OceanPredict
Advancing the science of ocean prediction

“MEAP in the UN Decade (and more)“

Co-chairs: Marjorie Friedrichs (VIMS, USA), Stefano Ciavatta (PML/NCEO, UK)

Agenda

12.00 - Welcome and objectives of the meeting

12.10 - ForeSea (**Eric Chassignet**, co-chair of the UN Decade Programme)

12.20 - SynObs (**Yosuke Fujii**, co-chair of the UN Decade Project)

12.30 - Marine life 2030 (**Frank Muller-Karger**, co-chair of the UN Decade Programme)

12.40 - Questions on UN Ocean Decade Programmes

12.50 - Flash-presentations by members (3 minutes each)

13.20 – Break

13.30 - Flash-presentations by members (3 minutes each) and Q&A

13.40 - "Assimilating remote sensing reflectance's into the Great Barrier Reef BGC model" by Emlyn Jones, CSIRO

14.00 - Discussion

14.30 - Closure

Objectives:

- 1. To share recent science highlights
- 2. To plan MEAP-TT engagement with the UN Decade Programmes and Projects
- 3. To plan other future activities

MEAP Terms of reference

Mission: Advancing the underpinning science and tools for integration of biogeochemical and ecosystem models into operational systems.

A broad definition of **operational** products that includes:

- Climate projections
- Hindcasts/reanalyses
- Short-term & seasonal forecasts
- Scenarios

See rationale in our OceanObs WP at: https://doi.org/10.3389/fmars.2019.00089

Major scientific and societal applications:

1) Carbon cycle research, carbon accounting

- Quantification of carbon uptake
- National carbon accounting
- Sensitivity of carbon fluxes to climate forcing, shifting baselines
- Climate projections

2) Marine productivity/ecosystems

- Fisheries management
- Conservation of endangered species
- Design of MPAs
- Future projections for ecosystems
- Marine health indicators (eutrophication, acidification, deoxygenation)

Active science/outreach collaborations within the MEAP-TT:

OceanPredict
Advancing the science of ocean prediction

Coordinator and seven investigators of MEAP-TT

SEAMLESS

PML Plymouth Marine Laboratory

OGS

NERSC

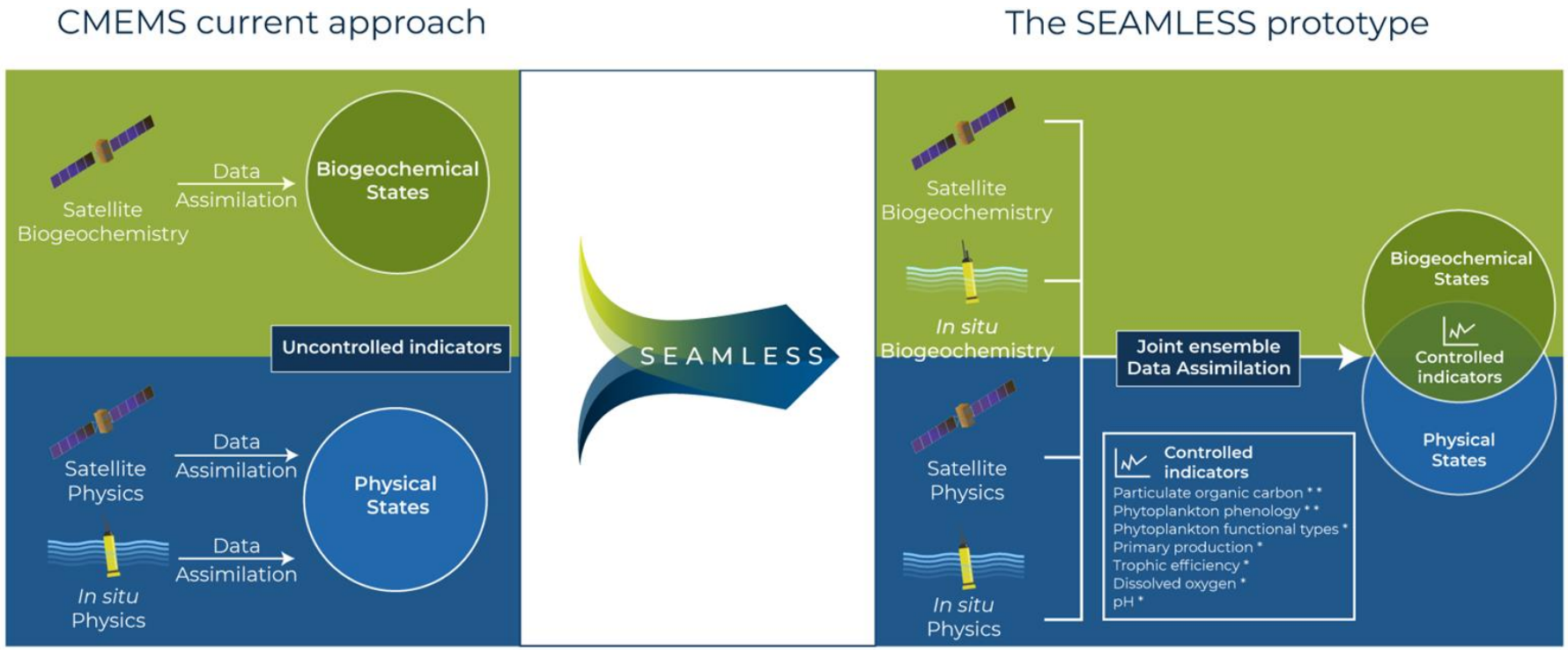
UGA Université Grenoble Alpes

cnrs

AWI

Bolding & Bruggeman

Programme: SPACE – Copernicus Evolution
Period: 2021-2023
Budget: €1.5M



ETOOFS Guide on “Operational Oceanography and Forecasting Systems"

- promote the development of new ocean forecasting systems around the globe
- promote best practices and standards, and give key points of contact

- Coordinated by ETOOFS
- Expected by GOOS and UN Ocean Decade
- Labelled IOC-WMO

- A booklet (https://www.mercator-ocean.fr/en/oofs-guide/)
- Online workshops (June 2021)
- A guide (published in 2022)

ETOOFS Booklet

ETOOFS workshops

ETOOFS Guide

Indroductory chapters	1.	Introduction
	2.	The international context of ocean forecasting
	3.	Definition of ocean forecasting systems: temporal and spatial scales solved by marine modeling systems
Main overview chapter	1.	Architecture of ocean monitoring and forecasting systems
Detailed description chapters	1.	Circulation modeling
	2.	Sea Ice modelling
	3.	Sea level modeling
	4.	Wave modeling
	5.	Biogeochemical modelling
Way foreward chapters	1.	Coupled Prediction: Integrating Atmosphere-Wave-Ocean forecasting
	2.	Downstream applications: From data to products
	3.	Challenges and future perspectives in ocean prediction

ETOOFS Guide on "Operational Oceanography and Forecasting Systems"

CHAPTER 9

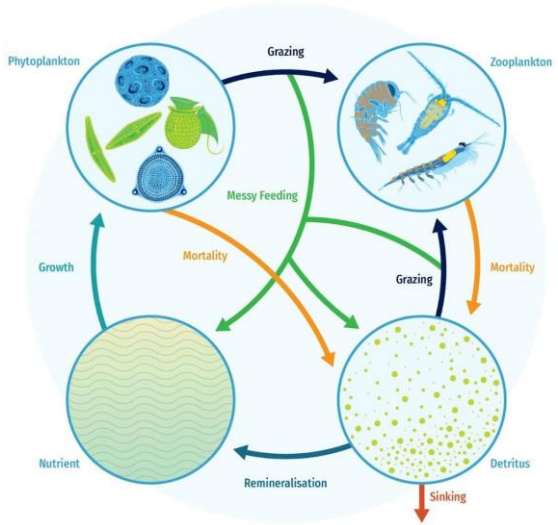
Biogeochemical modelling

E. Gutknecht, L. Bertino, P. Brasseur, S. Ciavatta, G. Cossarini, K. Fennel, D. Ford, M. Gregoire, D. Lavoie, P. Lehodey

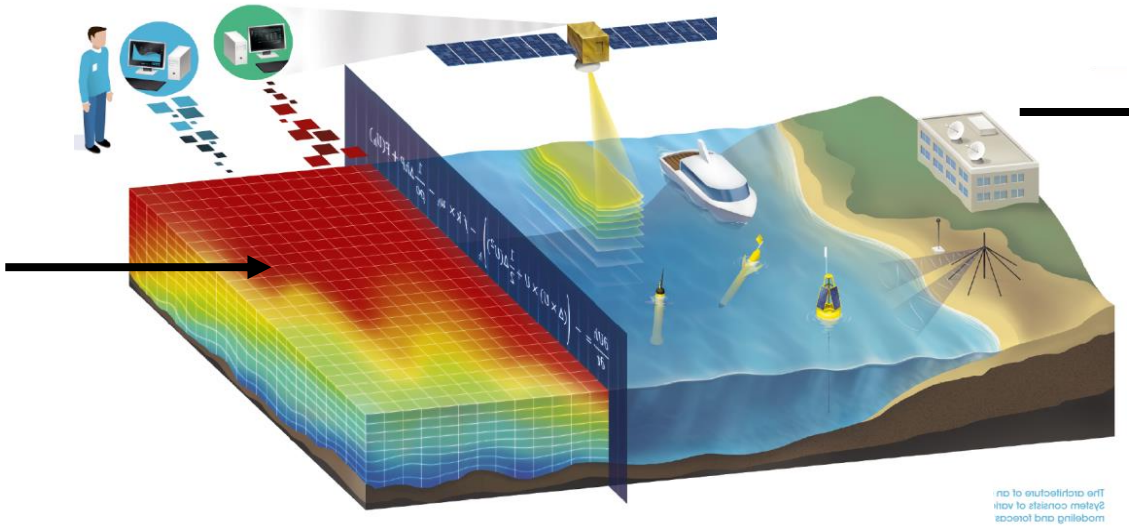
- overview of the state-of-the-art systems
- describe the different components: observations, BGC models, ensemble, assim, validation, end user products.
- Introduce HTL modelling
- inventory of existing operational systems

inventory of BGC Global (G) to Regional (R) to Coastal (C) operational forecasting systems.

Type	Continent	System	Covered Area	Resolution	PHY-BGC models	BGC Data Assimilation (method and data)	Products	Website
G	Europe	Global Ocean BGC system (MOI, France)	Global ocean	1/4°	PISCES coupled offline with NEMO (1/12° degraded to 1/4°) at daily frequency	SEEK method, using total Chla from OC satellite data	Chla, NO3, PO4, Si, Fe, O2, PHYC, NPP, spCO2, pH, 10-days forecast, updated weekly	https://marine.copernicus.eu
R	Europe	Northwest European Shelf Seas BGC system (UK Metoffice, UK)	European North-West shelf Seas	~7 km	ERSEM coupled online with NEMO	3D-Var NEMOVAR method, using total Chla from OC satellite data	Chla, NO3, PO4, O2, PHYC, NPP, spCO2, pH, Kd, 6-day forecast, updated daily	https://marine.copernicus.eu
R	Europe	TOPAZ5-ECOSMO Arctic Ocean system (Norwegian Meteorological Institute, Norway; Nansen Environmental and Remote Sensing Center, Norway)	Arctic Region	6 km	ECOSMO biological model coupled online to the HYCOM ocean physical model	assimilates Chla from OC satellite data using a nudging approach, and surface observations are projected downward in the water column applying an algorithm described by Uitz et al. (2006).	Chla, NO3, PO4, Si, O2, PHYC, ZOOC, NPP, spCO2, DIC, pH, Kd, 10-day forecast, updated daily	https://marine.copernicus.eu
R	Europe	Baltic Sea system (Swedish Meteorological and Hydrological Institute, Sweden)	Baltic Sea	1 nautical mile	ERGOM coupled online with NEMO	–	Chla, NO3, PO4, NH4, O2, spCO2, pH, NPP, ZSD, 6-day forecast, updated twice daily	https://marine.copernicus.eu
R	Europe	Iberia-Biscay-Irish system (MOI, France + consortium)	Iberian-Biscay-Irish shelves	1/36°	NEMO-PISCES online coupled model; nested into GLO-MFC PHY and BGC solutions	No assimilation	Chla, NO3, NH4, PO4, Si, Fe, O2, PHYC, NPP, spCO2, DIC, pH, ZEU, 10-days forecast updated on a weekly basis	https://marine.copernicus.eu
R	Europe	MedBFM3 model system (Euro Mediterranean Center on Climate Change - CMCC, Italy; OGS, Italy)	Mediterranean Sea	1/24°	BFM v5 model, off-line coupled with NEMO	3DVAR-BIO method, using Chla from satellite and vertical profiles of Chla and nitrate from BGC-Argo	Chla, PHYC, ZOOC, NO3, NH4, PO4, Si, O2, spCO2, pH, fCO2, ALK, DIC, NPP, 10-day forecast updated daily	https://marine.copernicus.eu
R	Europe	Black Sea system (University of Liege, Belgium)	Black Sea	~3km	BAMHBI, online coupled with NEMO	"Ocean Assimilation Kit" (OAK; Vandenbulcke and Barth, 2015) for assimilation of surface Chla from satellite	Chla, PHYC, NO3, PO4, Si, NH4, O2, spCO2, pH, fCO2, ALK, DIC, NPP, Kd, PAR, 10-day forecast produced daily	https://marine.copernicus.eu
C	North America	J-SCOPE forecast system (JISAO's Seasonal Coastal Ocean Prediction of the Ecosystem, funded by NOAA, US)	California Current System	1/10°	ROMS ocean model coupled with a BGC model	–	seasonal forecasts of sea surface temperature (SST) and BGC variables	http://www.nanoos.org/products/j-scope/home.php
C	North America	Harmful Algal Bloom Monitoring System (National Centers for Coastal Ocean Science, formed by the NOAA, US)	Coastal and lake regions of the US	–	–	–	Daily forecast	https://coastalscience.noaa.gov/research/stressor-impacts-mitigation/hab-monitoring-system/
C	Australia	Great Barrier Reef (Bureau of Meteorology et al.)	Great Barrier Reef	–	CSIRO eReefs modeling suite	–	a few days forecast	https://ereefs.org.au/ereefs
C	North America	Chesapeake Bay	Chesapeake Bay	600m	ChesROMS-ECB	-	nowcasts and a few days forecasts of physical and BGC variables (focusing on O2, acidification metrics, T, S)	www.vims.edu/hypoxia; https://oceansmap.maracoos.org/chesapeake-bay/



