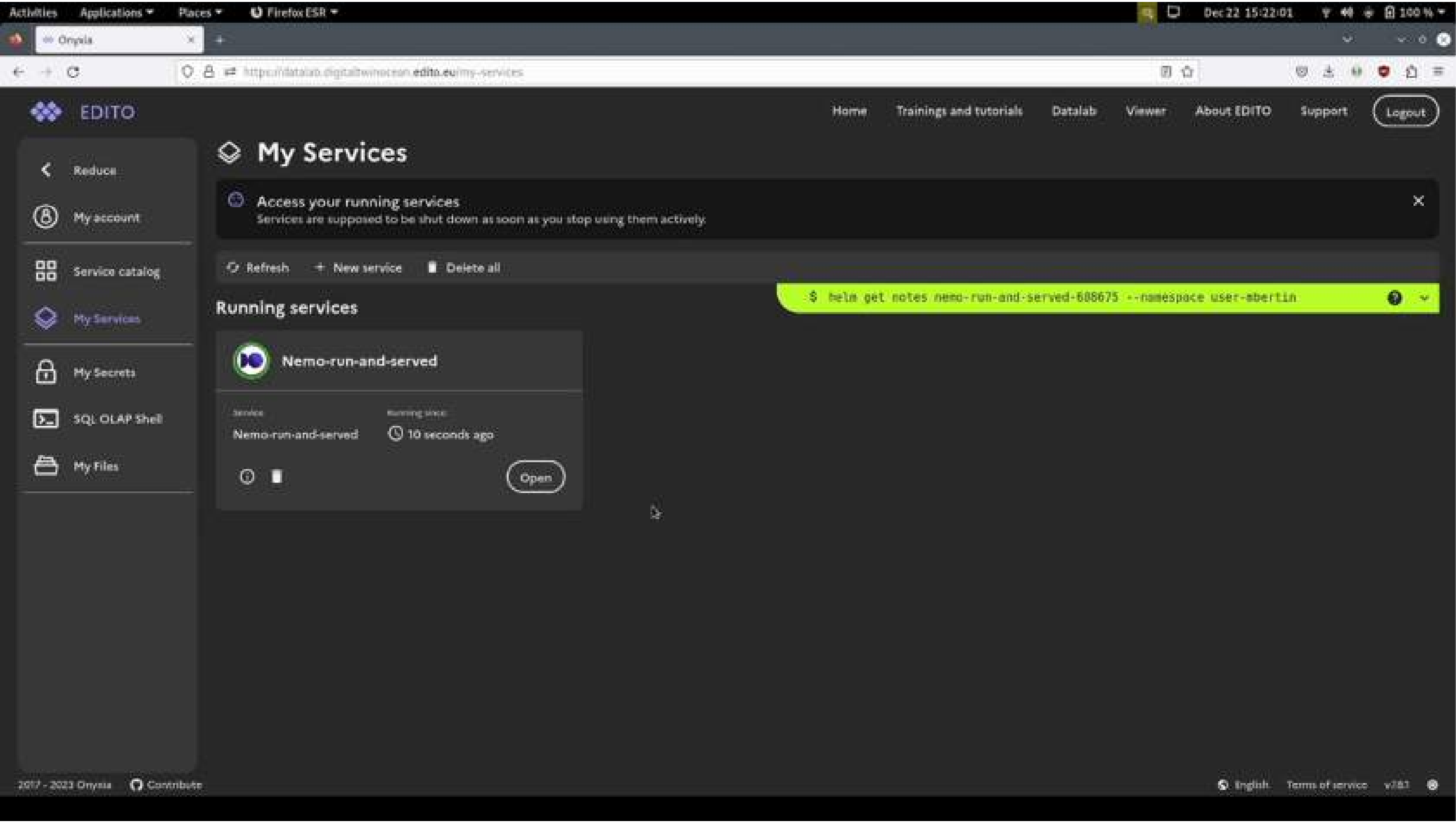


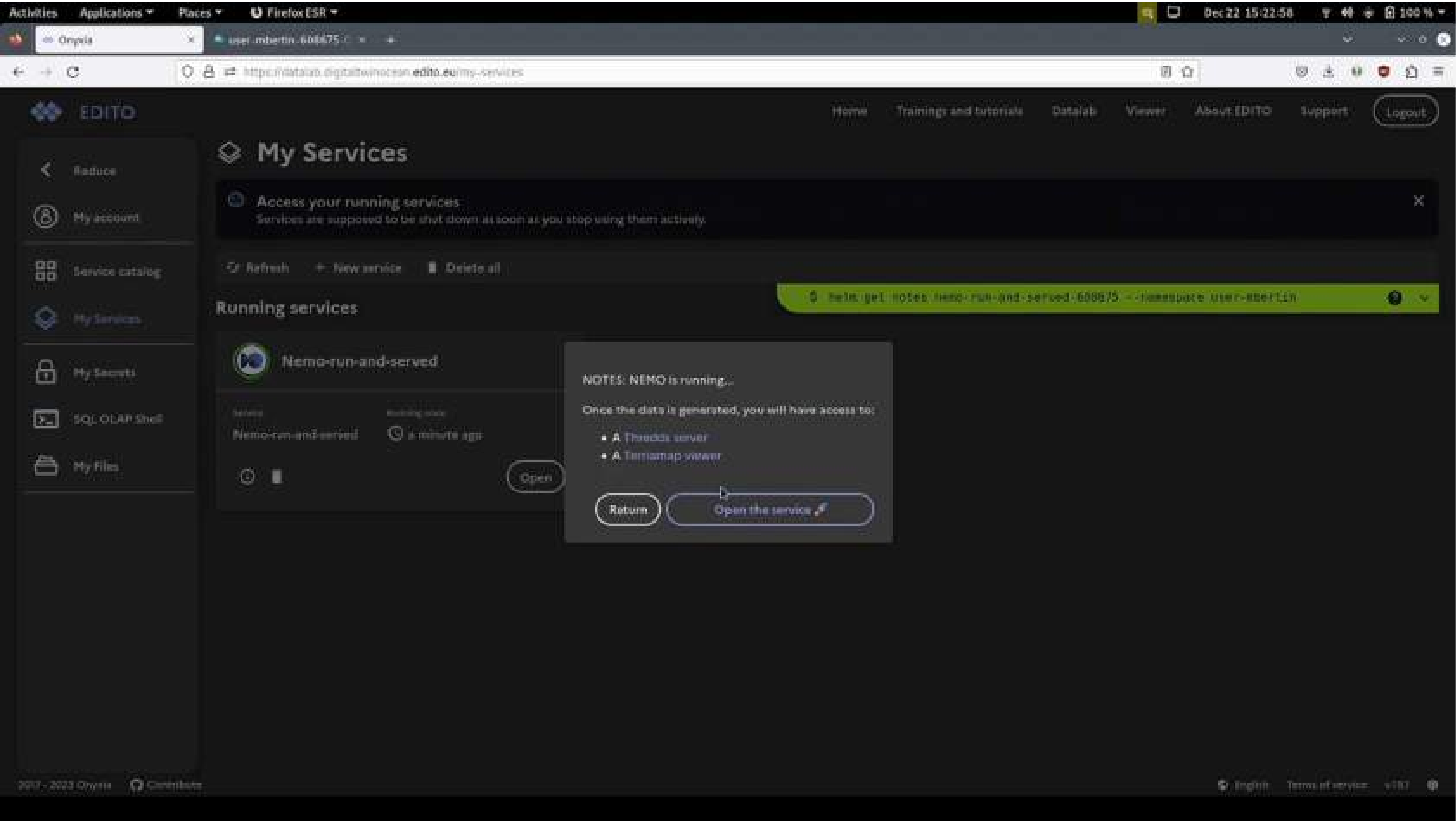


Demo is accessible from EDITO Tutorials page
https://tutorials.digitaltwinocean.edito.eu/training
Direct link to article on mercator's gitlab

EDITOModelLab


Activities
Applications
Places
Firefox ESR
Dec 22 15:21:10
100 %
Onyxia
https://datalab.digitaltwinocean.edito.eu/catalog/oceanprocesses/
EDITO
Home
Trainings and tutorials
Datalab
Viewer
About EDITO
Support
Logout
Reduce
My account
Service catalog
My Services
My Secrets
SQL OLAP Shell
My Files
Service catalog
Explore, launch and configure services with just a few clicks.
You are exploring Helm Chart Repository Ocean Processes: Ocean Processes
SEARCH
IDE
Databases
Automation
Ocean Modelling
Playground
Nemo-run-and-served
A Helm chart that runs NEMO and serves its output data through WMS
Launch
Coral-bleaching-job
Run process that allows to detect coral bleaching and save output data in your personnal datalab storage.
Launch
Marine-heat-waves-detection
Run process that allows to detect marine heat waves and save output data in your personnal datalab storage.
Launch
Coral-bleaching-detection
Run process that allows to detect coral bleaching and save output data in your personnal datalab storage.
Launch
2017 - 2023 Onyxia
Contribute
English
Terms of service


Activities Applications Places Firefox ESR
Dec 22 15:22:01
100 %
Onyxia
https://datalab.digitaltwinocean.edito.eu/my-services
EDITO
Home
Trainings and tutorials
Datalab
Viewer
About EDITO
Support
Logout
Reduce
My account
Service catalog
My Services
My Secrets
SQL OLAP Shell
My Files
My Services
Access your running services
Services are supposed to be shut down as soon as you stop using them actively.
Refresh
New service
Delete all
$ helm get notes nemo-run-and-served-608675 --namespace user-mbertin
Running services
Nemo-run-and-served
Nemo-run-and-served
10 seconds ago
Open
2017 - 2023 Onyxia
Contribute
English
Terms of service


Activities
Applications
Places
Firefox ESR
Dec 22 15:22:58
100 %
Onyxia
EDITO
Home
Trainings and tutorials
Datalab
Viewer
About EDITO
Support
Logout
My Services
Reduce
My account
Service catalog
My Services
My Secrets
SQL OLAP Shell
My Files
Access your running services
Services are supposed to be shut down as soon as you stop using them actively.
Refresh
New service
Delete all
Running services
Nemo-run-and-served
Open
NOTES: NEMO is running...
Once the data is generated, you will have access to:
A Thredds server
A Terriamap viewer
Return
Open the service

WP4 & WP5 | Example #2 NEMO Demonstration

- **What's next?**
  - **NEMO**:
    - optimization of container image, split into several images, integrate to a more complex workflow (several simulations in parallel "*a la WiS*")
    - Integrate into Autosubmit, run on HPC
    - Develop a dedicated web UI for setting experiment parameters
  - **THREDDS / TerriaMaps:**
    - Pre-fetch TDS services from TerriaMaps
    - Possibly convert to zarr to avoid TDS stage
    - Refine visualization parameters

BACK AT 4:25 PM

Achievements and next steps

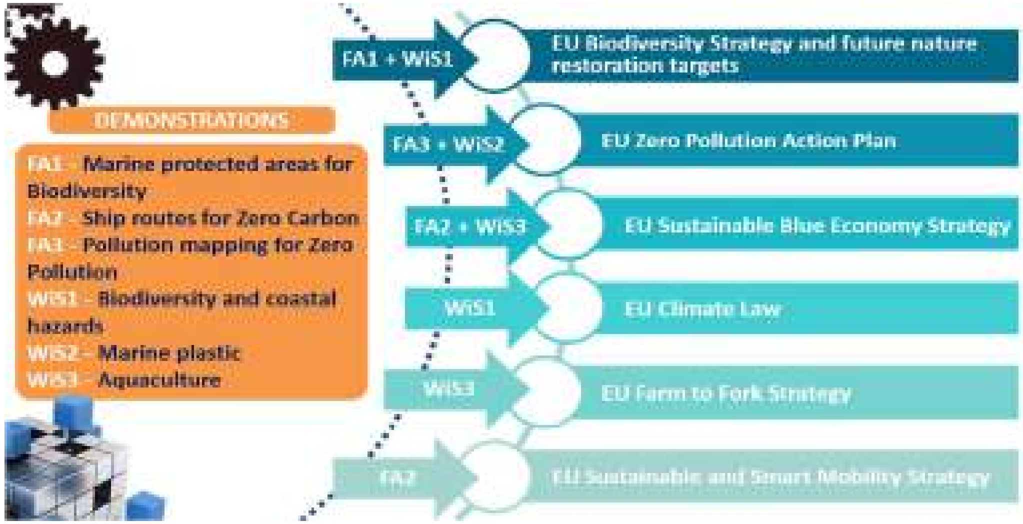
Focus applications and What-if-Scenarios (WP6 – WP7)

Moderator: G El Serafy (Deltares), J Staneva (Hereon)

Target

KER #5 Focus Applications and What-if Scenarios to demonstrate the benefit of the developed model components for the Mission priorities.

- → **KPI: 6 demonstrators** will be developed using EDITO models and tools *(reaching TRL8)*
- → **KPI** Capacity to explore application and scenario in less than 30min.
- → illustrate capabilities, functionalities, performances and the usefulness of the core model suite



Focus applications will include on demand simulation production (specific region, specific variable for a dedicated application)

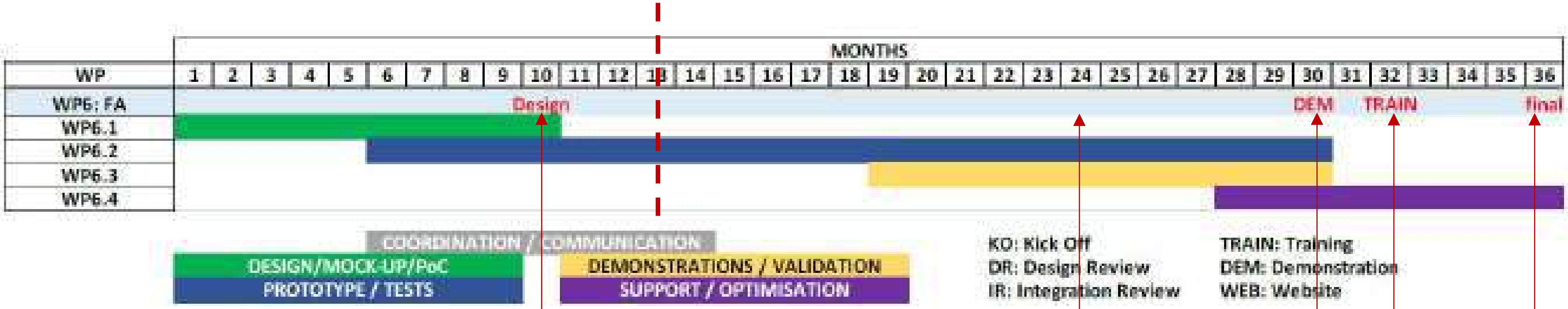
What-if scenarios will answer to (policy) questions using existing simulations and dedicated impact simulations based on pre-defined scenarios