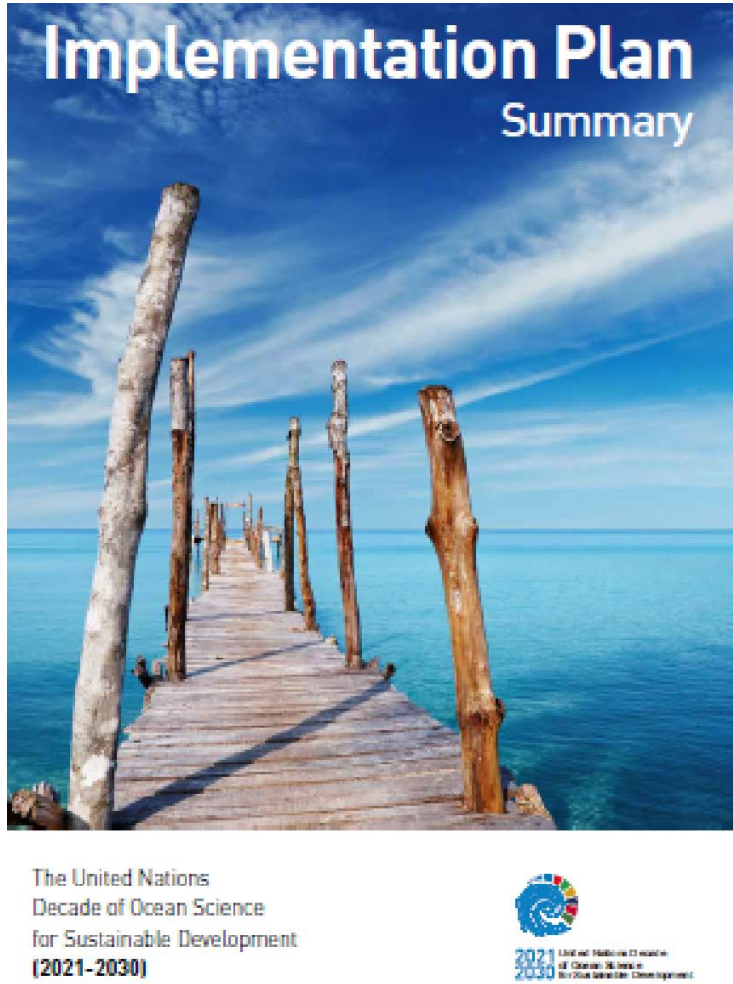
Biogeochemical model



2021 2030 United Nations Decade of Ocean Science for Sustainable Development

The UN Ocean Decade

In 2017, the United Nations General Assembly proclaimed the United Nations Decade of Ocean Science for Sustainable Development (2021-2030) ('the Ocean Decade').



The vision of the Ocean Decade is **'the science we need for the ocean we want'**.

The mission of the Ocean Decade is **'to catalyse transformative ocean science solutions for sustainable development, connecting people and our ocean'**.

Website: https://www.oceandecade.org/

Implementation plan: https://www.oceandecade.org/wp-content/uploads/2021/09/337521-Ocean%20Decade%20Implementation%20Plan:%20Summary

Moving from the ocean we have to the ocean we want

MEAP can contribute significantly !

Decade Actions

Decade Actions include **programmes and projects,** as well as **activities** and/or **contributions:**

• A **Decade programme** is typically global or regional in scale and will contribute to the achievement of one or more of the Ocean Decade Challenges. It is long-term, multi-year, interdisciplinary and multinational. A programme will consist of component projects and potentially enabling activities.

• A **Decade project** is a discrete and focused undertaking. It may be regional, national or subnational and it will typically contribute to an identified Decade programme.

Other relevant programmes:

CoastPredict, Digital Twins of the Ocean (DITTO), Ocean Observing Co-Design (ObsCoDe),Ocean Practices for the Decade

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1. Coralie/Elodie/Julien (MOi, FR)
2. David (MetOffice, UK)
3. Kostas (HCMR, GR)
4. Emlyn (CSIRO, AU)
5. Liuqian Yu, HKUST(GZ)
6. Tsuyoshi (NERSC, NO)
7. Stefano (PML/NCEO, UK)
8. Hae-Cheol Kim et al. (UCAR at NOAA, USA)
9. Marjy (VIMS, USA)
10. Paul Mattern (UCSC, USA)

SCIENCE HIGHLIGHT

coralie.perruche@mercator-ocean.fr
elodie.gutknecht@mercator-ocean.fr
julien.lamouroux@mercator-ocean.fr

Mercator Ocean International (hereafter MOi) implements **the Copernicus Marine Service**

- Development of operational monitoring and forecasting systems, in global and European regional seas

- **Achievements**
  - Assimilation of total CHL (from satellite obs. of OC) in the global BGC operational system
  - Regional BGC system for Atlantic European waters nested in the global BGC system
  - Process-oriented metrics derived from BGC-Argo data to evaluate the operational and reanalysis systems

- **Work in progress**
  - Optimisation of BGC model parameters using BGC-Argo data + Particle filter (1D-config, toward 3D)
  - Assimilation of pCO2 (H2020 coCO2 – SOCAT/CMEMS)
  - Toward ensemble-based assimilation of BGC-Argo for reanalysis and NRT purposes

- **Future developments**
  - Optical model + assimilation of optical properties
  - 2-way coupled PHY-BGC
  - Joint-assimilation PHY-BGC

OUTREACH/IMPACT HIGHLIGHT

Copernicus Marine Service

- Provides free and open marine data and services to enable marine policy implementation, support Blue growth and scientific innovation
  https://marine.copernicus.eu/

ETOOFS Guide on Operational Ocean Monitoring and Forecasting Systems

- overview of the state-of-the-art operational systems
- promote best practices and standards
  https://www.mercator-ocean.eu/en/oofs-guide/

Ocean State Report

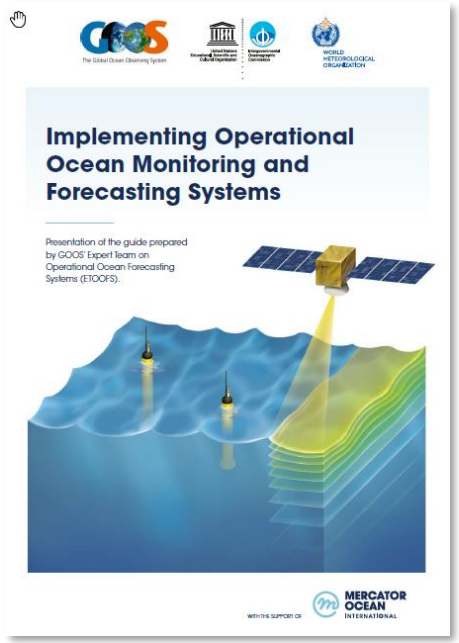
- provides a comprehensive and state-of-the art assessment of the state of the global ocean and European regional seas for the ocean scientific community as well as for policy and decision-makers.
  https://marine.copernicus.eu/access-data/ocean-state-report

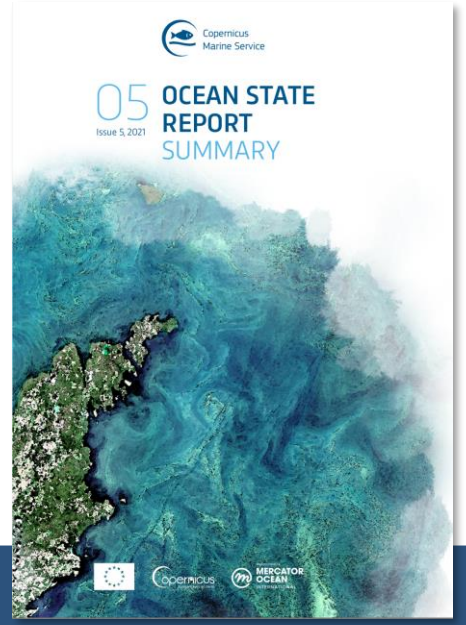
Ocean Monitoring Indicators

- free downloadable trends and data sets covering the past quarter of a century. These are key variables used to track the vital health signs of the ocean and changes in line with climate change
  https://marine.copernicus.eu/access-data/ocean-monitoring-indicators

H2020-coCO2 project + future Copernicus CO2 Monitoring Service

- European monitoring and verification support capacity for anthropogenic CO2 emissions.
  https://coco2-project.eu/





Example or idea of contribution to the UN Decade

Current contributions to programmes and projects of the UN Decade

MOi to be labelled as a **"Decade Collaborative Center for Ocean Prediction"**: support for ocean prediction collaborations strengthen the links between UN Decade programmes/projects such as Foresea/SynObs etc.

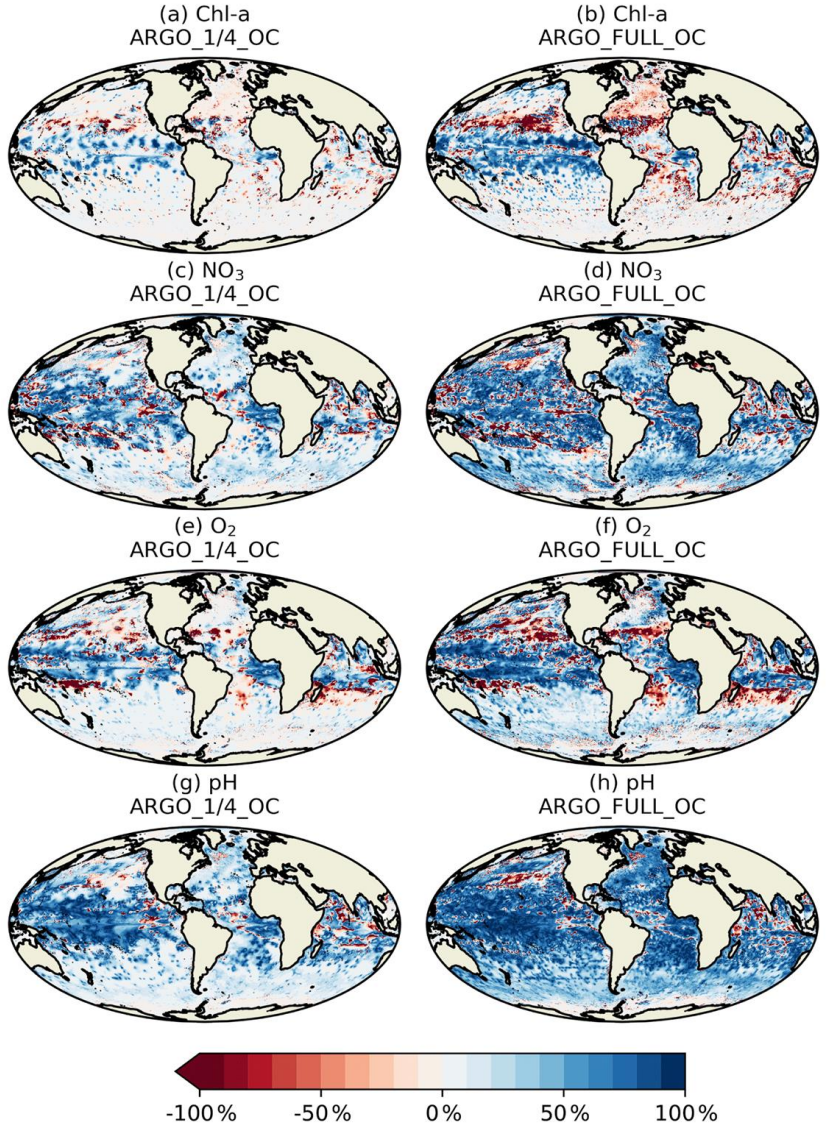
Contributions to SynObs project

- Observing systems evaluation = one of MOi's core activities (including BGCArgo, OC, Carbon)
- MOi contribution to OceanPredict OSEval-TT
- MOi/Copernicus Marine Service cross-cutting Working Group on BGC Data Assimilation (*BioDA-WG*): adequate place to share information – or foster exchanges – related to SynObs objectives/activities.

 fully aligned with SynObs objectives

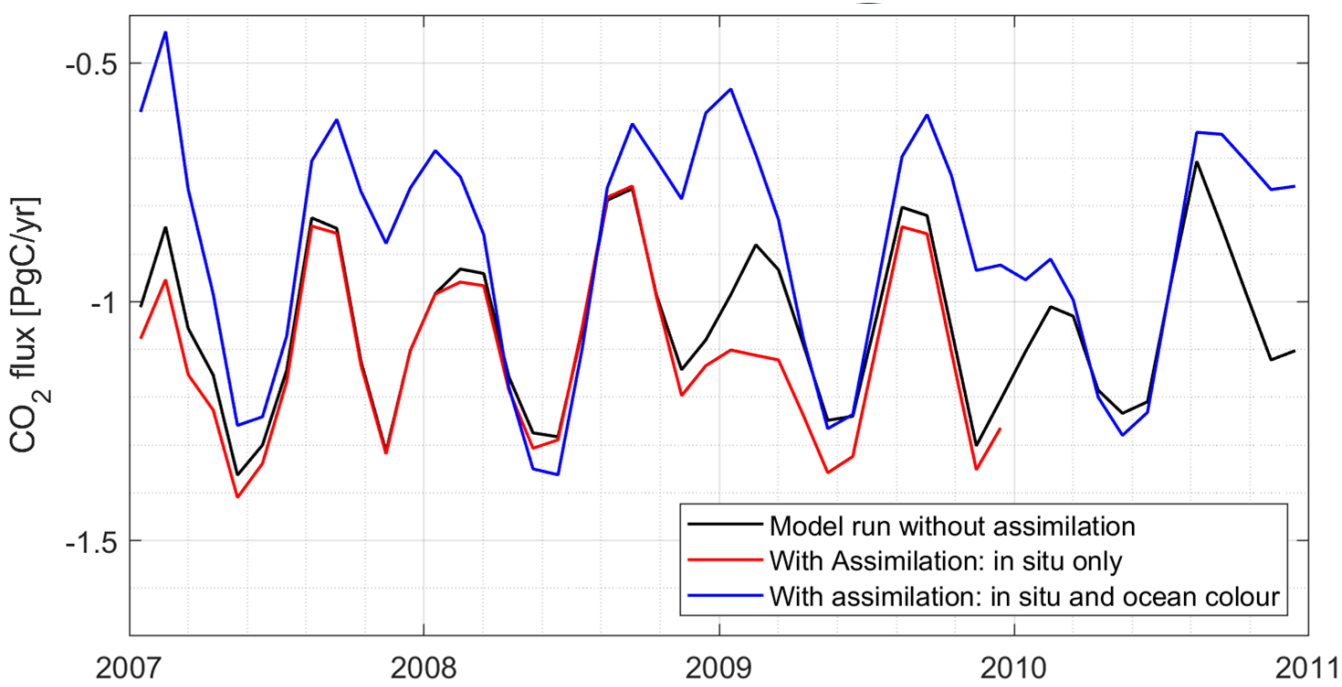
SCIENCE HIGHLIGHT

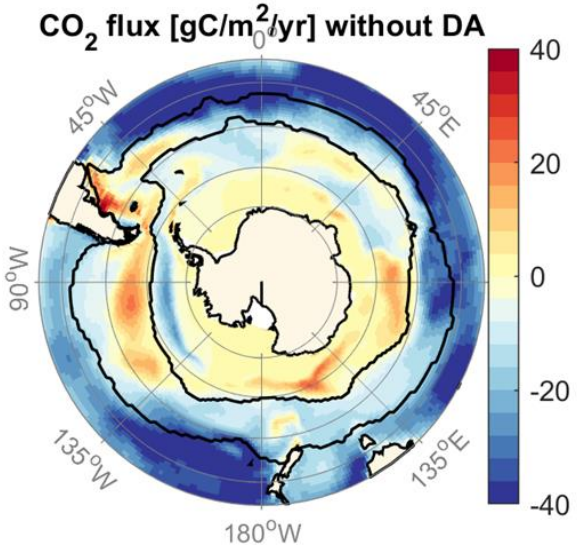
- OSSEs assimilating synthetic ocean colour and BGC-Argo
  - NEMO-CICE-MEDUSA, NEMOVAR (3D-Var)
  - Chlorophyll, nitrate, oxygen, pH assimilated
  - Tested 1000 and 4000 BGC-Argo floats
- Model improved throughout water column in both cases
- Better results with more BGC-Argo floats
- Ways to improve assimilation methodology identified
- Figure shows % reduction in median absolute error at 100m
  - Left: 1000 floats; right: 4000 floats
  - Top to bottom: Chl-a, NO_3, O_2, pH
- Ford, 2021, Biogeosciences

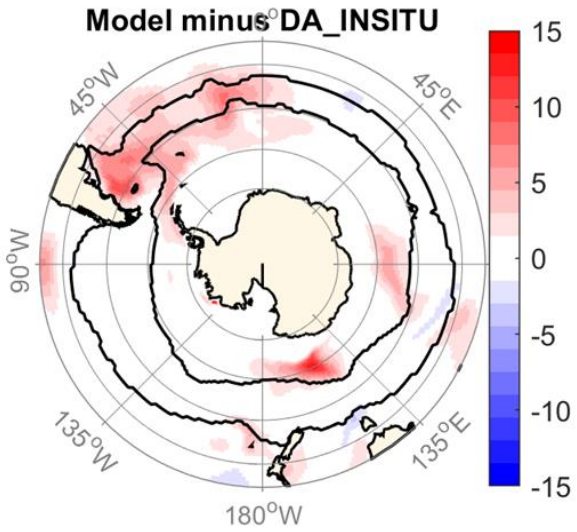


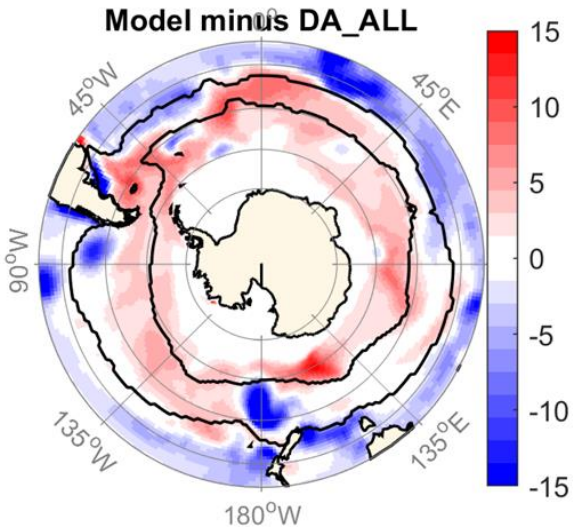
SCIENCE HIGHLIGHT

- Andrea Rochner (University of Exeter) extending method to real observations
- Initial test run 2007-2010 assimilating
  - CCI ocean colour chl-a
  - SOCAT fCO_2
  - GLODAP DIC, Talk, pH, NO_3, Si, O_2, chl-a
- Currently working to refine covariances
- Global model, focus on Southern Ocean
- Will also apply to BGC-Argo





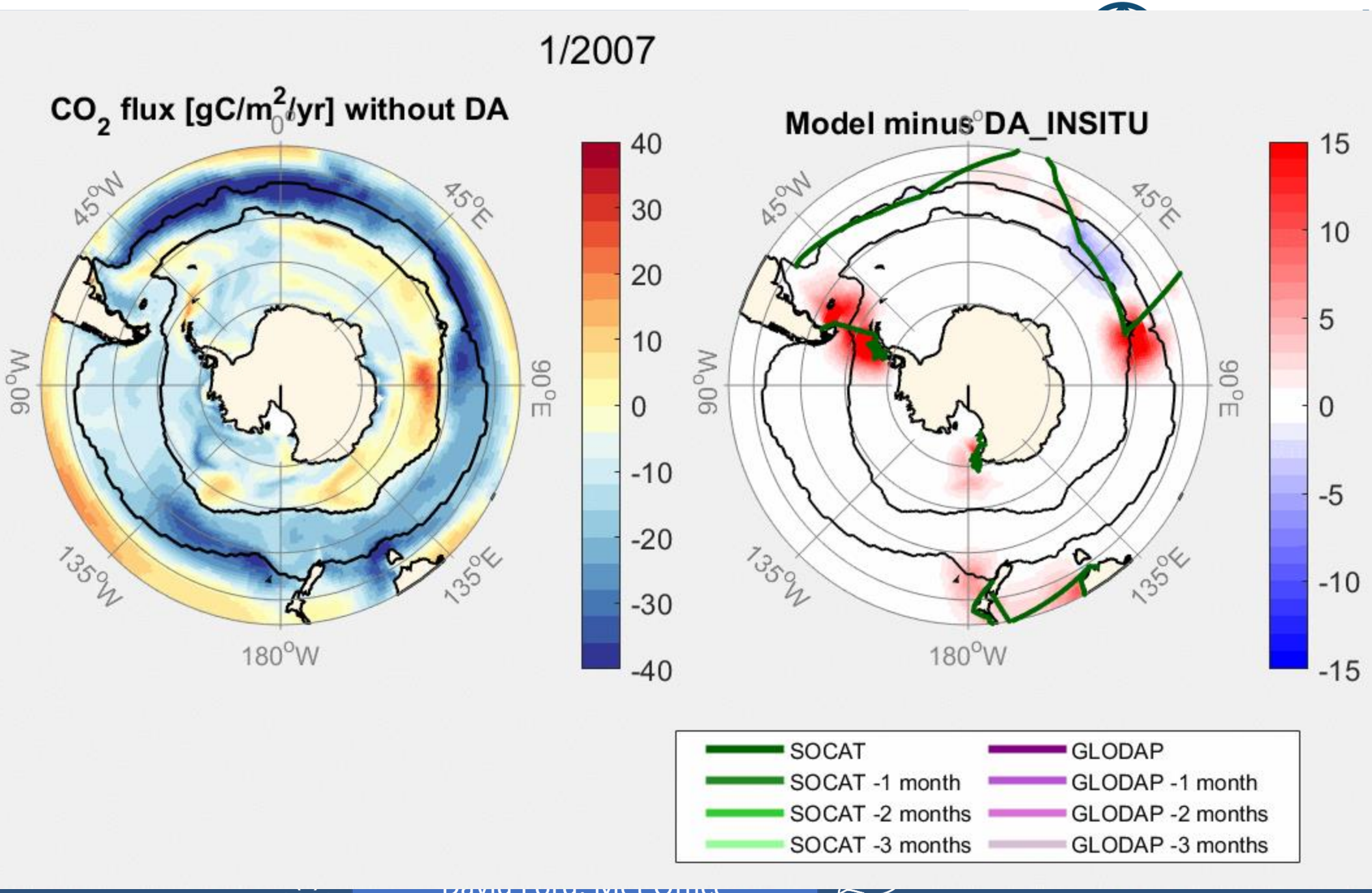




Top: Southern Ocean air-sea CO_2 flux

Left: CO_2 flux and difference Jun 2009

Courtesy Andrea Rochner


1/2007
CO_2 flux [gC/m^2/yr] without DA
0
45°W
45°E
90°W
90°E
135°W
135°E
180°W
40
30
20
10
0
-10
-20
-30
-40
Model minus DA_INSITU
15
10
5
0
-5
-10
-15
SOCAT
SOCAT -1 month
SOCAT -2 months
SOCAT -3 months
GLODAP
GLODAP -1 month
GLODAP -2 months
GLODAP -3 months