EDITOModelLab

WP6 - Focus Applications

EDITOModelLab | MERCATOR OCEAN INTERNATIONAL

WP6 Timeline



Month 10: M3 Workshop for co-design of FA WP6

Month 30: M12 Focus Applications prototype

Month 32: M14 Hackathon for FA testing

Month 36: M20 Focus Applications online

Month 24: D6.1 Focus Applications demonstrations

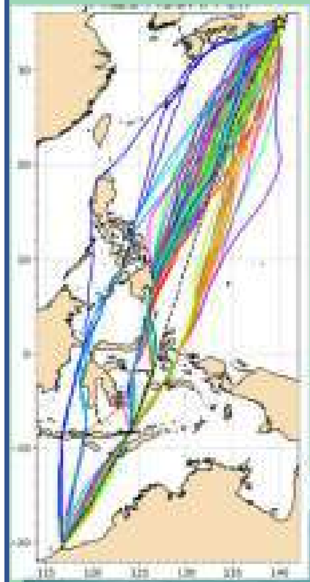
Focus Applications

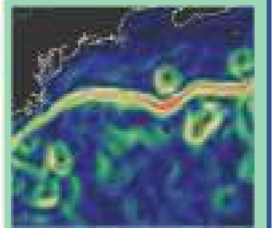
1. Marine Protected Areas & biodiversity

Habitat suitability and biodiversity indicators

2. Ship routing for zero carbon

Using forecasts of ocean waves and currents to reduce CO2 emmissions



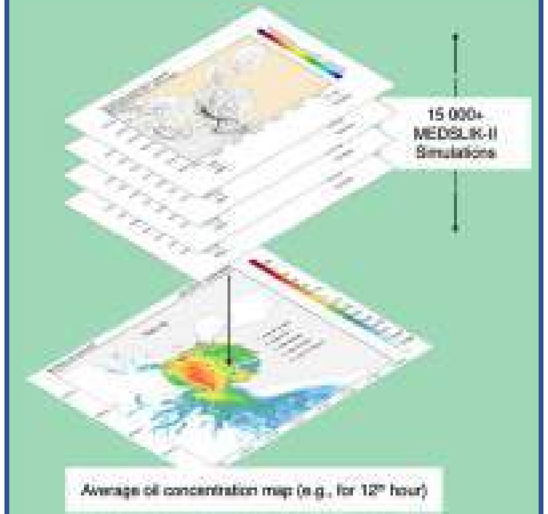


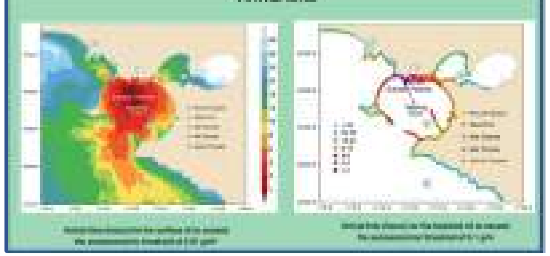
^ocean forecast

<output of VISIR-2 ship routing model for green corridor Japan-Australia

3. Zero pollution

Simulating release of oil from ships and plastics from land





Deltares hereon cmcc

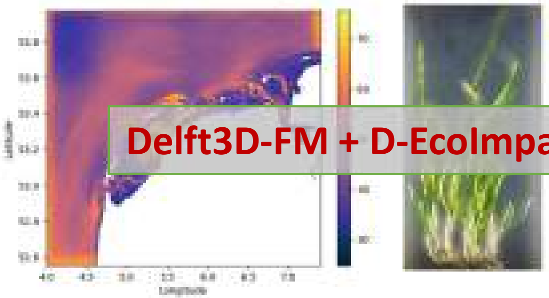
cmcc Centro Euro-Mediterraneo sui Cambiamenti Climatici

cmcc Danmarks Meteorologiske Institut EDITOModelLab

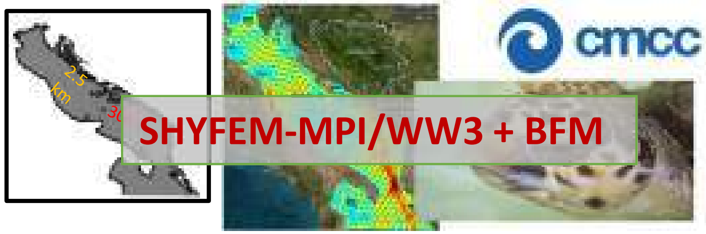
Focus Applications

FA1

Habitat suitability in the Wadden Sea



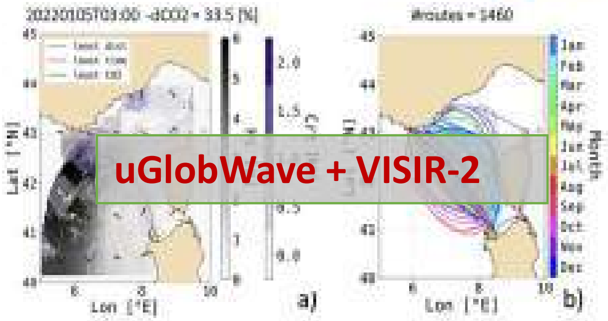
Biodiversity indicators for Torre Guaceto



Biodiversity indicators in the Southern North Sea

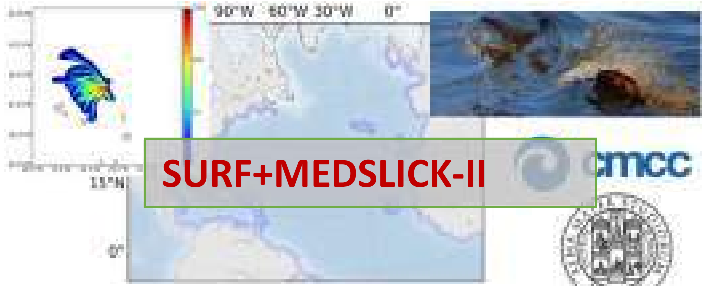
FA2

Ship routing for zero carbon

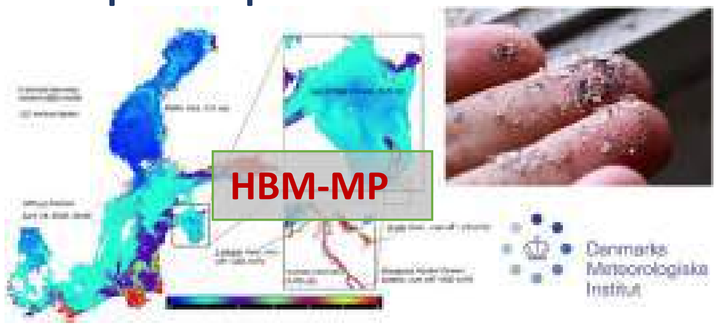


FA3

Oil Spill for zero pollution in Med Sea



Microplastics pollution in Baltic Sea



EDITOModelLab

Focus Application «products»

FA1	FA2	FA3
Habitat suitability in the Wadden Sea "Spatial habitat suitability index for pre-defined or user specified species." **Biodiversity indicators for Torre Guaceto** "Environmental Indicators based on high resolution circulation, waves and biogeochemistry models." **Biodiversity indicators in the Southern North Sea** "Biodiversity indicators from the dynamic physical-biological simulations."	**Ship routing for zero carbon** "Least distance, time and CO2 emission routes. Pre-computed routes with fixed departures or on-demand routes with any departure location."	**Oil Spill for zero pollution in Med Sea** "Coastal oil spill hazard index for operational spills. Cumulative oil spill trajectories for operational events. Oil Fate on the surface, Oil mass in the coast, Simulation Mass Balance." **Microplastics pollution in Baltic Sea** "Fate and pathways of land microplastics in the Baltic Sea. Spatiotemporal distribution, residence pattern, MP budget for user specified area."

EDITOModelLab

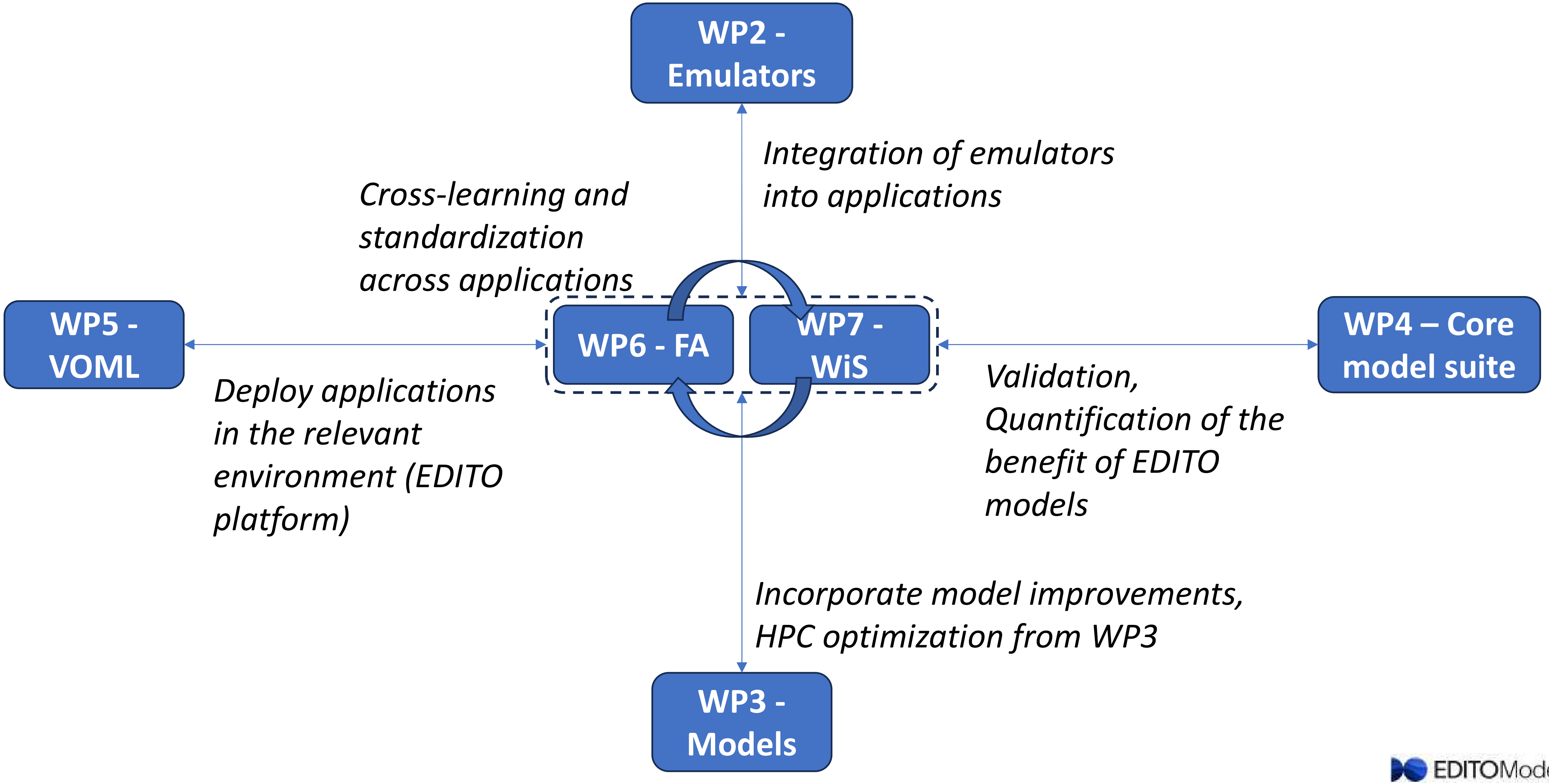
Achievements

- ✓6 technical FA teams (from 5 institutes) are up and running
- ✓Several FA coordination events took place (co-design meetings [June] and first demos in December 2023)

- ✓FA outputs/products identified but to be refined
- ✓Technical workflow components identified for all FAs
- ✓Data and compute infrastructure requirements identified
- ✓Basic user interfaces identified in most cases. Some already exist
- ✓Workflow components tested locally for most applications
- ✓Workflow components tested in EDITO-infra for some applications

EDITOModelLab

Future plans - INTEGRATION



Future plans – List of issues

Integration within Focus Applications and other WPs
Users should be guided upon an entry to the platform *(Which focus application to use for what area and for what variables and for which scientific questions?)*
Work towards **presenting the application homogenously** (presentation format)
Common repository or list of repositories (e.g. Wiki, Confluence) for collaboration (idea: dedicated GitHub for the project)
Expand / update technical table of **technical requirements** (link to temporary folder)
Make final **inventory of required input data that is not accessible** yet on EDITO platform (e.g. FES)
Discussion about **unstructured data formats** (e.g. u-grid)
FAs that need **native HPC installation** should collaborate and contact BSC + MOi
FA1: **Shared routines** (by Hereon+CMCC) to compute biodiversity indicators and to compute habitat suitability (D-EcoImpact by Deltares). The **compatibility** of output from Schism (HEREON), SHYFEM and NEMO (CMCC, University of Bologna) can be tested with D-EcoImpact

Future plans - INTEGRATION

FA1: Coastal biogeochemical models (WP3) + turbidity emulator (WP2)+ algorithms to develop biodiversity indices + D-EcoImpact (WP3)

FA2: Global hydrodynamics & wave model + global sea surface velocity emulator (WP2) + ship routing model (WP3)

FA3: Regional hydrodynamic model (WP3) + oil spill model / plastic dispersion model (WP3)

Future plans - External

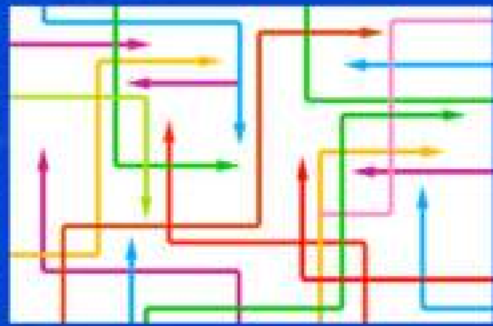
- **Technical exchange with ILIAD**:

WP7 Demonstration and impact assessment of Iliad pilots → WP6-7 EDITO Model Lab Focus Applications and What-if scenarios.

- **Demonstrations in conferences** to engage intermediate users:
  - EGU 2024 *(WP6 abstract submitted)*
  - Ocean Decade Conference 2024 *(WP6-7 abstract submitted)*
  - Digital Ocean Forum 2024 *(demos to be submitted)*

EDITOModelLab

What-IF Scenarios



EDITOModelLab

MERCATOR OCEAN INTERNATIONAL

What-IF Scenarios

1. Nature Based Solutions for biodiversity and coastal hazards

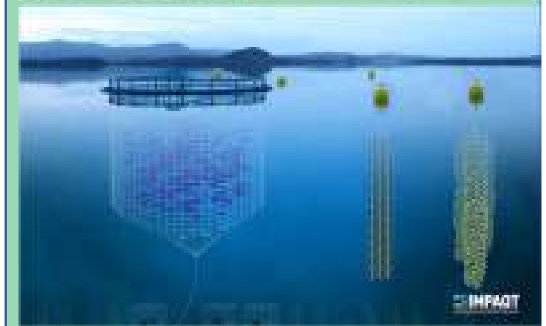
Impact of extreme events on ecosystems protection and mitigation

2. Marine plastic for Zero pollution

Effects of plastic pollution levels reductions in LOC in the marine environment

3. Aquaculture for Zero carbon

Marine aquaculture offers opportunities for emissions reduction and the potential for carbon sequestration. .



hereon Danmarks Meteorologiske Institut Deltares

Danmarks Meteorologiske Institut cmcc hereon MERCATOR OCEAN INTERNATIONAL Deltares EDITOModelLab

WP6/WP7: Demonstrations

6 demonstrators will be develop based on models and tools that will be available

→ Focus applications will include on demand simulations production (specific region, specific variable for a dedicated application)

→ Whatif scenario will answer to questions using existing simulations and dedicated impact simulation to provide information on the impact base on a scenario.