OUTREACH/IMPACT HIGHLIGHT

OceanPredict
Advancing the science of ocean prediction

EGU Blogs » Divisions » Ocean Sciences » Satellite data for ocean reanalysis

Satellite data for ocean reanalysis

David Ford · September 22, 2020 · OS Research · Comments Closed

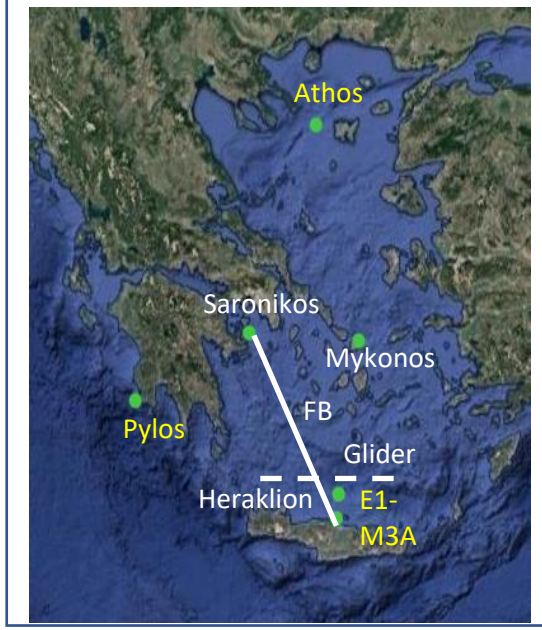
https://blogs.egu.eu/divisions/os/2020/09/22/satellite-data-for-ocean-reanalysis/

Example or idea of contribution to the UN Decade

- Contributions still be determined
- Could contribute to various aspects of SynObs and other programmes/activities
- Global and Northwest European Shelf Seas

SCIENCE HIGHLIGHT

OceanPredict
Advancing the science of ocean prediction



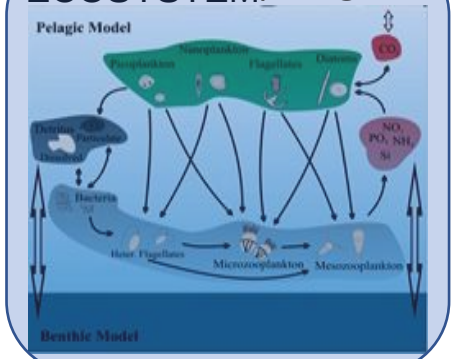
POSEIDON

Observing system
3 multi–parametric
Off shore stations
3 Coastal stations
1 Ferrybox line
1 glider line
3 Argo floats/yr

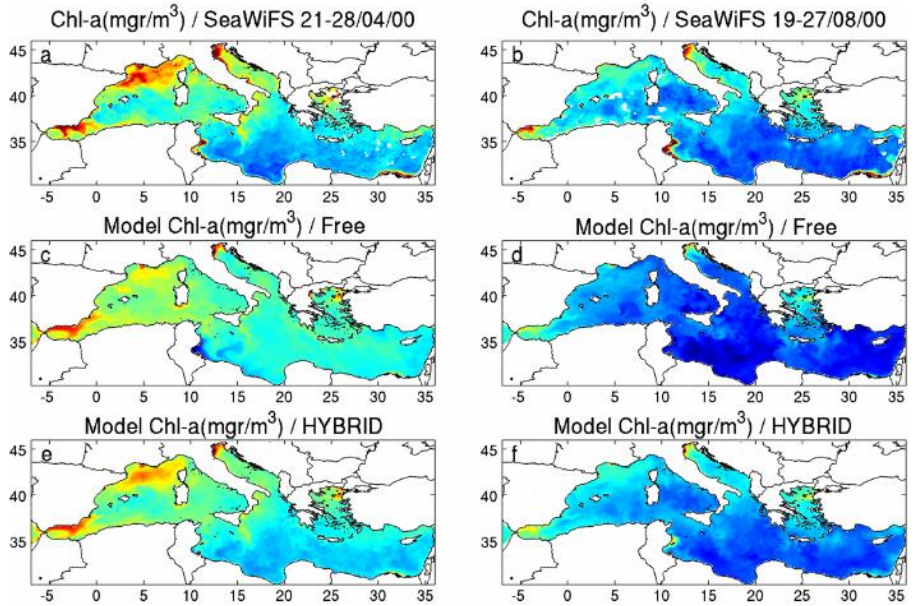
To come
1 glider line
1 FerryBox line

Forecasting system
Atmospheric / ETA
Hydrodynamic / POM

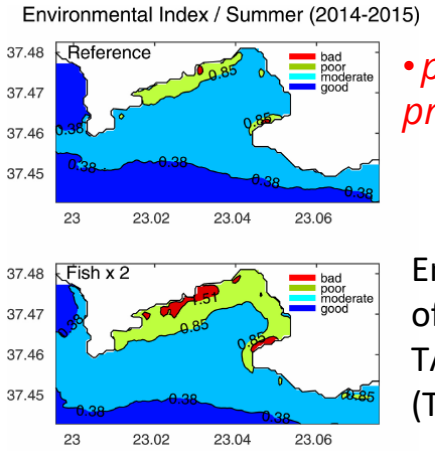
ECOSYSTEM/ ERSEM



Kalaroni et al. 2020

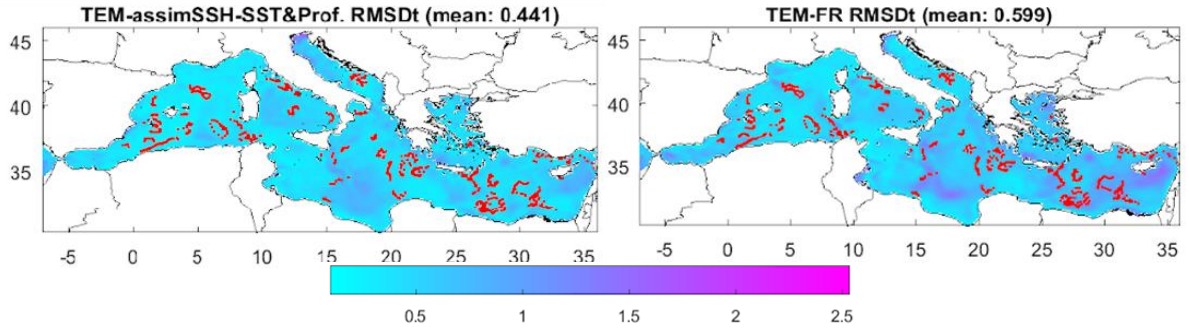


Hybrid ensemble Kalman Filter (OPEC EU project)
Assimilation of satellite Chl-a (Tsiaras et al., 2017)



• *provision of biogeochemical products for end users*

Environmental impact
of aquaculture
TAPAS EU project
(Tsiaras et al. 2022)



Assimilation of T/S profiles and impact on BGC
NAUTILOS EU project (on-going)

• *Drive forward method*

MEAP-TT objectives

• *Guide optimal design through observing system simulation studies;*

OUTREACH/IMPACT HIGHLIGHT

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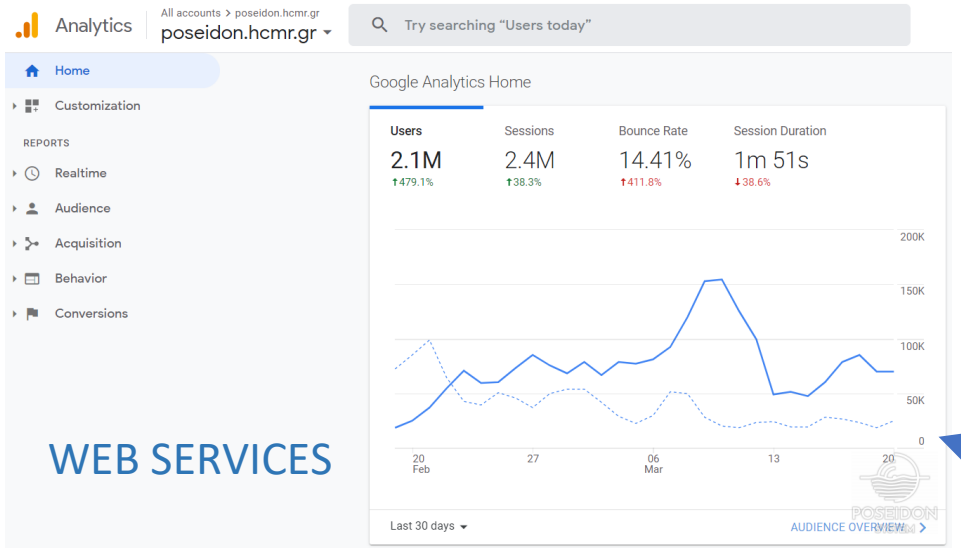
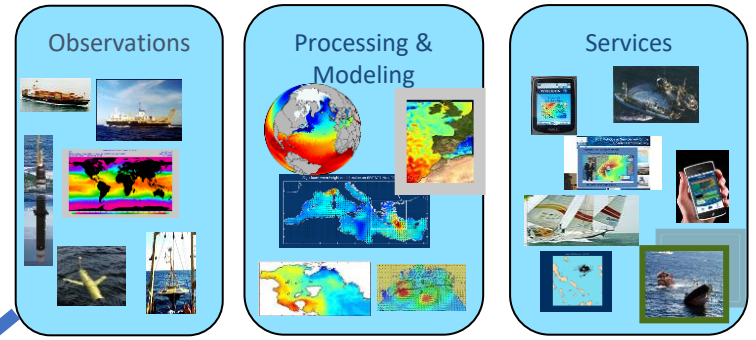


WEB SERVICES

OPEN ACCESS PHYSICAL/VIRTUAL

RESEARCH COMMUNITY - INDUSTRY



DATA AGGREGATORS

DG GROWTH

DG MARE

DG RTD

EMODnet

SeaDataNet

SERVICES TO AUTHORITIES

OIL SPILL

REMPEC IMO

SAR

SUPPORT TO POLICY

WFD

EU INFRASTRUCTURES / ERICS – I3

JERICO RI

Euro Argo

GROOM

emso ERIC

Example or idea of contribution to the UN Decade

No current contribution to UN Decade programmes/projects

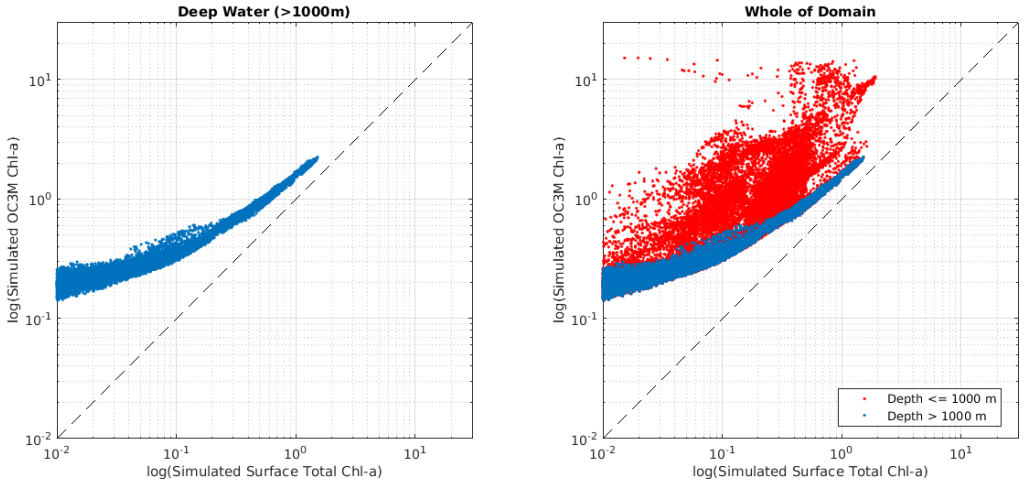
Potential future contribution

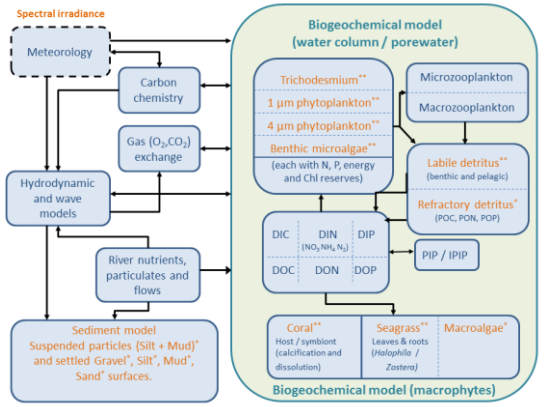
- *Share the output from NAUTILOS OSSE simulations on the impact from observations (T/S profiles and surface SSH/SST) on hydrodynamic/biogeochemical model (on-going, expected in the next 2-3 years)*
- *Evaluation of POSEIDON observing system through OSSE simulations (future priority)*

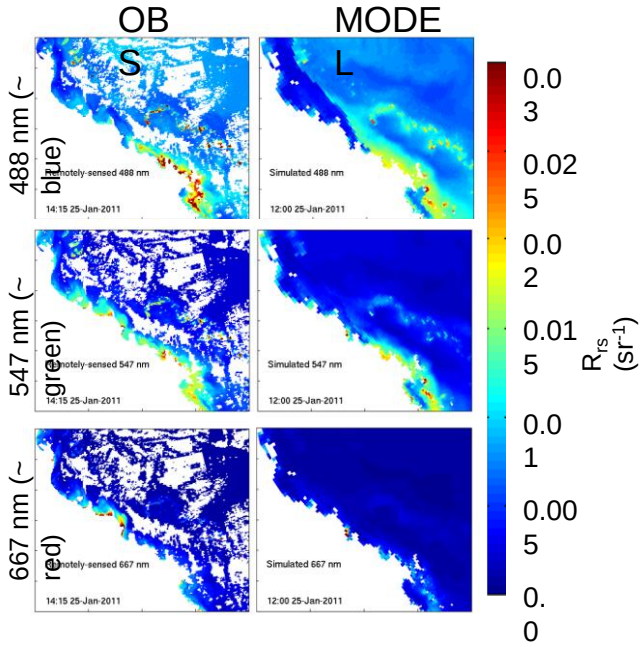
SCIENCE HIGHLIGHT

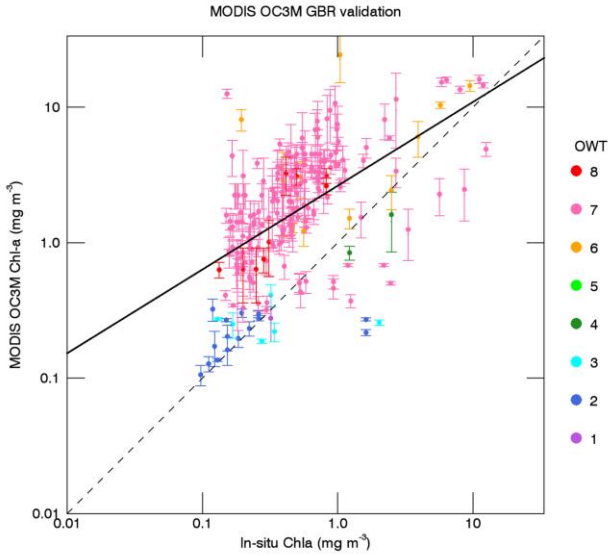
OceanPredict
Advancing the science of ocean prediction

Development of data assimilation systems that can ingest multi-platform remote sensing reflectance









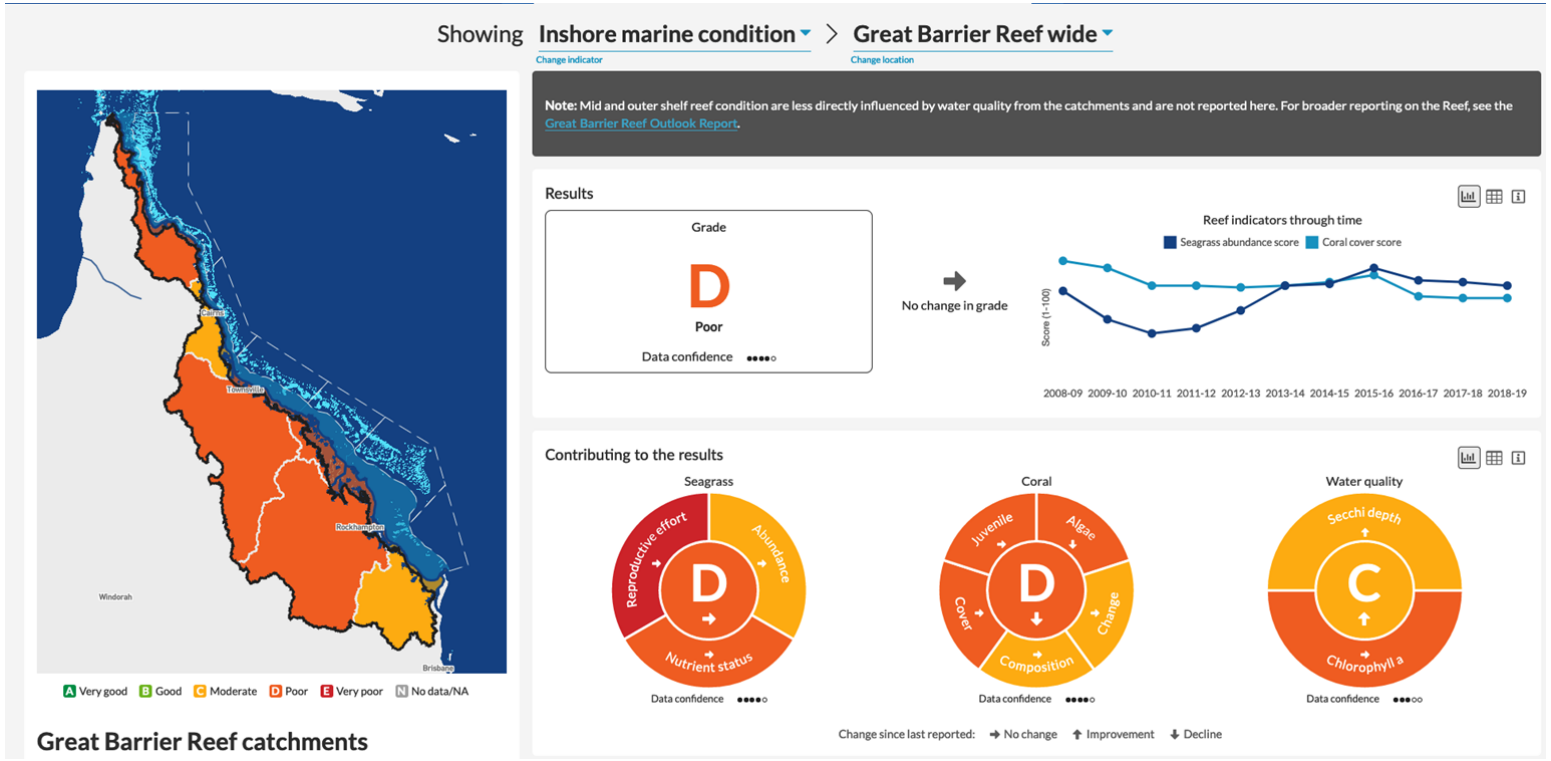
- Simply assuming OC3 or OC4 is a direct proxy for P biomass is dangerous (see figures to the left).
- Using an optical model linked to the optically active BGC state variables (see orange text above). EMS is able to produce a simulated remote-sensing reflectance.
- Simulated Remote sensing reflectance is directly comparable to the the L3 observed remote sensing reflectance products served by ESA and NASA (see top right).

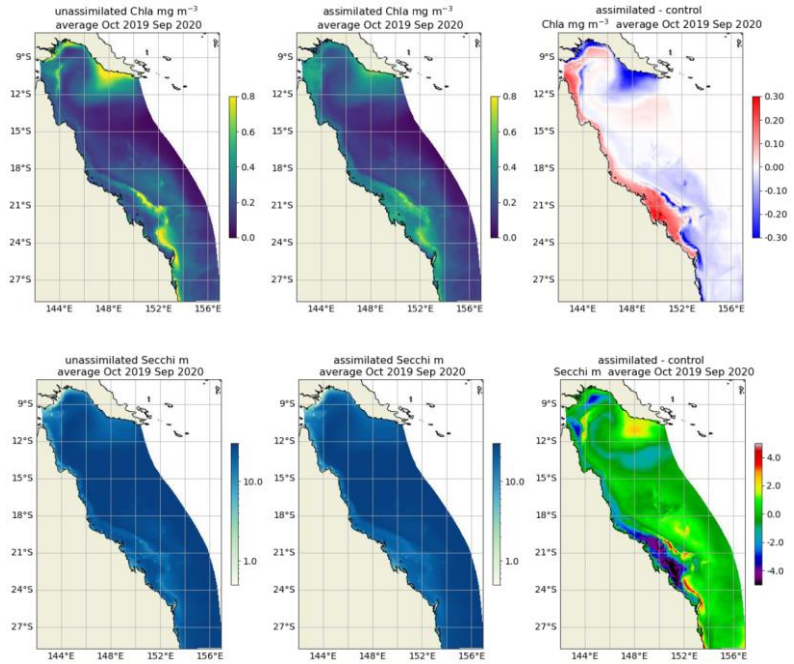
OUTREACH/IMPACT HIGHLIGHT

OceanPredict
Advancing the science of ocean prediction

Output from the assimilation system is used for the annual reef health report card

- eReefs BGC Reanalysis System assimilates remote sensing reflectance from MODIS, VIIRS and sentinel. We then use in-situ observations for independent assessment.
- Feeds into interactive web-based report cards (https://reportcard.reefplan.qld.gov.au/).





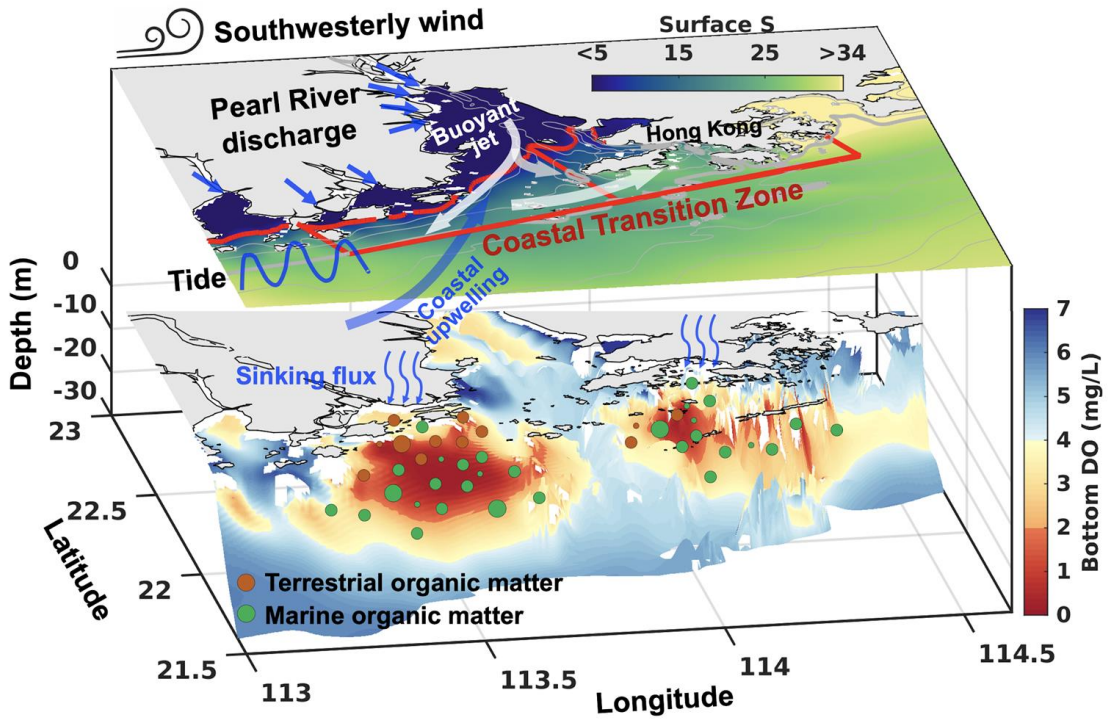
Example or idea of contribution to the UN Decade

- *Limited interaction so far, primarily with CoastPredict and the FLAME initiative.*
- *Interested in DITTO (Digital twins of the Ocean)*
- *Interested in SynObs and ForeSEA, but have had limited exposure thus far.*

SCIENCE HIGHLIGHT

OceanPredict
Advancing the science of ocean prediction

Diagnosis of the **intensifying eutrophication & hypoxia** off the Pearl River Estuary



- ROMS with Fennel BGC module (+ terrestrial POM & DOM)
- A process-oriented modelling framework forced by typical summer forcing

Some facts

Large river Pearl River≈60% of Mississippi River discharge

Excessive nutrient input ≈40% of Mississippi/Atchafalaya N load

Short residence time ~10 days

Emerging seasonal hypoxia ~1000 km^2

Highlights

Where & why

- two hypoxia centers in the convergence zone induced by cyclonic vortices

Terrestrial *vs* marine-derived OM

- nutrients from decomposition of terrestrial OM cannot be overlooked

Impact of river-induced P limitation

- Reversing from reducing to amplifying hypoxia as P-limitation severity decreases