KER #5 FA and WiS to demonstrate the benefit of the developed model components for the Mission priority. Link with Obj 5, 6 Contribution to EO 3, 5, 6, 8	3 FA + 3 WiS to illustrate capabilities, functionalities, performances and the usefulness of the core model suite and to answer, explain and quantify change and impact for protecting and restoring ecosystems and biodiversity, for zero pollution, and for decarbonisation and net greenhouse gas emissions reduction. Capacity to explore application and scenario in less than 30min.	Consortium and especially, Deltares, CMCC, UniBO, Hereon, DMI, SOCIB

EDITOModelLab

EDITO Model Lab What-if Scenario

EDITO Lab Digital Twin will be built enabling What-If scenarios to be tested.

What-if in:

- Nature Based Solutions for Biodiversity and coastal hazards
- Marine plastic for Zero pollution
- Aquaculture for Zero carbon

Developing a locally adapted Digital Twin using the most up-to-date cross-disciplinary modelling systems.

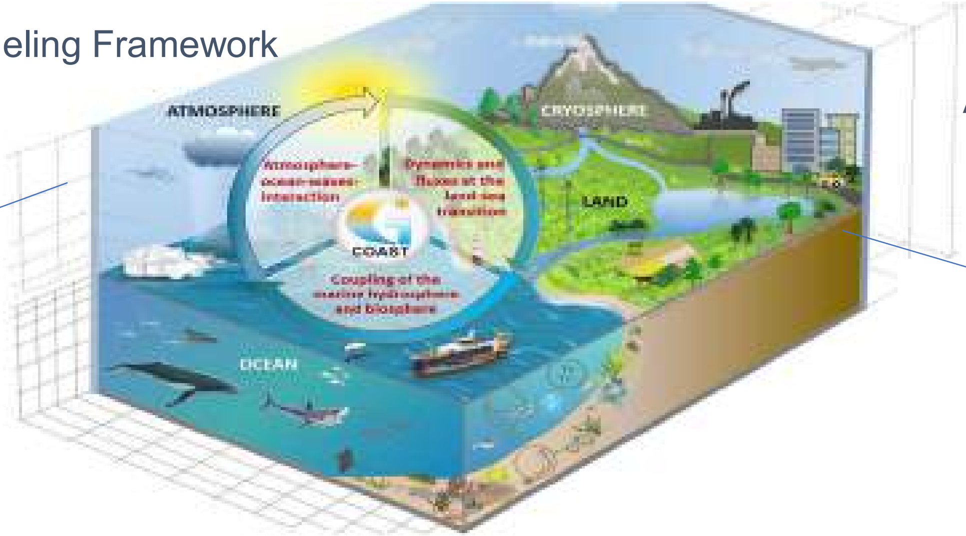
End to end development of a Digital Twin that provides new products and on demand models for What-If scenario

EDITOModelLab

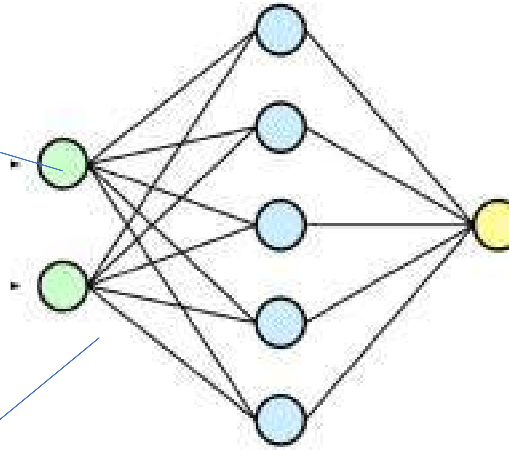
Tools and methods

Observations

Modeling Framework



AI framework



EDITOModelLab

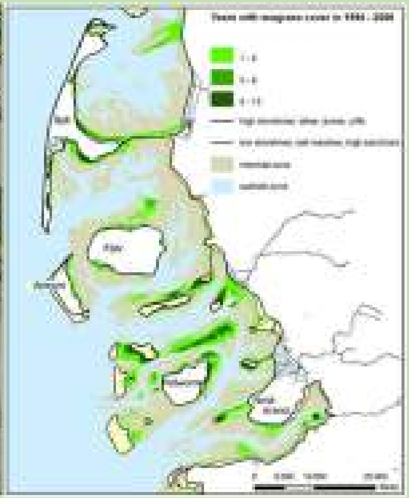

Seagrass meadows are an example of
nature-based solutions for coastal resilience
that will be addressed

What-if scenarios in NATURE BASED SOLUTION

DIGITAL TWIN FOR COASTAL NBS

WIS designed to improve protection of local communities and mitigation of the impact of the flood, droughts, storms on biodiversity using NBS

- Are indigenous seagrass meadows able to reduce the energy of storm surges, and if so how?



Problem and Solution to be tested

Problem:
European coasts
Flooding and coastal erosion

Solution:
Coastal sea grass : potential NBS for wave amplitude reduction

Digital Twin Modelling framework

- Wind-wave model
- Hydrodynamic model
- SPM model
- Vegetation model
- AI/ hybrid model

Calibration/ Validation with satellite data and local observations

What if scenarios

What are the best seagrass types and their landscaping for optimal coastal protection?

How can the optimal seagrass meadow (location, size) be determined regarding the management strategies and climate change (e.g. SLR)?

Model and methods

Hydro-model (SCHISM-WWM) — Hydrodynamics

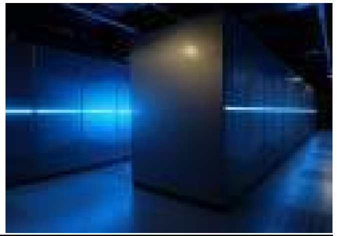
Provides water level, wave spectrum as boundary forcing

Morph-model (XBeach) — Morphodynamics

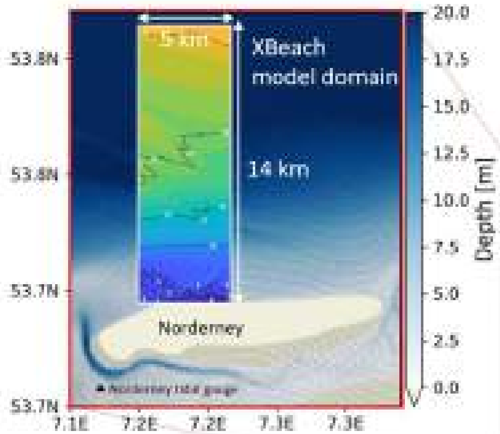
What if ...