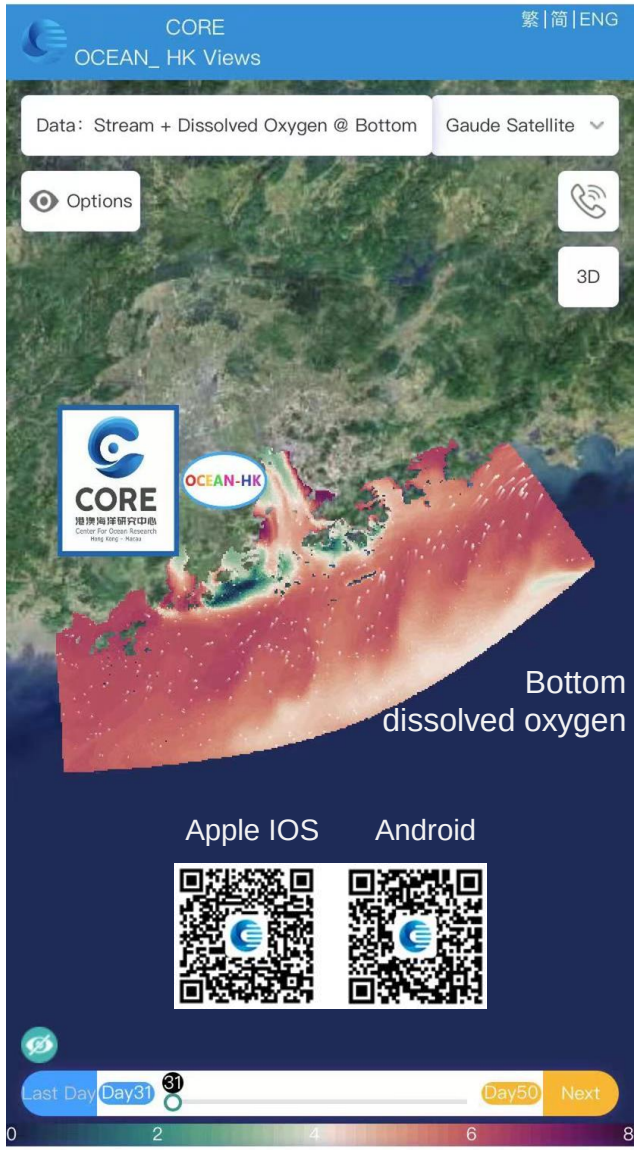
Mitigation strategy - oyster farming; oyster reef restoration

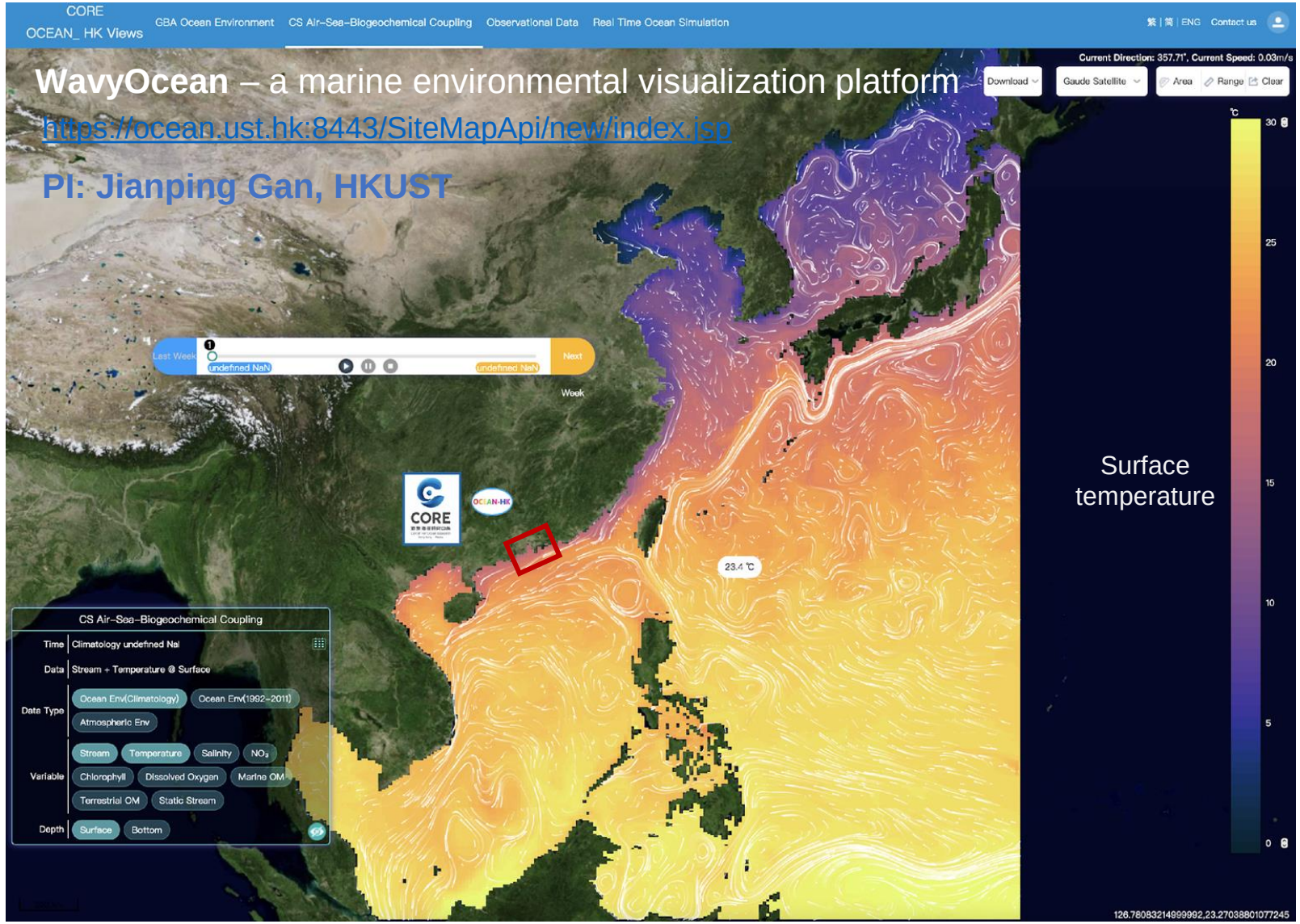
Future climate projection

Li et al. (2020) *JGR-Oceans*; Yu et al. (2020) *L&O*; Yu & Gan (2021) *ES&T*; Yu & Gan (2022) *WR*

OUTREACH/IMPACT HIGHLIGHT

OceanPredict
Advancing the science of ocean prediction





Example or idea of contribution to the UN Decade

OceanPredict
Advancing the science of ocean prediction

Biogeochemical modelling in support of sustainable aquaculture

https://www.remoteasiaphoto.com/photo/oyster-farms-amp-floating-houses/
Bivalve farms in Fu Jian, China

- *Method development*: coupling higher and lower tropic levels
- Addressing questions:
  - What are the impacts of different aquaculture species on aquatic biogeochemistry and planktonic dynamics?
  - How will the aquaculture be affected by environmental changes (e.g., warming, eutrophication, hypoxia, harmful algal bloom, acidification)?
  - How can we lessen the impact of aquaculture on aquatic environment?

…

SCIENCE HIGHLIGHT

OceanPredict
Advancing the science of ocean prediction

- *Drive forward method development focused on two main aspects:*
  - *the extraction of ecological information from proxy observations (incl. satellite observations of ocean colour and bio-optical measurements from autonomous in-situ sensors), and*

    > *ESA PRODEX project: Reconstruction of surface Chl-a concentration from atmospheric reanalysis variables (SST, heat flux, SLP, wind) for filling missing satellite Chl-a data*

    > *NERSC SubMAPP project: Estimation of Chl-a profile from satellite Chl-a and the atmospheric variables by machine learning trained by BGC Argo data over the Norwegian Sea*

- *Contribute to the development and provision of biogeochemical and biological products for end users through assessments of product quality and end user needs;*

  > *Copernicus Marine Service:* ***Arctic Ocean BGC Reanalysis: ARCTIC_MULTIYEAR_BGC_002_005*** *by Ensemble Kalman Smoother is now available for 2007-2018* ***Arctic Ocean BGC Analysis and Forecast: ARCTIC_ANALYSISFORECAST_BGC_002_004*** *is now available for 2019-05-04 and after.*

- *Demonstrate and quantify the improvements in biogeochemical and biological model skill resulting from advances in biogeochemical/biological ocean observation and assimilation, including identification of metrics for system evaluation.*

  > *Bjerknes Centre FTI/SKD project: Optimization of ECOSMO BGC model against BGC Argo Chl-a/Oxygen profiles over the Norwegian Sea*

OUTREACH/IMPACT HIGHLIGHT

Please provide an highlight on your communication of your MEAP-related R&D and/or examples of its uptake by stakeholders, for example observational systems implementation, or impacts, e.g., on policy, economy, science practices

1. Horizon 2020 SEAMLESS project: Guidelines for multiplatform (satellite, Argo, ocean gliders) BGC data assimilation systems and ocean-BGC coupled data assimilation systems by 2024

2. Copernicus Marine Service: System/Product evolution in ***Arctic Ocean BGC Reanalysis*** *and* ***Arctic Ocean BGC Analysis and Forecast*** *by 2024*

Example or idea of contribution to the UN Decade

OceanPredict
Advancing the science of ocean prediction

1. *Contribute to the "Development of an integrated description of the 4D biogeochemical state of the ocean based on satellite and in situ observations" under ForeSea/SynObs activities (themes 1 and 2 jointed).*

2. *Contribute to the "observing system evaluation showcase" under SybObs activities to demonstrate the feasibility and effectiveness of observing system evaluation*

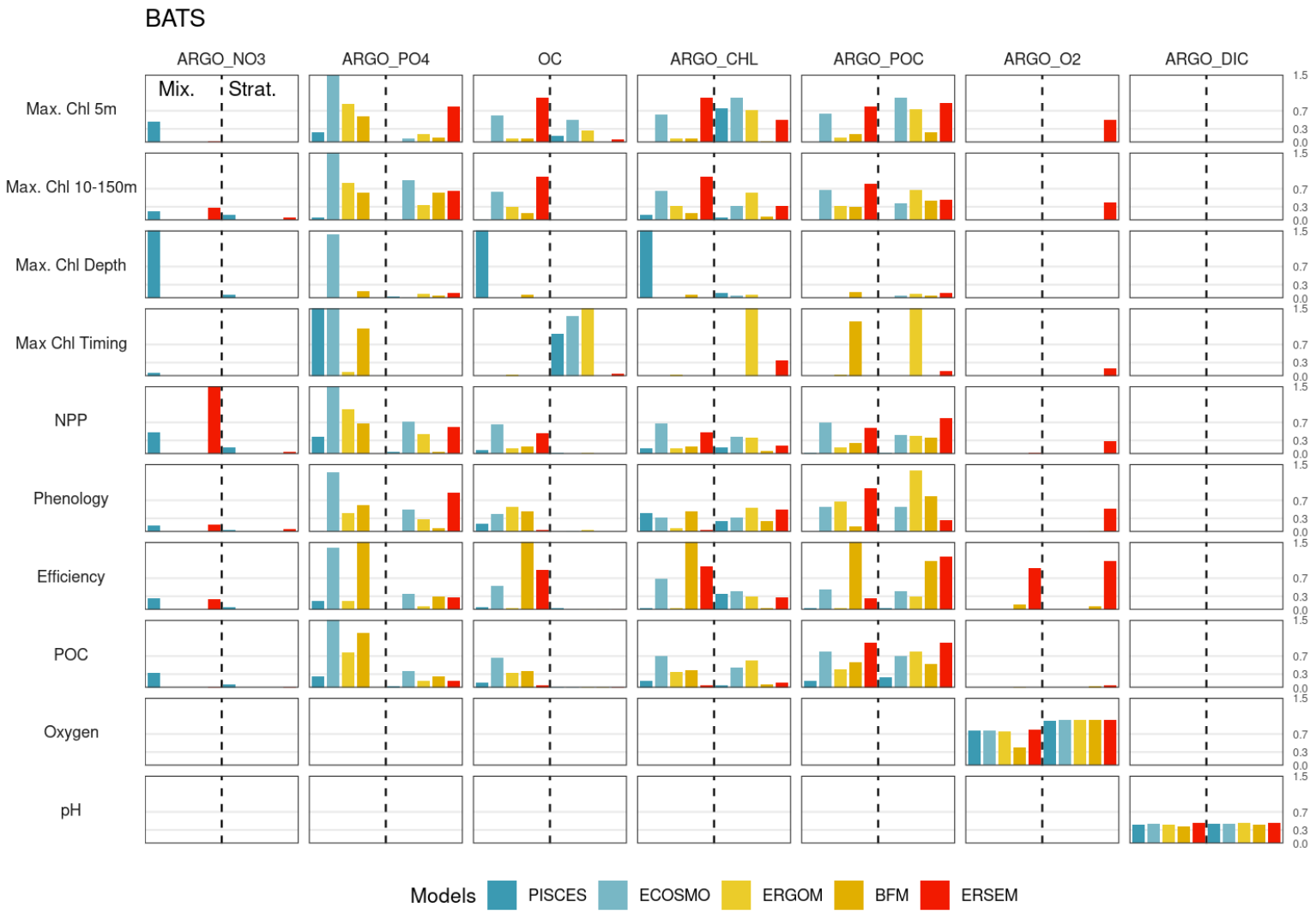
2. *Participate in the on-site and on-line meetings of SynObs and share the information on the development of DA schemes for BGC*

2. *Conduct collaborative evaluation of the impacts of satellite ocean color data and BGC Argo floats with SynObs*

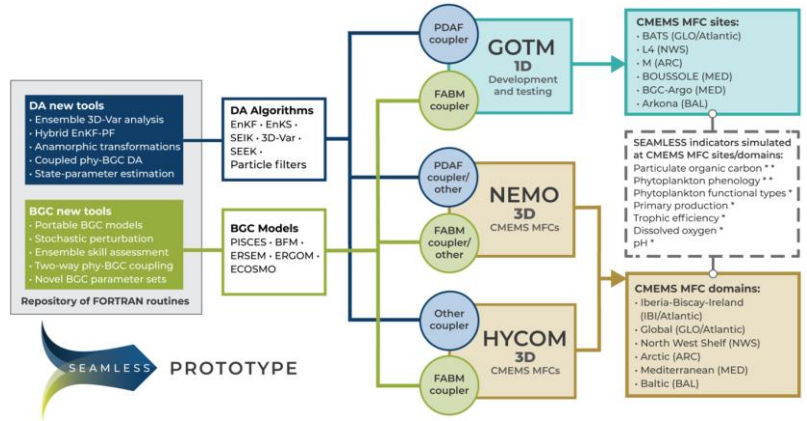
2. *Provide examples of BGC observing system evaluation for the SynObs observation impact report*

Controllability of ecosystem indicators by observations

OceanPredict
Advancing the science of ocean prediction



The tool:



https://github.com/BoldingBruggeman/eat

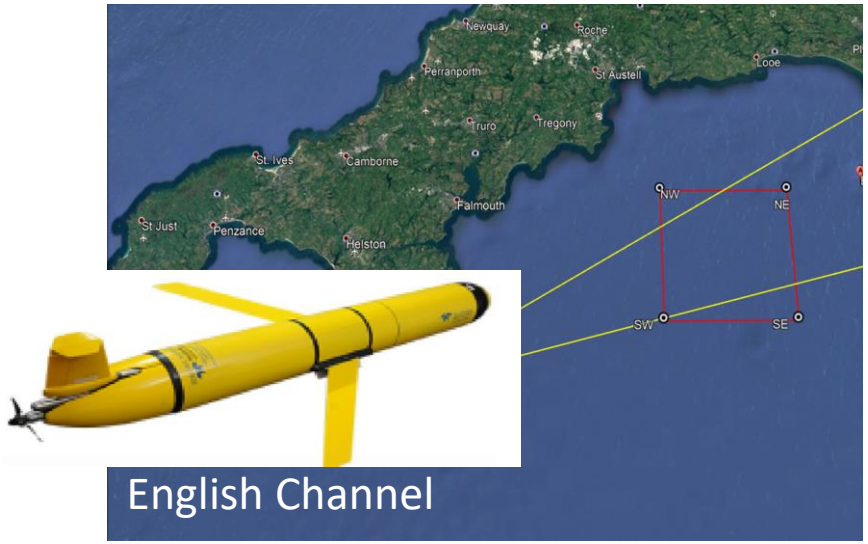
Ciavatta et al., 2022, SEAMLESS, Project report, https://doi.org/10.5281/zenodo.6580236

@SEAMLESSproject

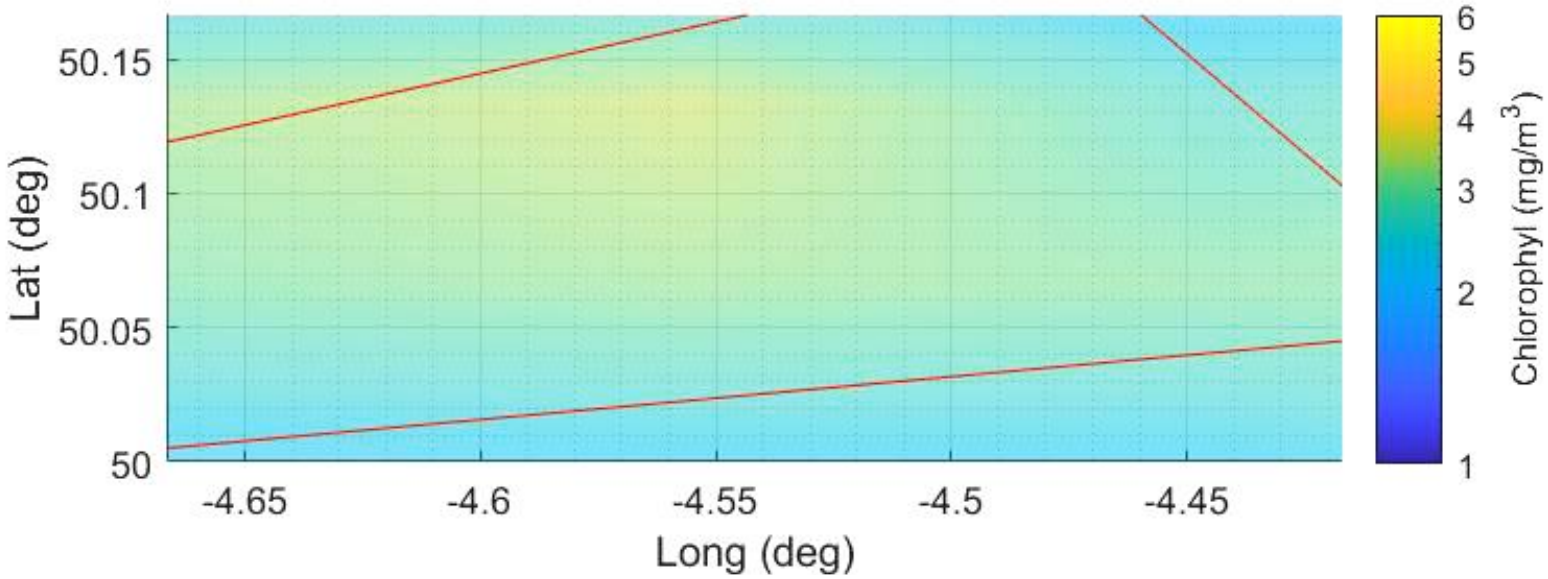
SCIENCE/OUTREACH HIGHLIGHT

OceanPredict
Advancing the science of ocean prediction

A new paradigm for operational biogeochemical model and data integration



Chlorophyll model forecasts & glider trajectory



Ford et al., in preparation

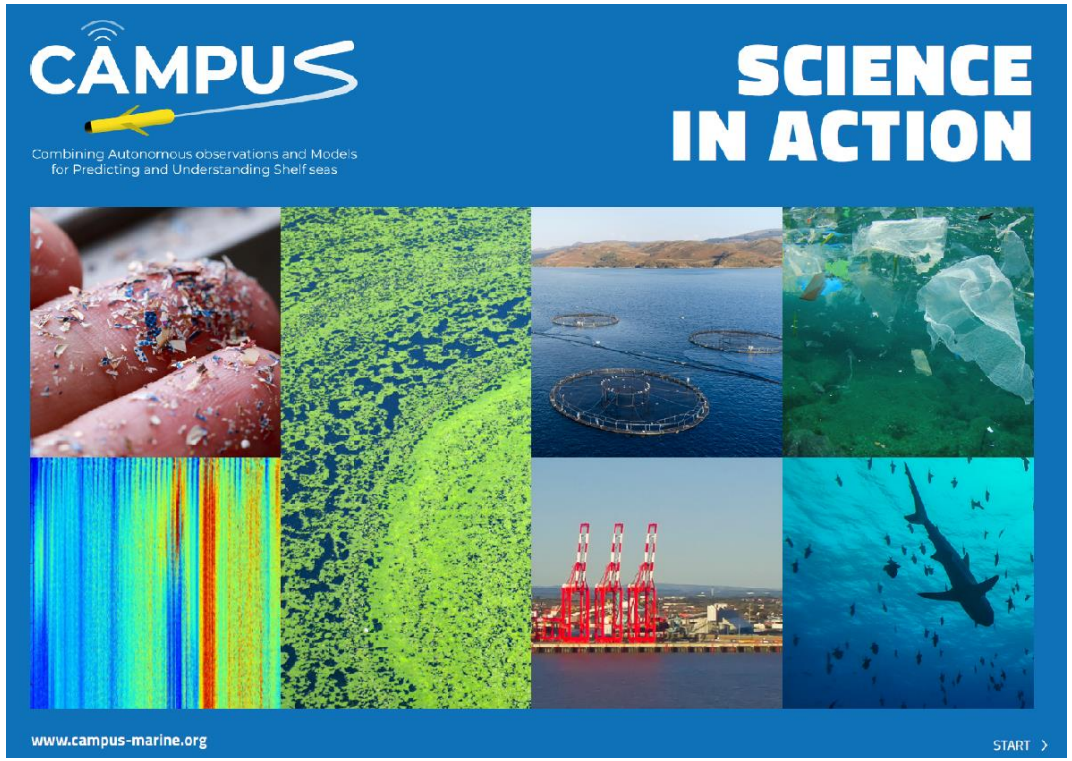
Courtesy of Gianmario Rinaldi, Shenan Grossberg

UNIVERSITY OF EXETER

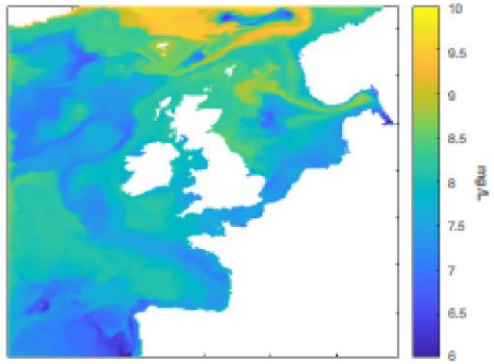
UKRI Natural Environment Research Council

CAMPUS

OUTREACH/IMPACT HIGHLIGHT



Bottom oxygen concentration – OSPAR's procedure



"The CAMPUS project might be used to provide extremely valuable inputs for helping us start a more ecosystems-based approach to salmon management, examine the proximate drivers of increasing salmon mortality at sea, and ultimately determine if there are ways we can possibly mitigate or improve management to prevent stock collapses."

Dr Colin Bull
Principal investigator of The Missing Salmon Alliance

Ciavatta et al., 2022. CAMPUS Project Booklet. https://doi.org/10.5281/zenodo.6490001

Example or idea of contribution to the UN Decade

OceanPredict
Advancing the science of ocean prediction

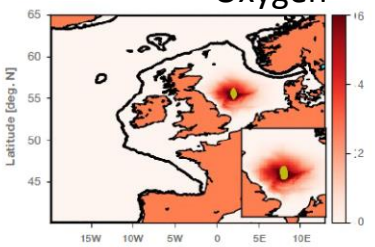
- Developing and evaluating integrated monitoring/modelling systems (link to SynObs, GOOS co-design)

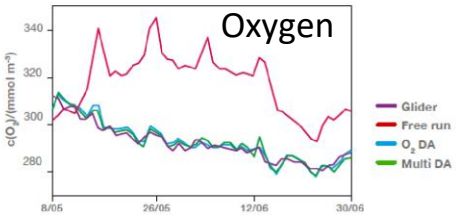
Table 3
The Table Demonstrates the Skill Measured by Bias (4), Spatial BC RMSD (8) and Temporal BC RMSD (Equation 10) of the Free Run and the Relative (%) Changes to the Skill Carried by the Different Assimilative System Components

Variable	Free run	Phys DA	Sat chl *a* DA	Glid chl *a* DA	O_2 DA	Multi DA
Chl *a* bias	0.31 mg m^{-3}	+6.8%	−80%	−46.4%	0%	−56.7%
Chl *a* temporal BC RMSD	0.77 mg m^{-3}	+5.2%	−54.6%	−70.3%	0%	−65.4%
Chl *a* spatial BC RMSD	1.14 mg m^{-3}	−5.5%	−15.3%	−61.9%	0%	−59%
O_2 bias	25 mmol m^{-3}	−3.8%	+10.6%	+0.7%	−97%	−98%
O_2 temporal BC RMSD	13.5 mmol m^{-3}	−4.3%	+10.8%	−5.4%	−83.8%	−83.7%
O_2 spatial BC RMSD	29.8 mmol m^{-3}	−7%	−5.7%	−14.6%	−44.5%	−47.4%

Note. The skill compares the model simulations with the glider data. The percentage changes in the columns for the assimilative runs are calculated relative to the free run skill. The negative percentage means that the bias, or (spatial, temporal) BC RMSD is reduced by the specific system component, whilst the positive percentages mean that bias, or (spatial, temporal) BC RMSD, increases.