- Without seagrass
- With seagrass
  - Different experiment scenarios

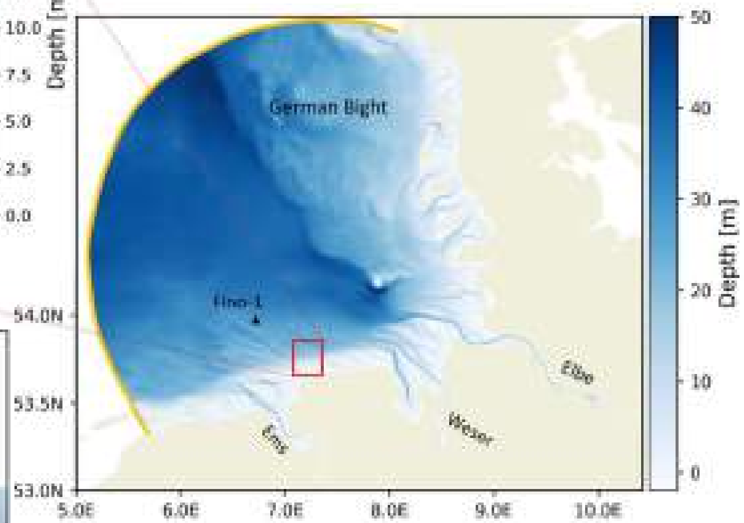
Evaluation of Coastal Erosion

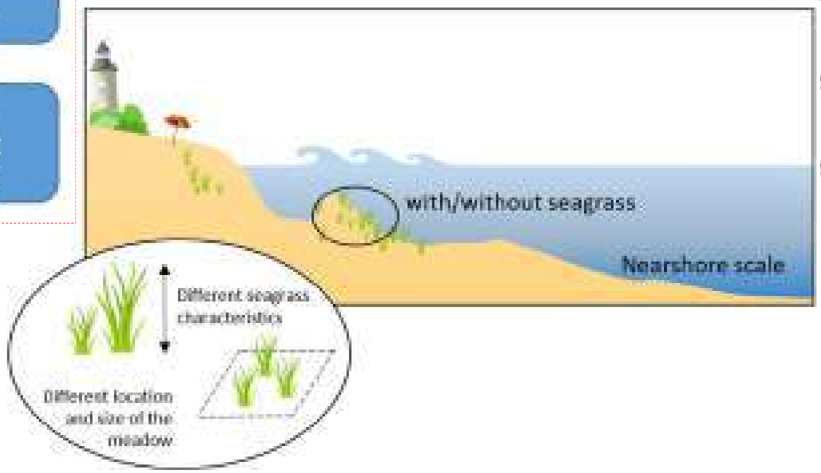



1280 cores
+
896 cores



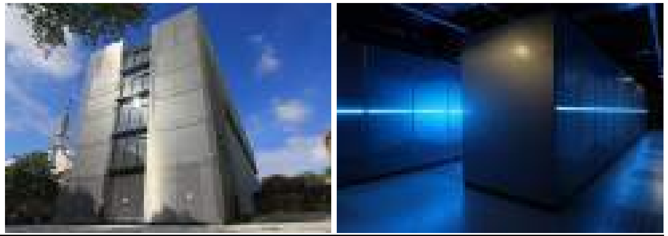
SCHISM-WWM model domain

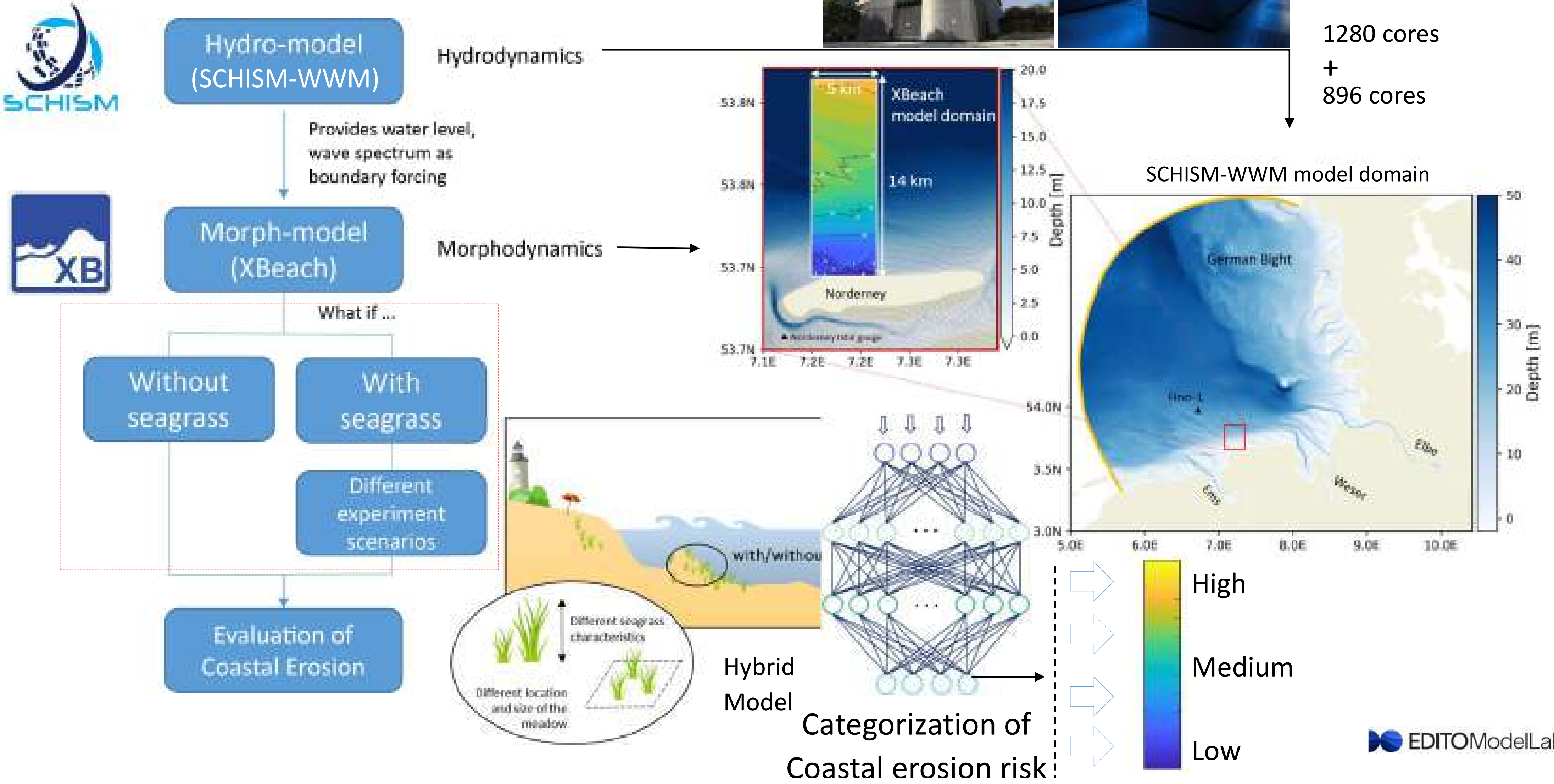




EDITOModelLab

Model and methods



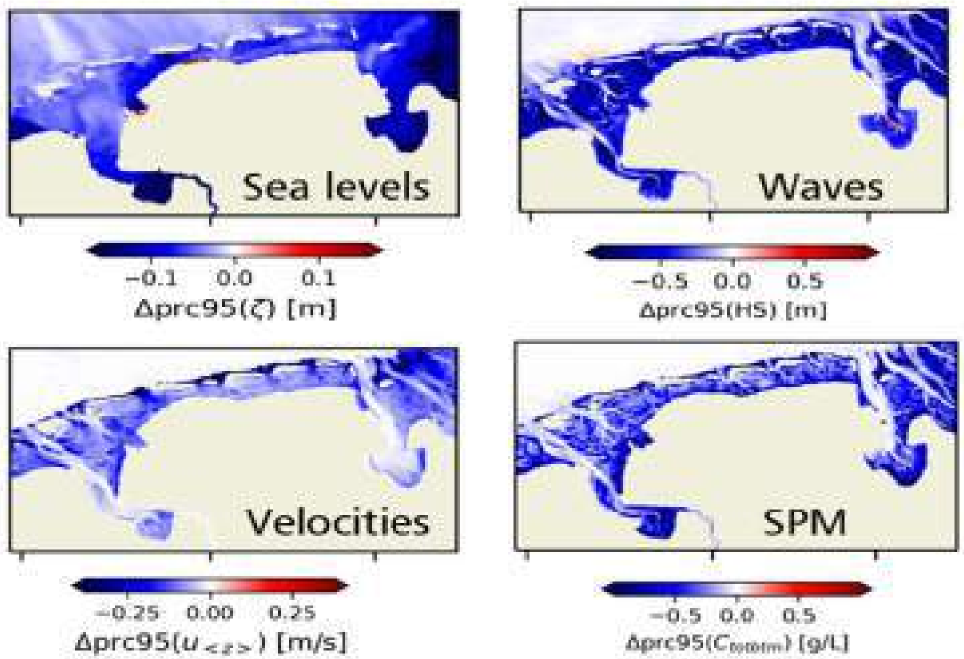


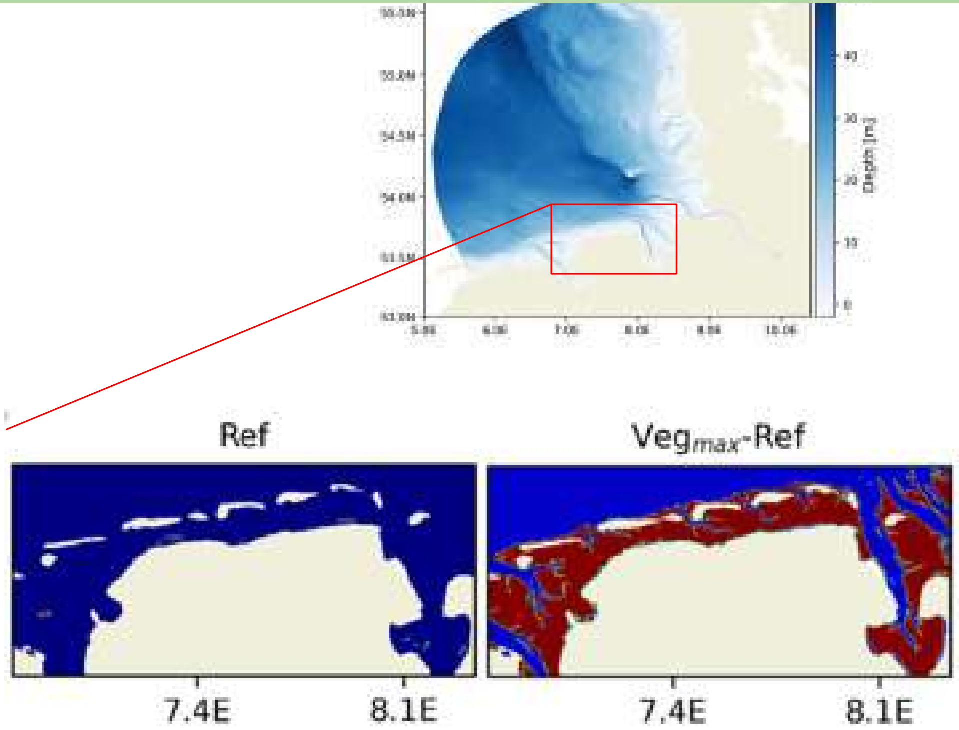
EDITOModelLab

What-if scenarios

- ➢ **Sea grass can efficiently reduce (30-80%) kinematics, coastal erosion and resulting sediment mobilization.**
- ➢ **Sea grass expansion could directly contribute to flood risk reduction in SLR**
- ➢ **Seagrass expansion could be a useful addition to engineered coastal protection measures**

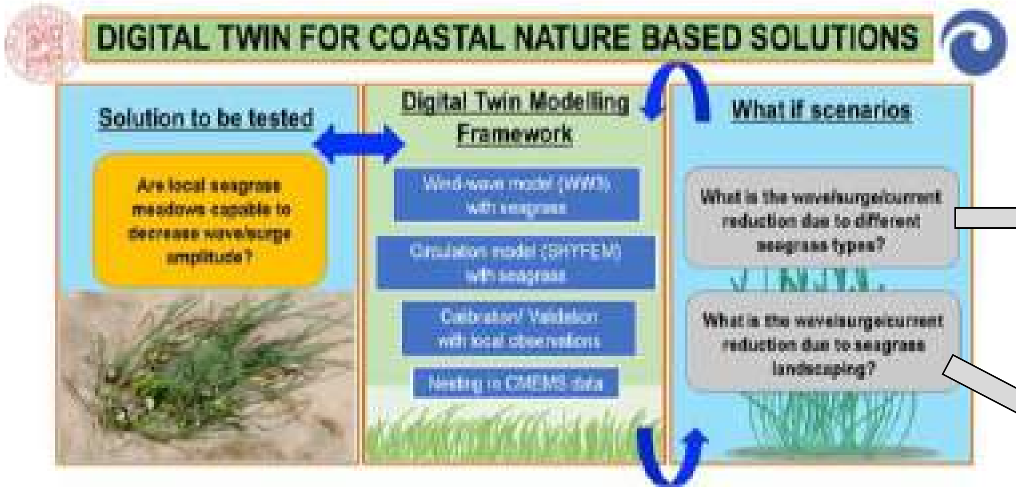
with v.s. without seagrass

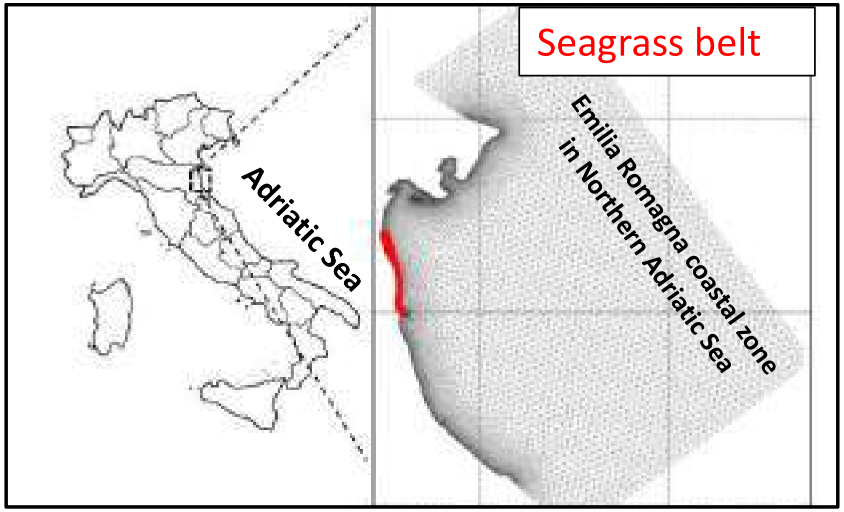


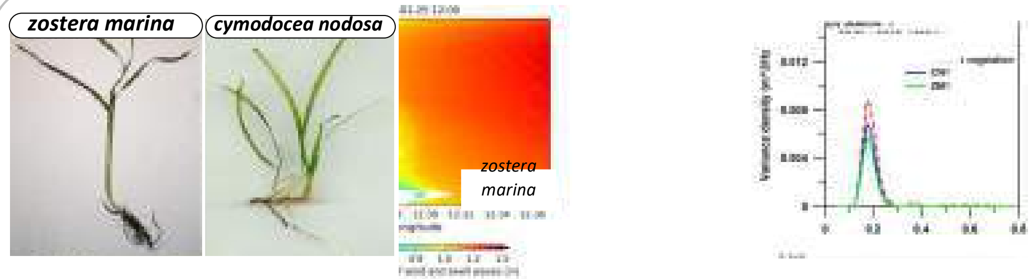


EDITOModelLab

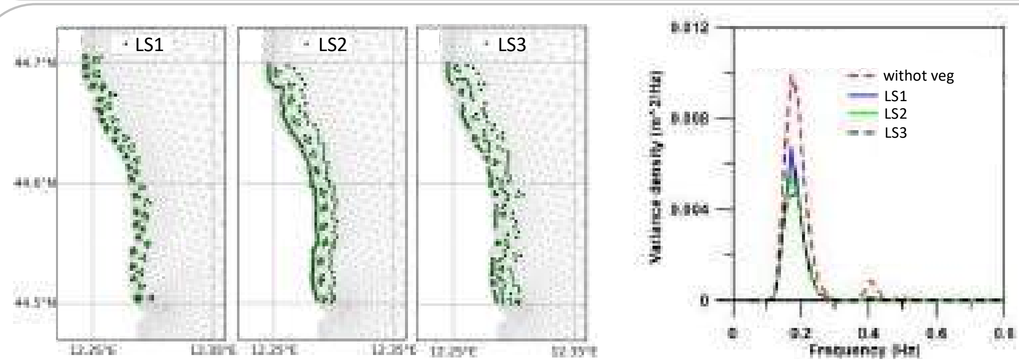
WiS1: What-if of Nature-based Solution in Northern Adriatic Sea







Greater attenuation using *Zostera marina*



Higher attenuations obtained with the broken strips along with the cluster arrangement

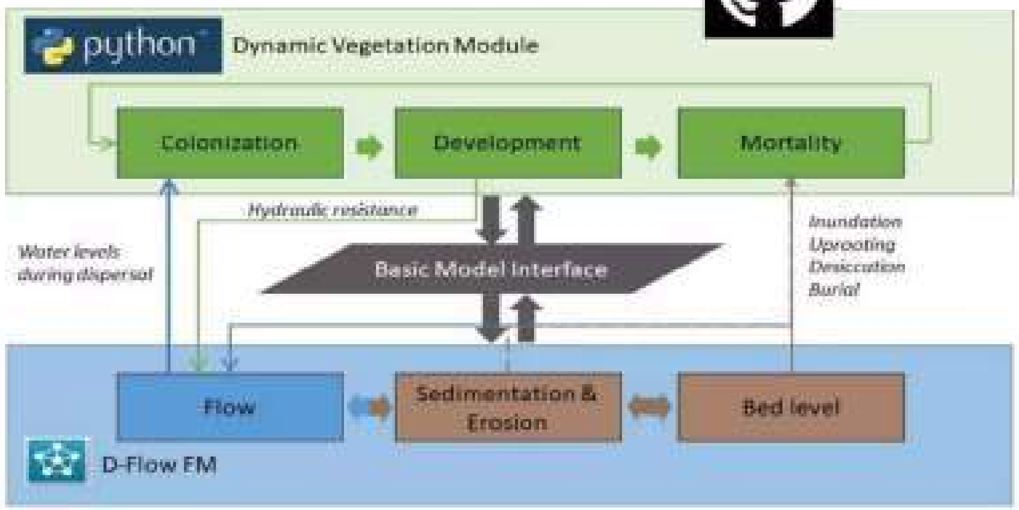
Next:

- Advance with effect on **circulation**
- Include flow-dependent parametrization of **flexible** vegetation (dev WP3)
- Detailed **validation**

What-if scenarios in NBS, Examples

Deltares

- Numerous pilots in the North Sea and tropics (e.g. Indonesia) as part of the EcoShape consortium. Salt marsh development modelling, dynamic vegetation modelling (the dynamic extent of the salt marsh is assessed by modeling online-coupled hydrodynamics, morphodynamics and vegetation growth using the numerical **Delft3D-Flexible Mesh** model, and a vegetation growth module).

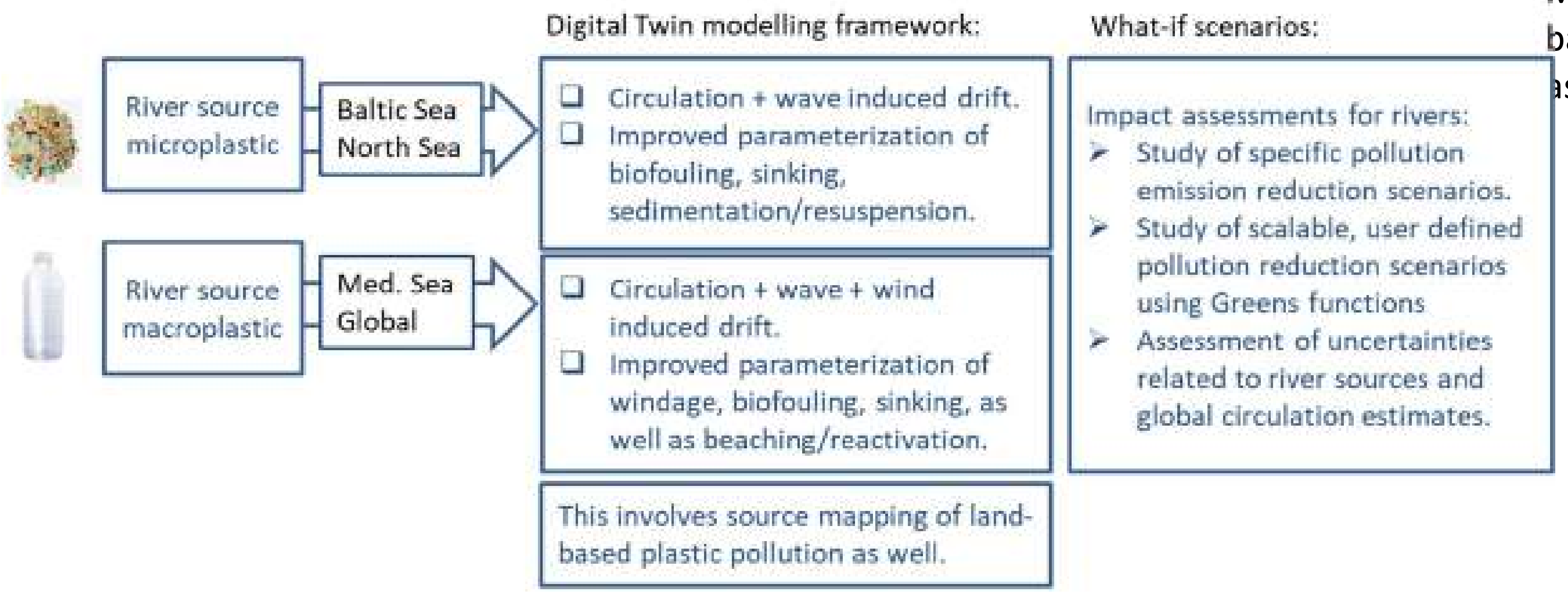


EDITOModelLab

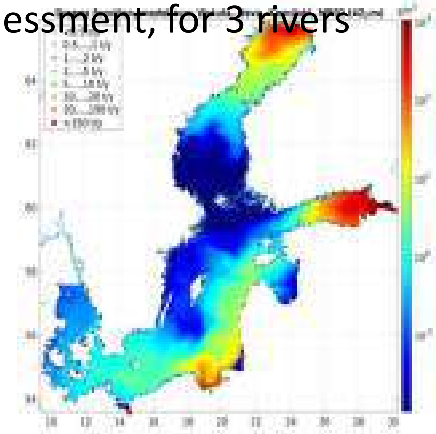
WIF in Marine plastic for Zero pollution

What-if scenarios to study the effects of plastic pollution levels reductions in rivers on the spatial distribution of plastic in the marine environment.

The assessment uses updated drift and fate modelling components and source mapping estimates (DTO) to study spatial and seasonal distributions of marine plastic pollution using Greens functions and user defined reduction scenarios for individual rivers.



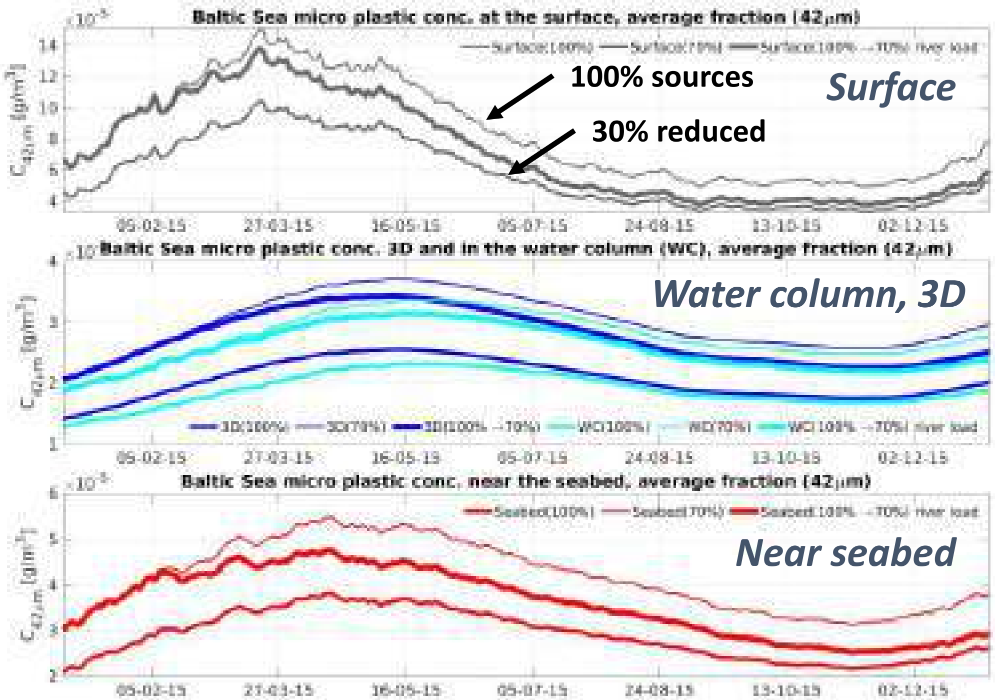
Model simulation used for based Greens function assessment, for 3 rivers



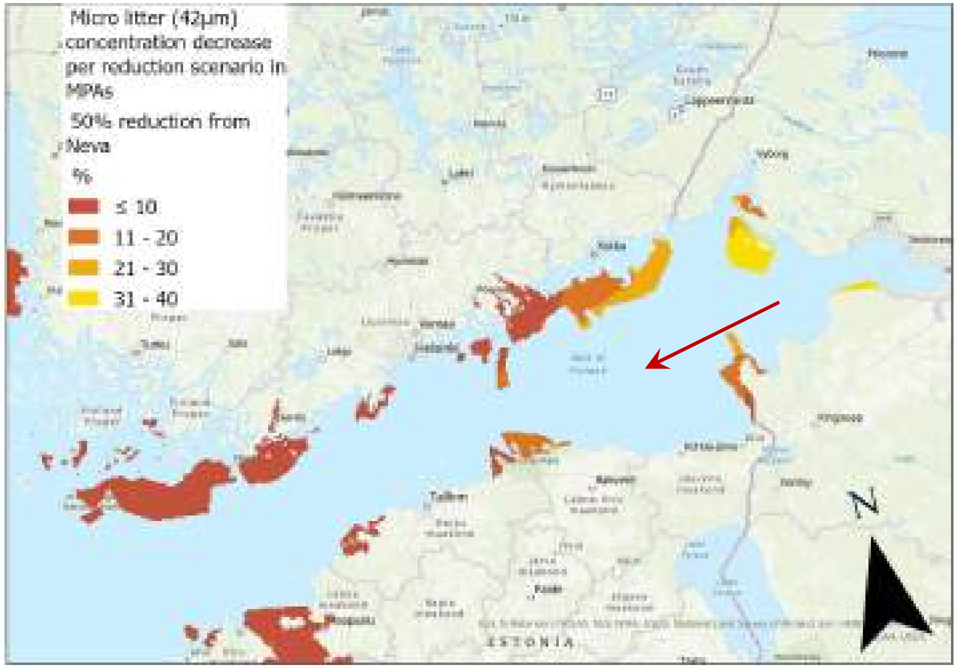
EDITOModelLab

WiS2 service products: management scenarios for land-based microplastic (MP) pollution (Baltic Sea) - HBM model

Danmarks Meteorologiske Institut



User needs: **with x% of reduction in a major source (a river or WWTP), what are the impacts on the reduction in the sea?**
Example: 30% reduction of river inputs for Household MP, showing MP reduction in surface, water column and seabed



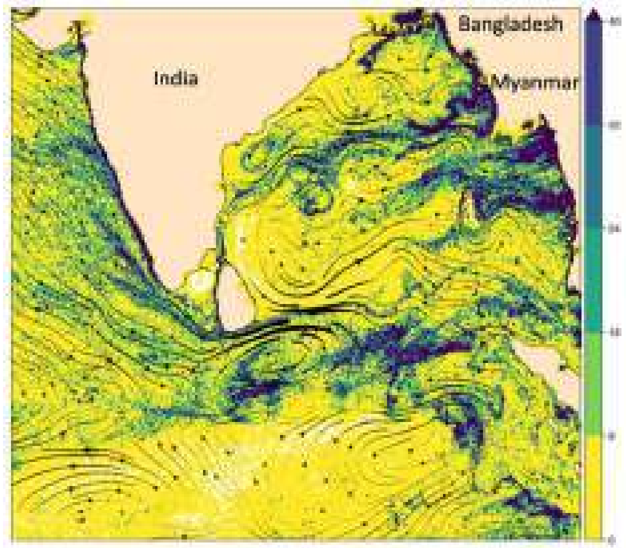
User needs: how will reduction of x% MP in given catchments will affect MP concentration in targeted MPA areas
Example: Neva, Impact of a source reduction of 50%: Simulated changes in concentrations of middle-size micro plastics (42 μm) in the HELCOM MPAs in the Gulf of Finland (user to specify MPA)

EDITOModelLab

WiF– MOI

Surface 2D Lagrangian drift tool modelling plastic abundance at global scale using mass coastal and riverine input estimations, enabling what if scenario on input levels to assess impact at local/regional scale.

- **Application:** enabling users to assess different plastic reduction scenarios geographical area: full global coast coverage time scale: access to sufficiently long period of simulation (decadal timescale) to include ocean circulation variability
- NEMO model



Simulated plastic abundance for a given month obtained with ocean and wave current reanalysis product

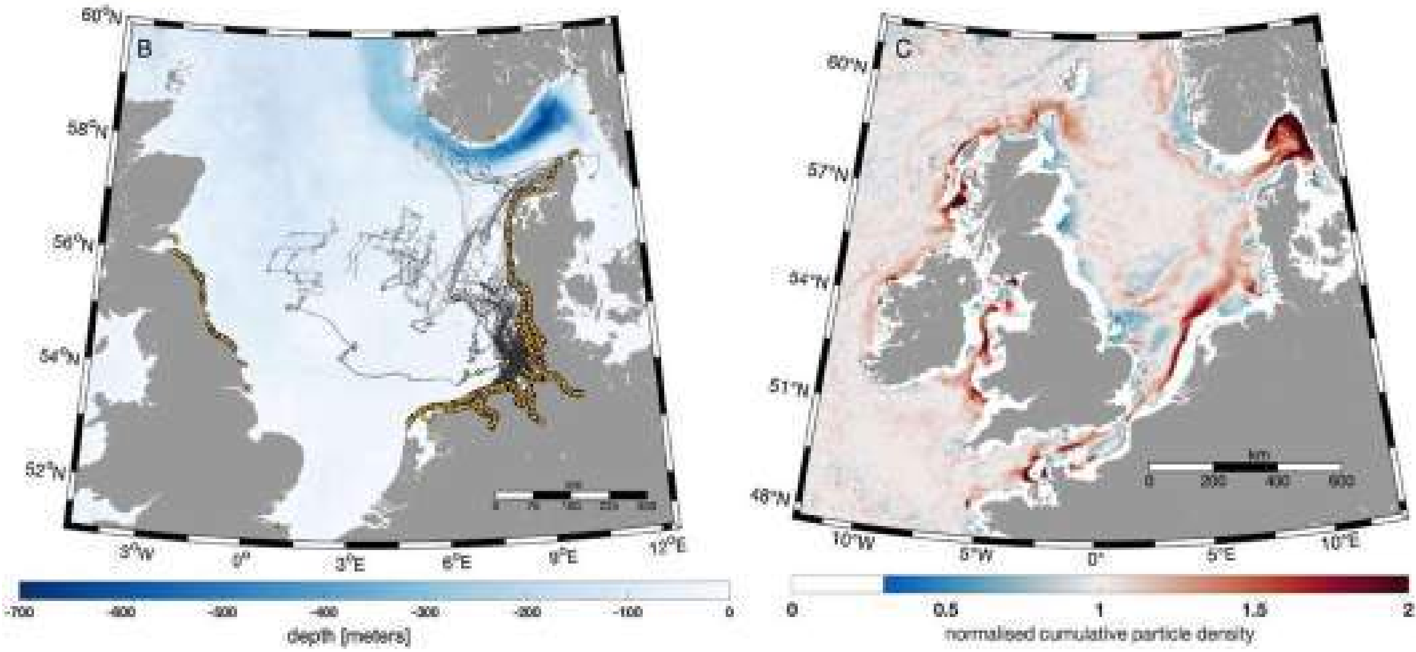
EDITOModelLab

WiS2 for Marine Pollution

- Demonstration Area: **North Sea**
- **Products depending on:**
  - user-specified scenario based on the change rate in the river discharge, and macroplastic disposal volume.
  - user-specified river(s).

User needs:

- Information/data of different human-use scenarios to promote more robust and **effective efforts to macroplastic disposal reduction**.
- Information/data about the **major sources** of macroplastic pollution.
- Information/data on the **possible pathways of macroplastic into MPAs** in different scenarios to improve management and mitigation plans.



Example of visualization:

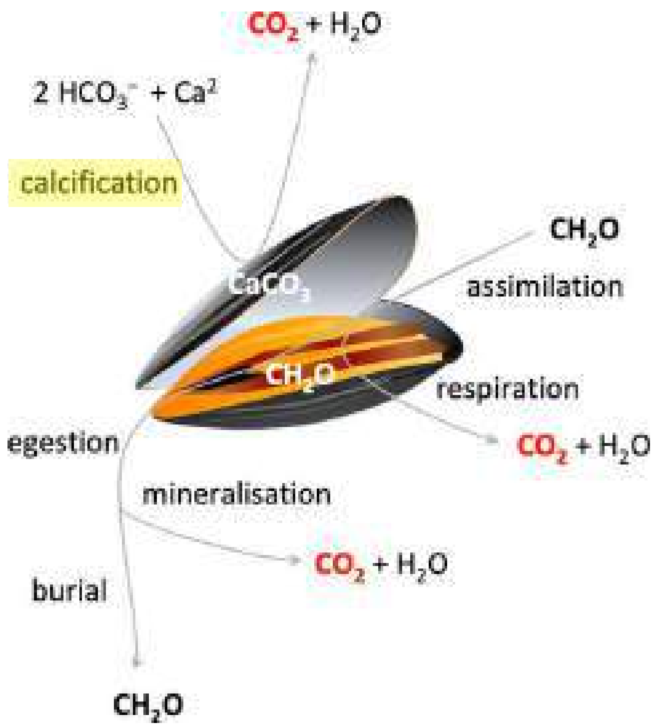
(left) particles along the coast (yellow dots), and cumulative trajectory (black lines) for a user-specified scenario;

(right) Macroplastic (particles) concentration showing the tendency of particle accumulation (NCPD>1) and dispersal (NCPD<1)

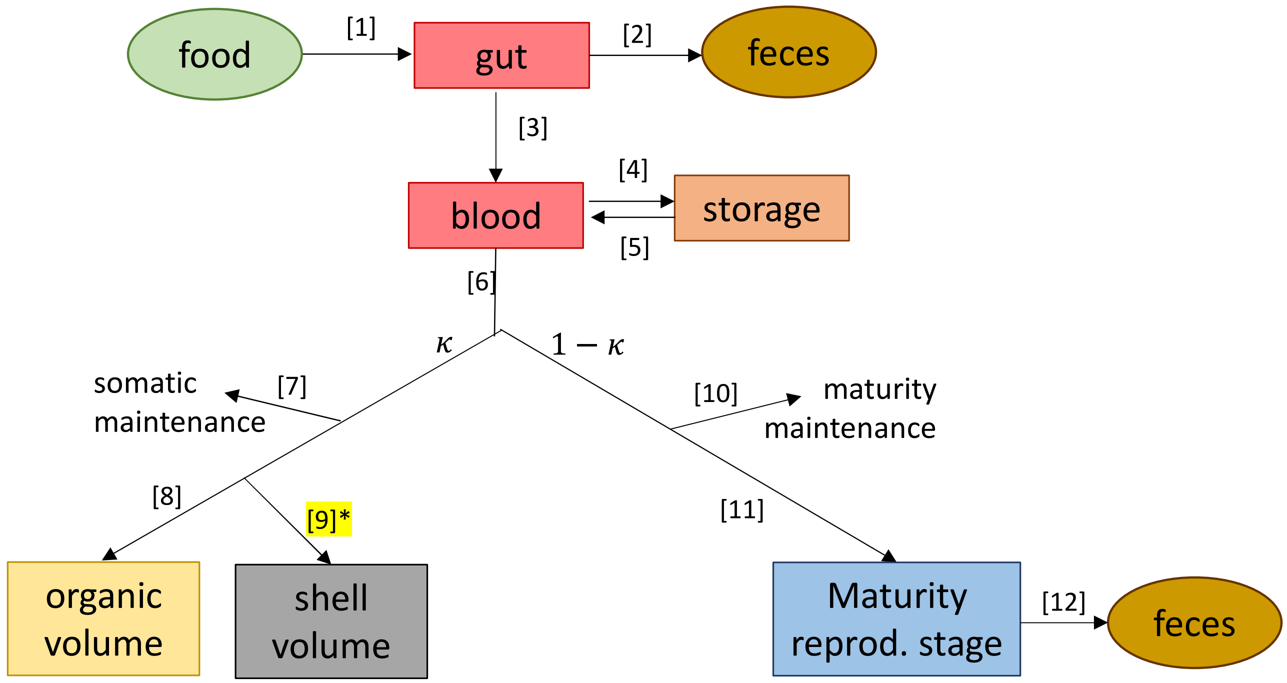
EDITOModelLab

WiS3: including biocalcification DEB representation of shellfish

In 2023 calcification (Stechele & Lavaud, 2024) is added as a process [9] to representation of shellfish in the DEB-model, integrated in Delft3D-FM-WAQ



Álvarez-Salgado et al. 2022



Adjusted scheme, based on figure 2.1 from: Troost et al., 2010

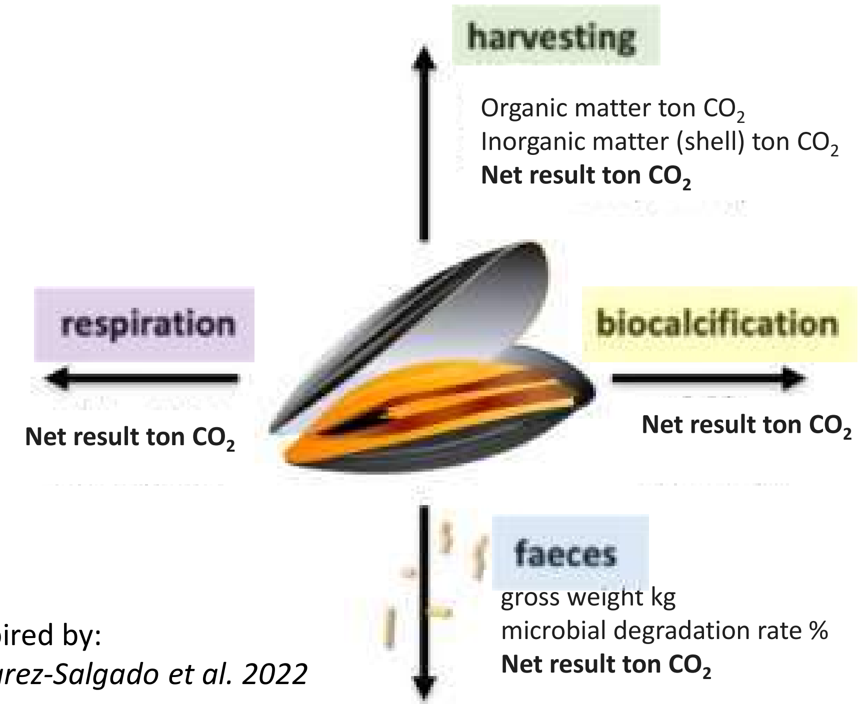
General structure of a DEB model with [1] ingestion, [2] defecation, [3] assimilation, [4 & 5] reserve/storage dynamics, [6] utilization, [7] maintenance, [8] organic growth, [9] shell growth or calcification, [10] maturation, [11] reproduction, and [12] spawning.

EDITOModelLab

WiS3: Impact of upscaling shellfish cultivation on carbon cycle

Work for 2024:

- Parametrization of DEB-model extension
- **Running** carbon-cycle **impact scenarios** with hydrodynamic simulation of North Sea and DEB extension
- Creating impact visualisation, like hereunder
- Integrating on EDITO platform



Inspired by:
Álvarez-Salgado et al. 2022

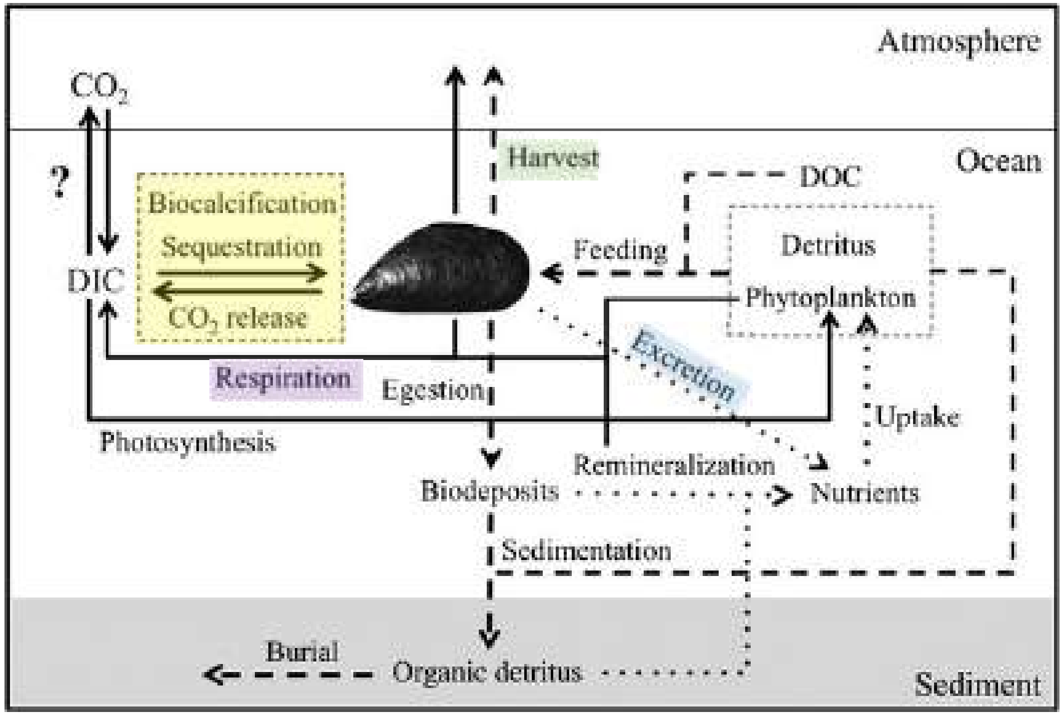
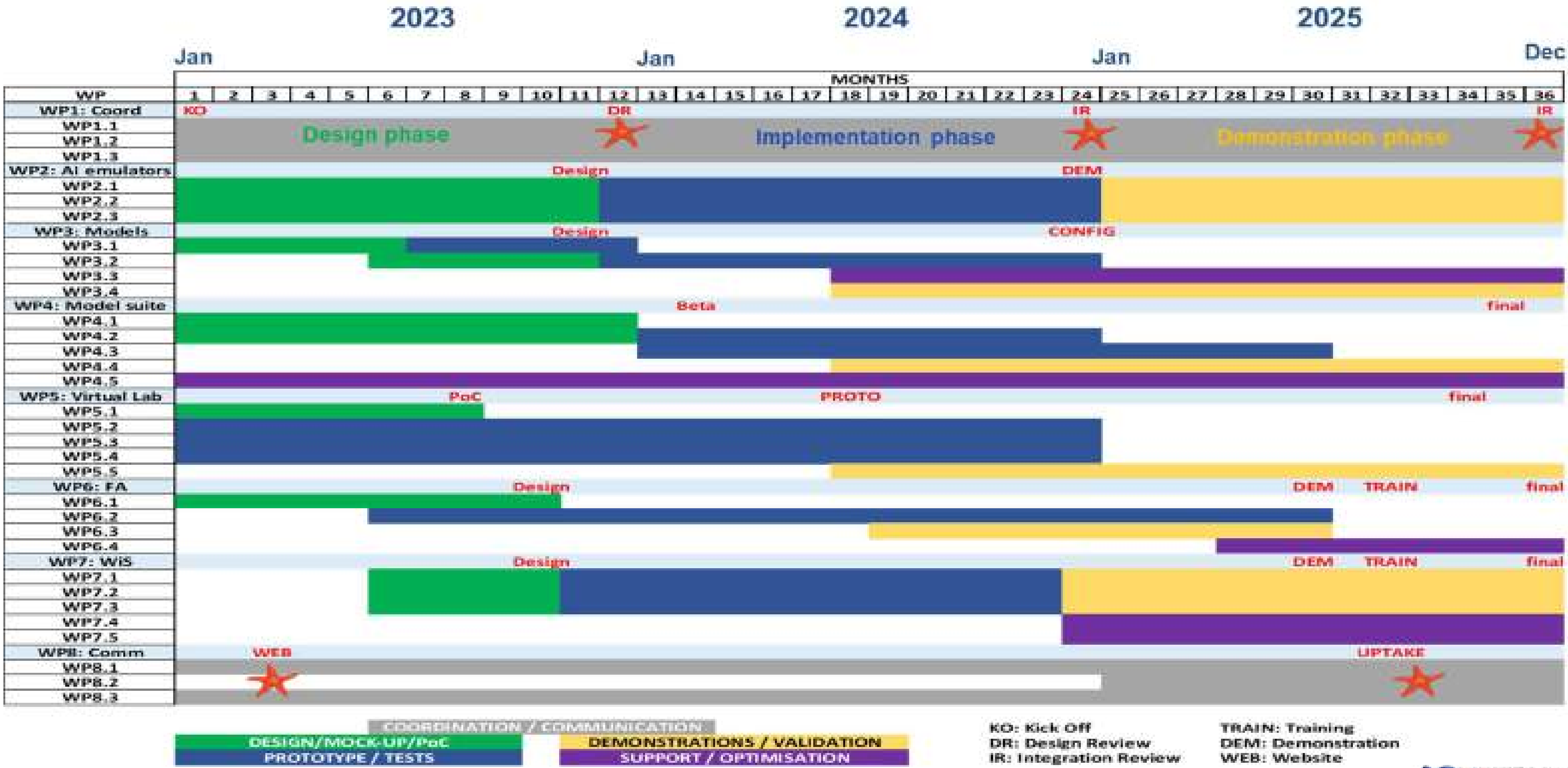


Figure source: Filgueira et al., 2015: figure 2

EDITOModelLab

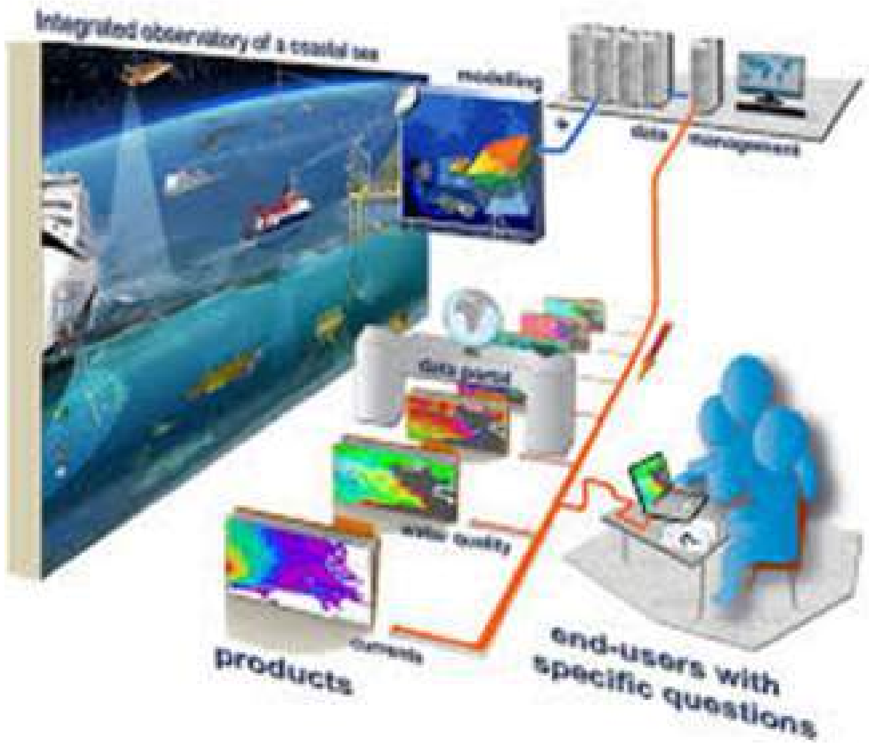
Milestones



EDITOModelLab

Task 7.4 Training end-users and stakeholders (Lead: SOCIB | Partners: MOi, CMCC, Deltares, UniBO, DMI, Hereon, +ATLANTIC)

Training tools will be developed to support the end users hands-on training session
The material will ensure **that users can create sessions** of work to develop their own what-if scenarios and simulations based on the DTO infrastructure.



The training:

1) a plenary presentation introducing the system and tools;
2) a hands-on practical session during which the trainees will be able to implement and run what-if scenarios,
3) a debriefing session to discuss achievements and potential difficulties.

Task 7.5 Fit for the purpose of scientific validation and assessment of what-if scenarios (Lead: MOi | Partners: CMCC, Deltares, UniBO, DMI, Hereon, SOCIB).

- Develop **fit-for-purpose solutions** in the frame of the Mission as well as with projects funded under the Green Deal call
  - *discussion and connections with ILIAD, ULTFARMS started*

- **Evaluate fitness-for-purpose**, and **perform quality assessment** and user validations.
  - *will be coordinated with other validation tasks in WP3, WP4*

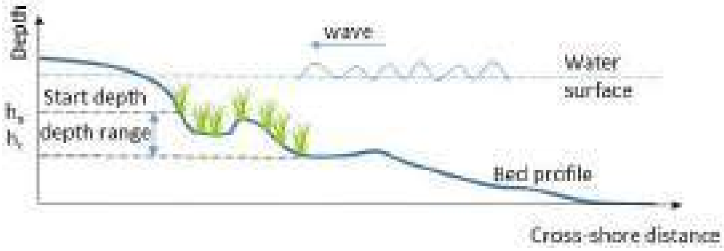
- Support and facilitate **synergies between the Mission's lighthouses** and the European DTO developments ensure appropriate communication
  - *link with communication activities especially T8.3*

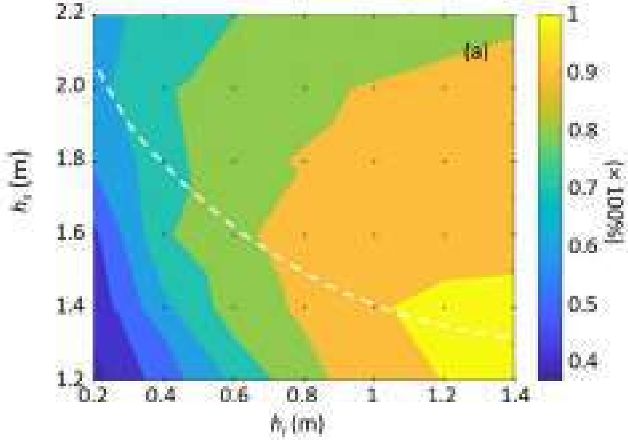
EDITOModelLab

For each WIF technical information is provided, here example for WIF1 - Different meadow sizes and locations

Task	Computing	Container	Input Size	Output Size	Typical
Data - Access	Cloud				1 CPU
Data - Download	Cloud			CMEMS hydrodynamics ≈ **180 GB**	1 CPU
Pre Processing -	HPC		**~180 GB 1**	**< 1 GB**	1 CPU
Pre Processing Physical bou	HPC		**same input as above**	**< 2 GB** (1 year, Sponge layer)	1CPU
Pre Processing -	Cloud		**1GB**	**1GB**	1 CPU
Pre Processing - Grid +			**1GB**	**150 MB**	1 CPU
(Pre-)Processing -	HPC				168 CPU
Processing -	HPC	None	**<2 GB**	**25 GB per day / ~ 9 TB per year**	1280 CPU
SCHISM-ECOSMO @SNS	HPC	None	**<10 GB**	5 GB /day, 2 TB/year	360 CPU
Post Processing -	Cloud or HPC	Docker or	**125 GB**	temporarly 25 GB per day / ~ 9	<1-12 CPU
Post Processing -	Cloud	Docker or	**4 - 30 GB**	**3 - 36 GB**	1 CPU

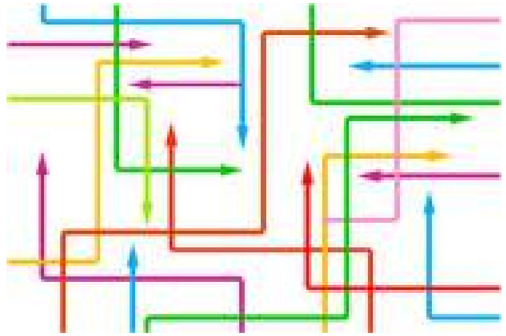
Reduced erosion volume





Technical Online meeting for WIS1

Meeting with WP3-5 and EDITO Infra to

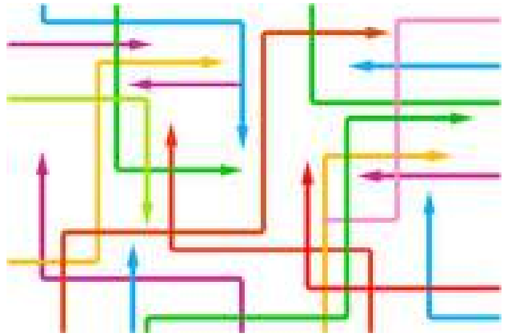


- Demonstrated the level of readiness of WIS applications
- Show the data workflow
- Discuss technical demands
- Discuss visualization strategy
- **Integrate** WIS1 data and model system in the EDITO infrastructure

hereon EDITOModelLab

Technical Online meeting for WIS – Future actions

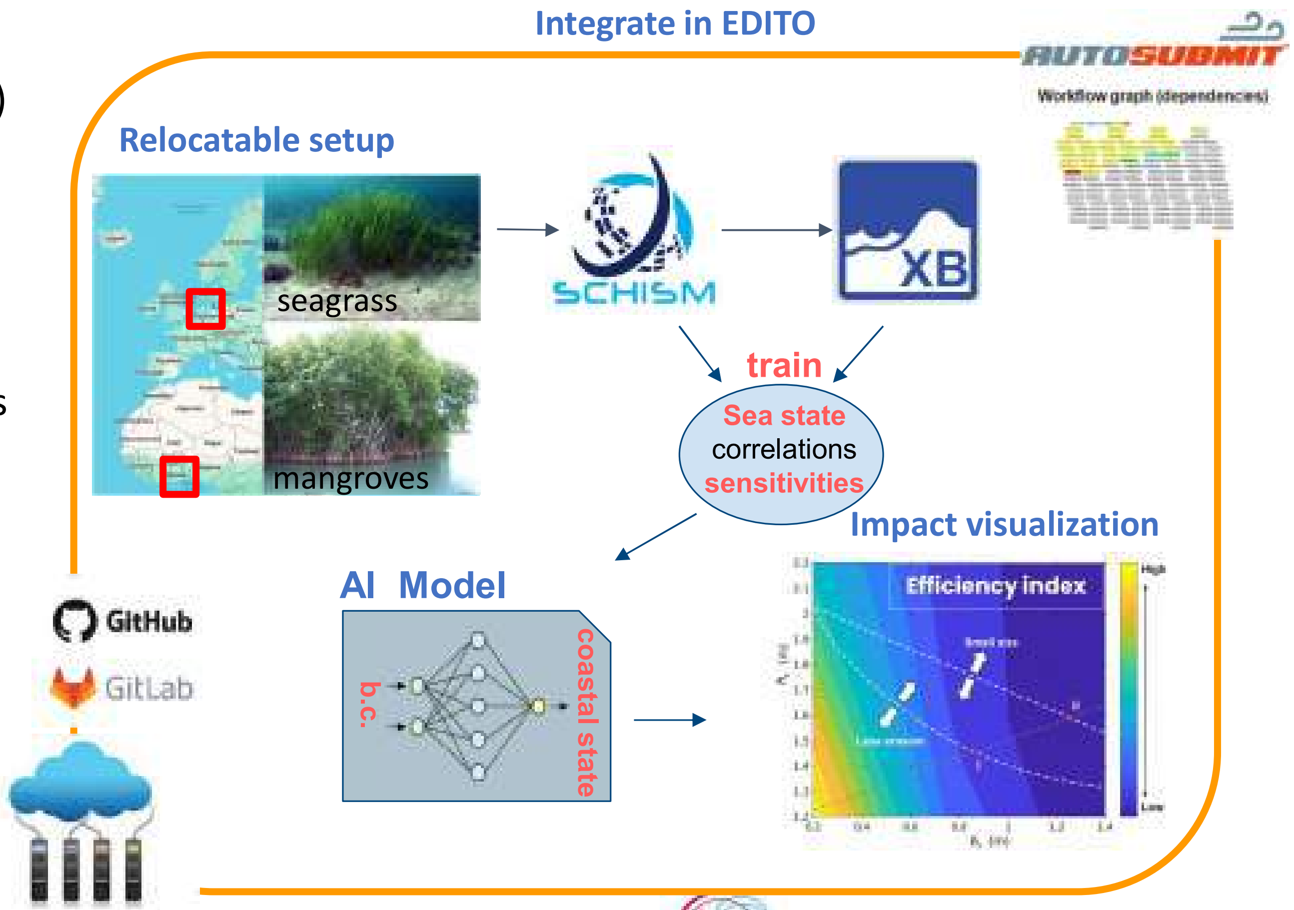
- Define specific questions for the users for the WIS
- Expand / update technical table of requirements as an entry to the platform
- Update information about Input/Output
- Requests for native HPC installation
- Common repository (e.g. Wiki, Confluence) for integration on HPC (idea: dedicated GitHub for the project)
- Bi-lateral meetings to organize technical specifies
- Preparing VIDEO (WP8)



hereon EDITOModelLab

Workplan 2024

- Enable **relocatable** Setups on EDITO platform
  - with configurable NBS (seagrass, mangroves)
- **AI** developments as part of the modelling system
  - to enable faster simulations
- Impact **visualizations**
  - user can browse different metrics of benefits from NBS
- **Integrate** model system in the EDITO infrastructure
  - containerized setups
  - autosubmission



hereon EDITOModelLab

Example 1

The Digital Twin Ocean to assess coastal **Nature Based Solutions** capable of protecting the coasts against storm surge and coastal erosion

Deliverables

Deliverables: D7.1 (Demonstration including handbook). **Contribution to D1.2** (Design of the What-if Scenarios including stakeholders' contribution) **and D8.3** (Outcomes for the What-if Scenarios)

D7.1	What-if Scenarios demonstrations	WP7	8 - HEREON	DEM — Demonstrator, pilot, prototype	PU - Public	24

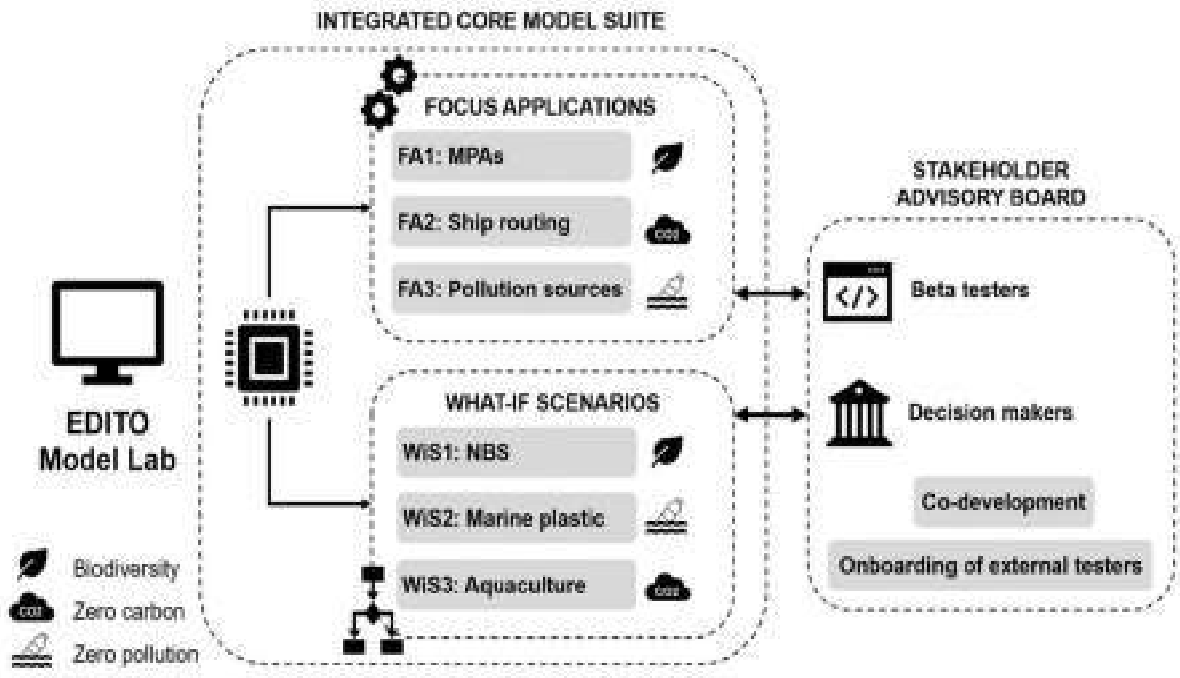
Demonstrations of the usage and outcomes of the DTO engine with 3 WIS:

(i) Nature Based Solutions for Biodiversity and coastal hazards,
(ii) Marine plastic for Zero pollution, and
(iii) Aquaculture for Zero carbon.

- The WIS demonstrations will support the Ocean Mission Ocean Lighthouses by running test cases in the global ocean and the European Seas (lighthouses)
- The application of the modelling suit and its quality assessment will documented in handbooks (e.g. Wiki, Confluence) to support the training of end-users and the usability of the DTO methodology on WIS , in line with the Mission priorities

EDITOModelLab

Questions?



EDITOModelLab

European Digital Twin Ocean

EDITO ModelLab

VISIR-2 for zero-carbon shipping in a Docker container

16 January 2024 – Lecce & online

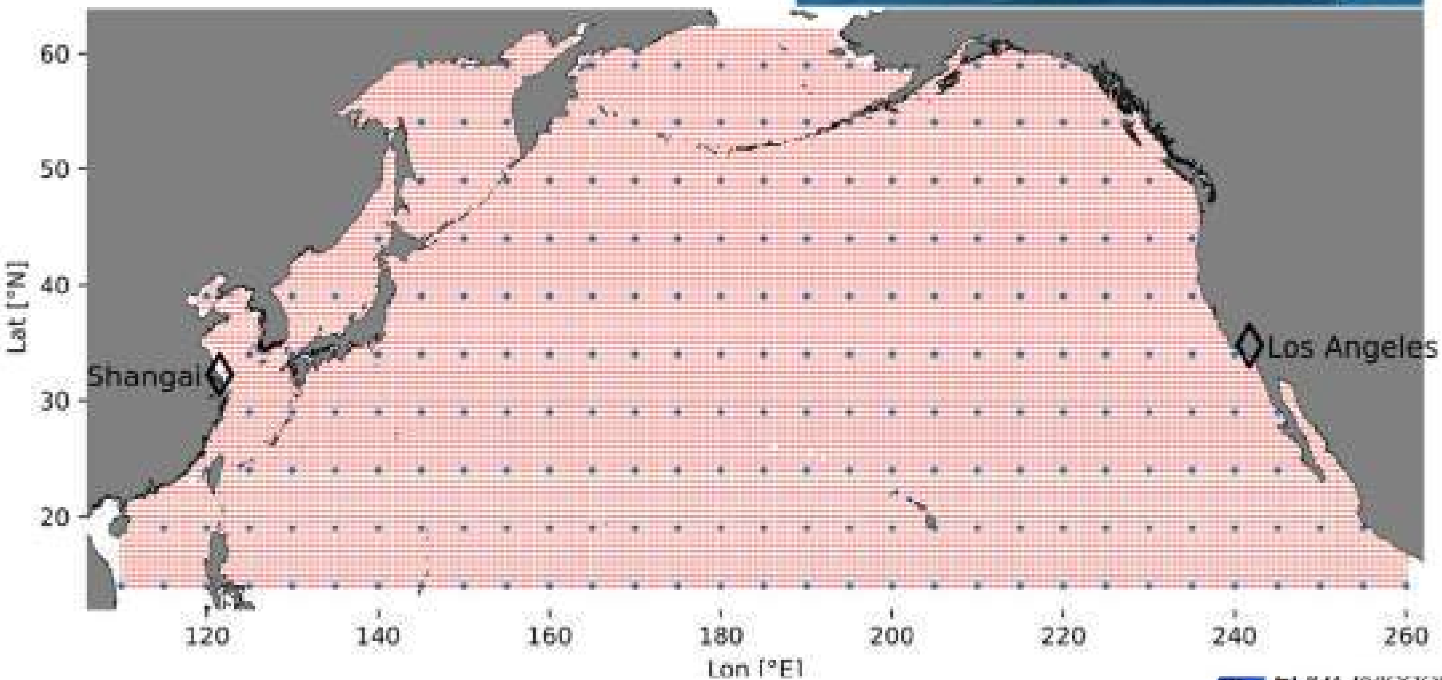
Gianandrea Mannarini, Mario Leonardo Salinas, Amal Salhi, Ivan Federico

cmcc
Centro Euro-Mediterraneo sui Cambiamenti Climatici

MERCATOR OCEAN INTERNATIONAL

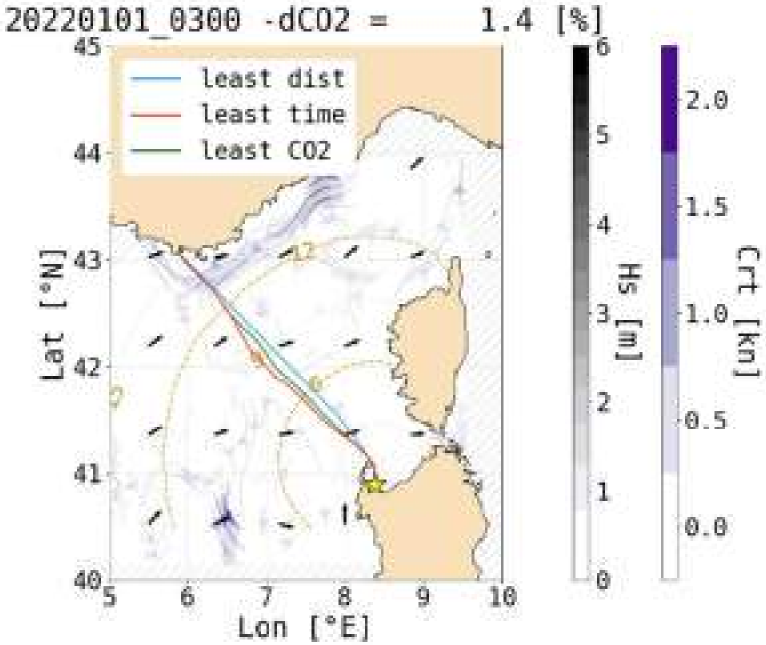
VISIR-2 planned deployment in the Pacific

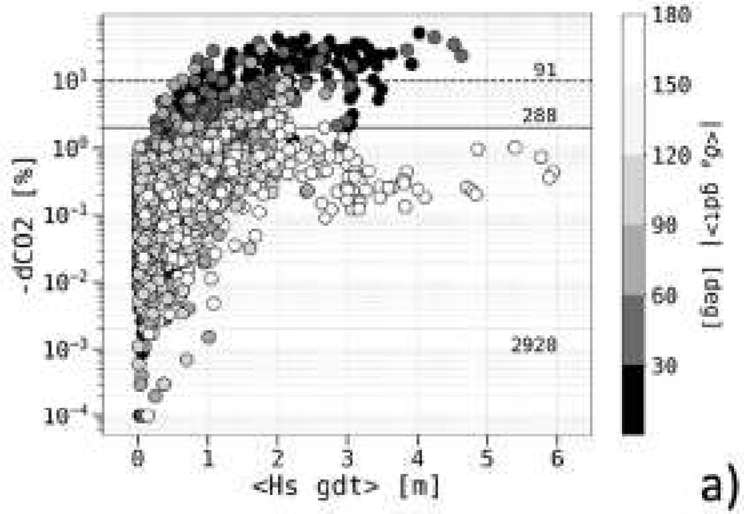
- Shanghai - Los Angeles green corridor of shipping
- preliminary assessment of VISIR-2 computational cost
- graph of the North Pacific with ~ (½)° horizontal resolution
- two products/ service levels:
  [**freemium**] precomputed routes with departures on a coarser grid (5°)
  [**premium**] on-demand routes, with any departure location (nearest to the ½ grid)



VISIR-2: published case study

cmcc
Centro Euro-Mediterraneo sui Cambiamenti Climatici





VISIR-2 open-source ship routing model (preprint under evaluation):

- spatial diversions to: avoid upwind sailing and exploit currents
- two-digit CO_2 percentage savings possible

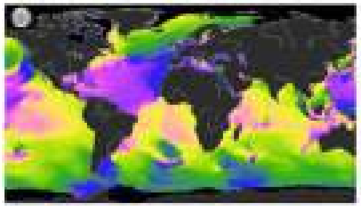
PREPRINT:
https://egusphere.copernicus.org/preprints/2023/egusphere-2023-2060/

EDITOModelLab

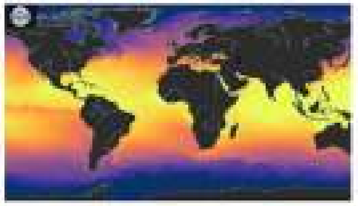
VISIR-2 for EDITO-ML: input wave fields

cmcc Centro Euro-Mediterraneo sui Cambiamenti Climatici

①



Global Ocean Waves Analysis and Forecast



Global Ocean Physics Analysis and Forecast

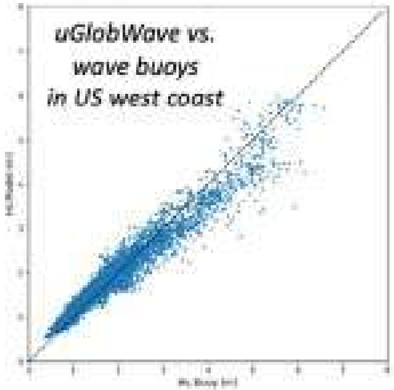
CMEMS waves and currents

- (1/12)° grid
- based on MFWAM model
- daily analyses since 2021
- 10 days forecasts
- 3-hourly resolution

https://data.marine.copernicus.eu/product/GLOBAL_ANALYSISFORECAST_WAV_001_027/description

Copernicus Europe's eyes on Earth — Copernicus Marine Service

②



uGlobWave

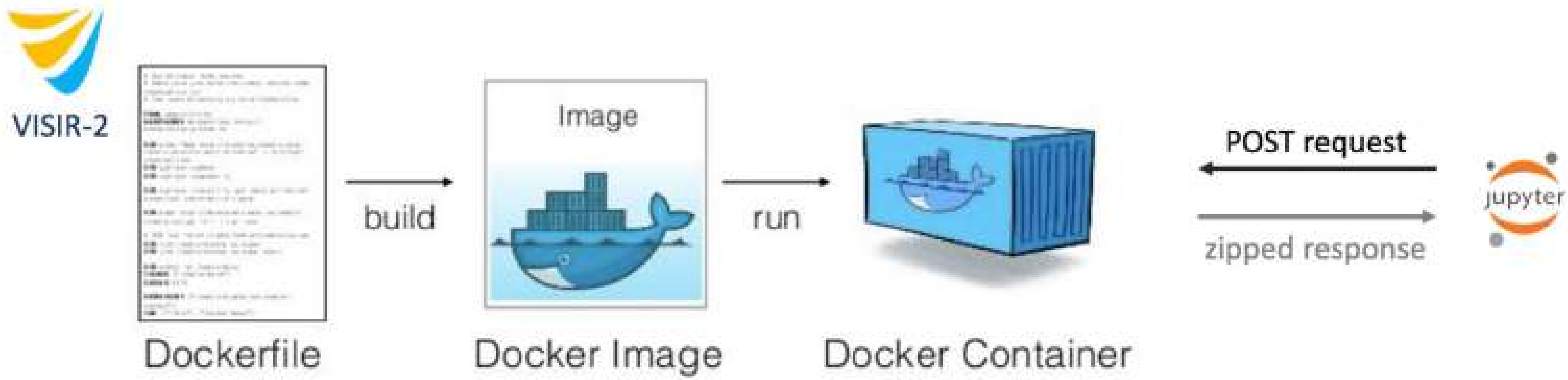
- (1/2)° grid from Mentaschi_2023
- based on WW3 model
- we already have one full year (2020)
- hindcast will be extended for a longer period (an EDITO-ML WP3 output)

Mentaschi et al., 2023 DOI: 10.3389/fmars.2023.1233679

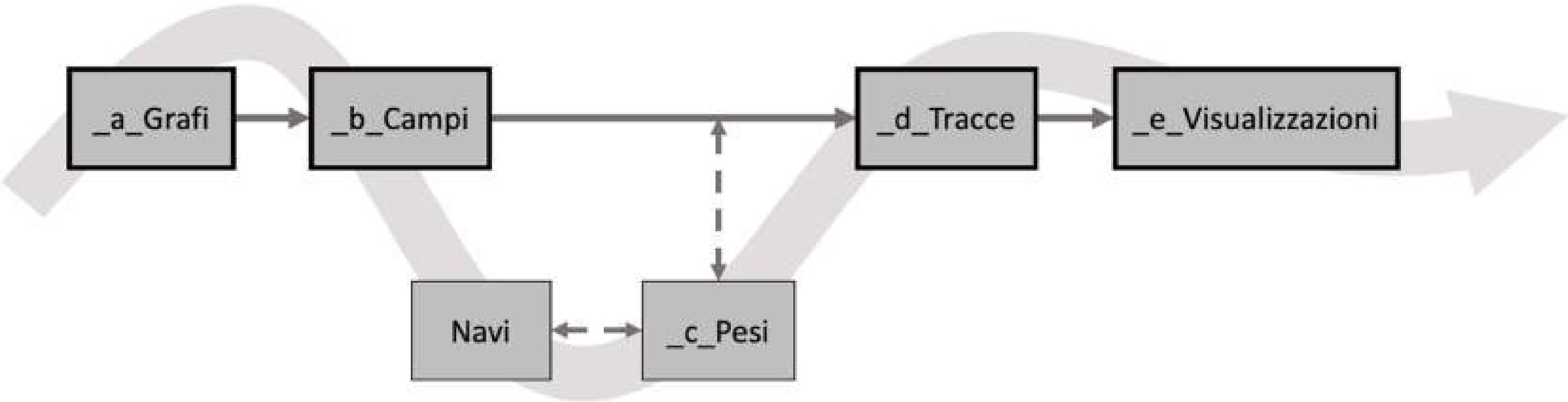
frontiers | Frontiers in Marine Science

EDITOModelLab

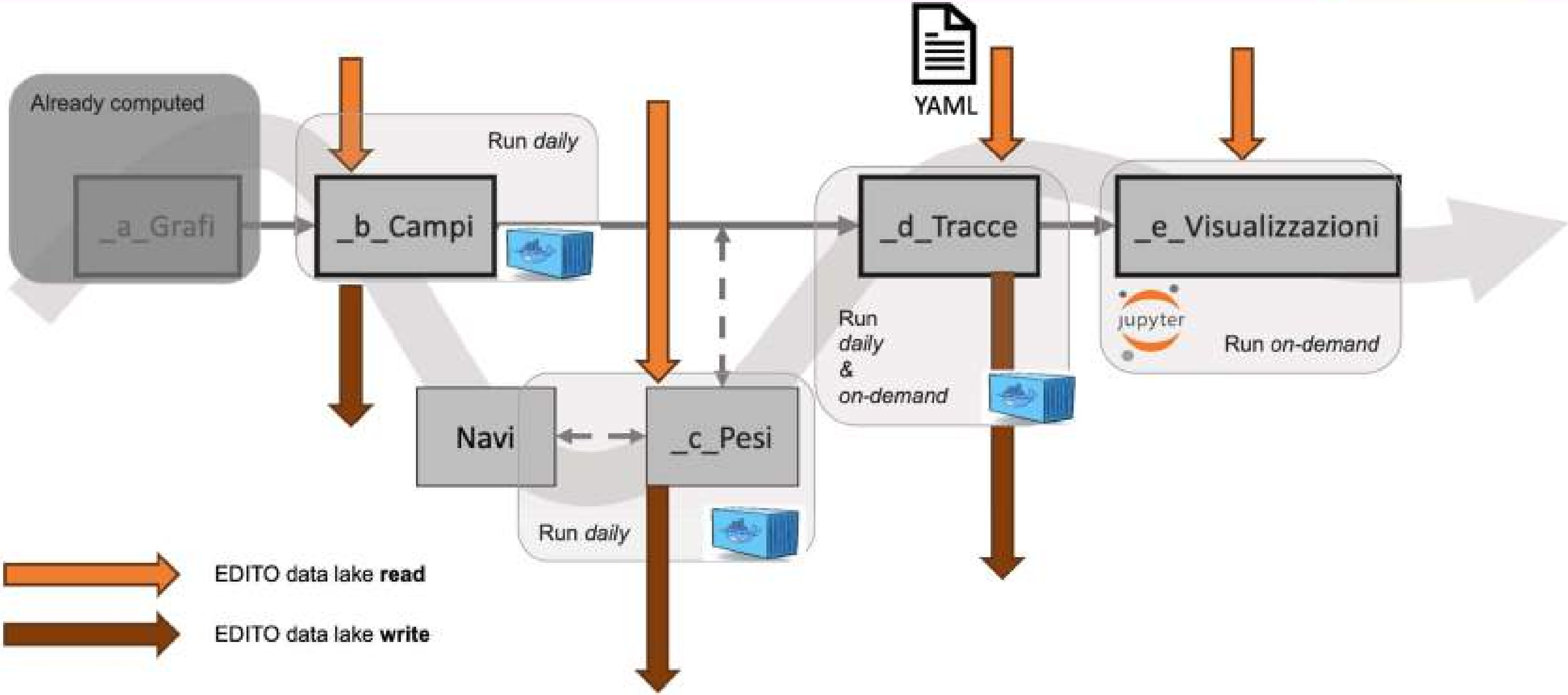
VISIR-2 for EDITO-ML: dockerization



VISIR-2 for EDITO-ML: workflow



VISIR-2 for EDITO-ML: workflow



EDITOModelLab

Own web application as an EDITO service

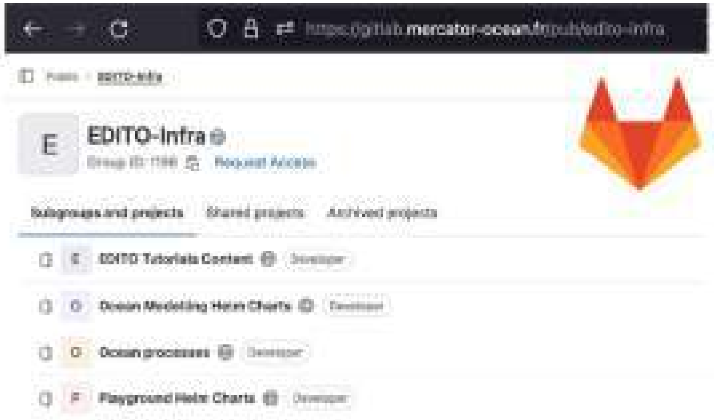
cmcc Centro Euro-Mediterraneo sui Cambiamenti Climatici

- Publish VISIR-2 Tracce image online

- Create helm chart (--> orchestrator) from EDITO template

HELM

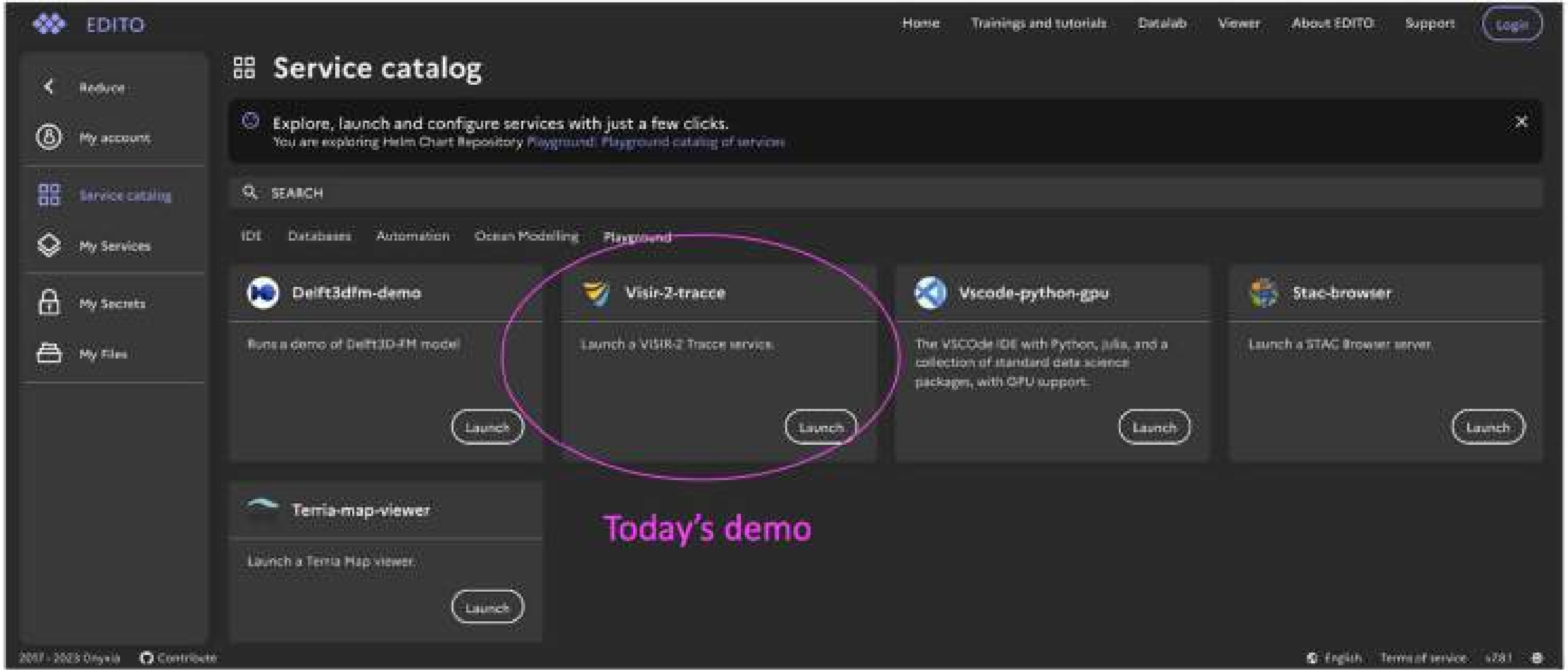
- Send *merge request* to one of the EDITO git repositories (Playground, Ocean Modelling)



Tutorial: https://gitlab.mercator-ocean.fr/pub/edito-infra/edito-tutorials-content//blob/master/articles/HelmCharts/BasicWebApplication.md

EDITOModelLab

EDITO-ML Service Catalog



VISIR-2 for EDITO-ML: Further steps & questions

cmcc
Centro Euro-Mediterraneo sui Cambiamenti Climatici

DONE:

Developed HTTP interface for VISIR-2

VISIR-2 Tracce containerized

VISIR-2 Tracce deployed on EDITO-ML Datalab

Jan 2024 — Dec 2024

TODO:

Consolidate VISIR-2 Tracce service (process+notebook)

Integrate all VISIR-2 modules in EDITO-ML

Production of VISIR-2 routes (from operational data feeds)

EDITOModelLab

Discussion

- Discussion (10’)

BACK TOMORROW

9:30 *start*


dakujem
Hvala vam
tack
obrigado
mulţumesc
gracias
Ačiū
Grazzi
Dziękuję Ci
grazie
Paldies
Danke
Děkuju
Hvala vam
thank
dank je
Благодаря ти
you
aitäh
tak skal du have
σας ευχαριστώ
Kiitos
Merci
köszönöm
go raibh maith agat