Oxygen





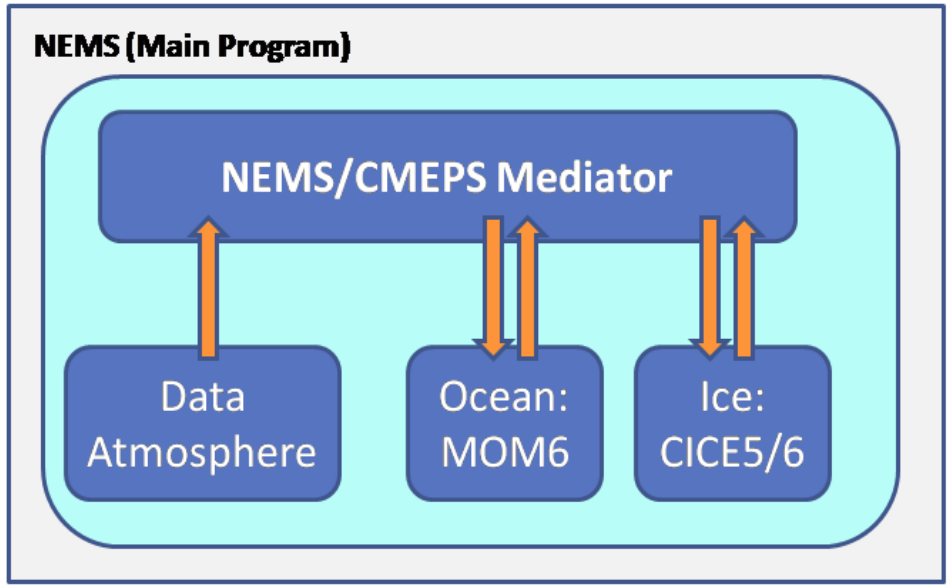
Skákala et al., 2021, https://doi.org/10.1029/2020JC016649

- (Hope to) develop Higher-Trophic-Level operational modelling systems (link to Marine Life 2030 & GOOS Co-Design)
- “Smart” autonomous observing/prediction systems (link to ForeSea) (Ford et al., in preparation)

SCIENCE HIGHLIGHT

The coupled **DATM–MOM6–CICE6** based on NEMS/CMEPS has been developed. In tandem with the FV3-MOM6-CICE6 but without feedback to the atmosphere.

Forcing: NOAA CFSR, GEFS Reanalysis, and weekly 11 member ensemble are available



Ocean: MOM6 (GFDL):

- 0.08° spatial resolution
- 41 layer hybrid vertical coordinates

Sea-Ice: Los Alamos CICE6

- 0.08° spatial resolution
- Same grid as the ocean
- Default setup with deactivated mushy thermodynamics

BGC: Biogeochemistry with Light, Iron Nutrient Gas (BLINGv2; Dunne et al., 2020)

Status:

- DATM-MOM6-CICE6 for CPC 40 year reanalysis -> 1° resolution (complete); 0.25° (in progress); 0.08° (TBD)
- **Continuous UFS-Weather model system update**

SCIENCE HIGHLIGHT

OceanPredict
Advancing the science of ocean prediction

Joint Polar Satellite System's Proving Ground Risk Reduction project

The **overarching goals** of this project are to …

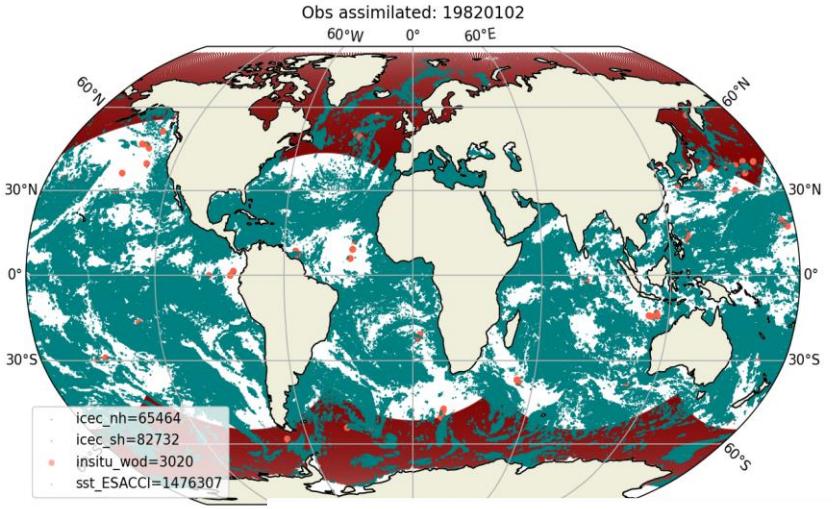
- Support NOAA/NCEP's **operational weather forecasts** at subseasonal-to-seasonal (S2S) scales by improving ocean state initialization through the ingestion of near real-time ocean biogeochemical data and the integration of biophysical feedback in the marine component of the UFS;
- Start building NOAA/NCEP's **ecological forecast capabilities** for monitoring critical changes and "tipping points" in coastal ecosystems.

- Implementation of biogeochemical data assimilation in the Next-generation global ocean data assimilation system (***NG-GODAS***)
- Implementation of biogeochemical modeling in the Unified Forecast System (***UFS***)
- *Preliminary results*: prototype UFS marine initialization experiments and sub-seasonal impact of biogeochemistry on SST predictions

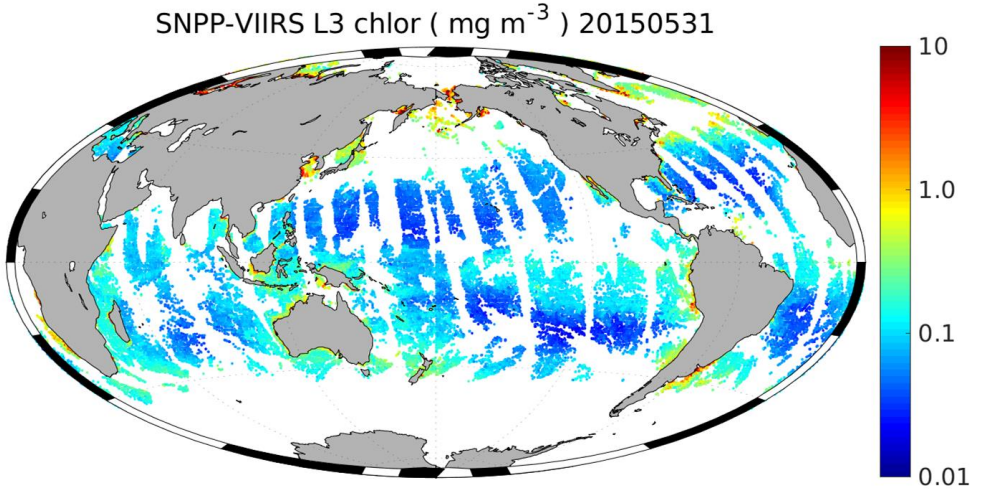
SCIENCE HIGHLIGHT

- DATM-MOM6-CICE6: 1-degree in Joint Effort Data assimilation Integration-Sea ice Ocean and Coupled Analysis (JEDI-SOCA 3DVar) framework

Obs type	Date
ADT	1993-2020 (NESDIS)
Satellite SST (AVHRR)	1981-200208 (ESACCI L3U), 200208-201811 (NESDIS L3U)
Insitu (T&S)	1979-2020 (WOD)
SSS	SMOS ESA L2 (2010-2020), SMAP RSS/JPL L2 (2015-2020)
Sea ice Conc	NSIDC L3 SSMR, SSMI (1979-200305), EMC L2 (200306-2020 SSMI, SSMIS)



Over 1 Million Observations per day



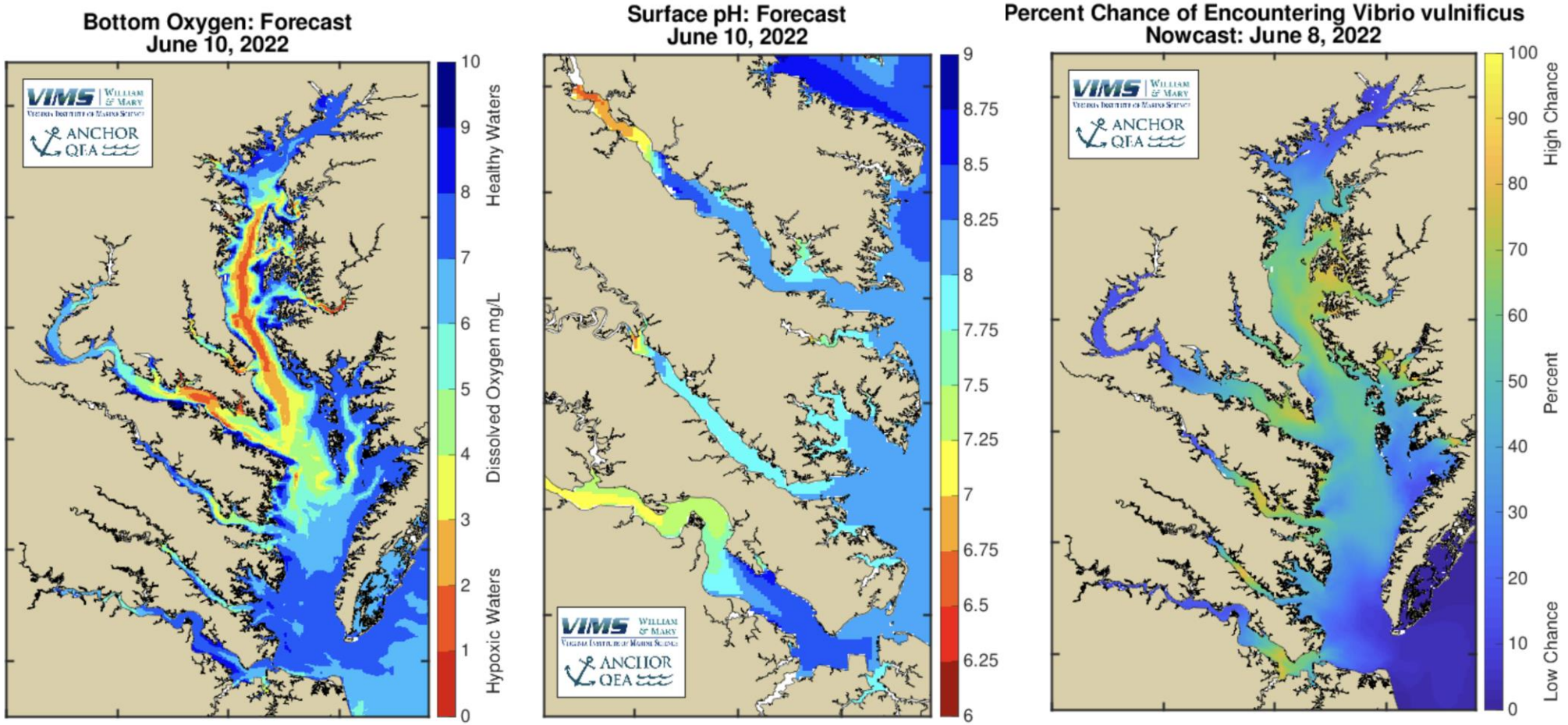
NOAA CoastWatch SNPP-VIIRS L3 chlorophyll retrievals (daily composite, 05/31/2021)
Preprocessing: 50% random thinning, <30 mg m^{-3}, assuming 30% observational error

Example or idea of contribution to the UN Decade

1. *We can participate in the on-site and on-line meetings of SynObs and share the information on the development of DA schemes for BGC*

SCIENCE HIGHLIGHT – www.vims.edu/cbefs

OceanPredict
Advancing the science of ocean prediction



- ***Contribute to the development and provision of biogeochemical and biological products for end users through assessments of product quality and end user needs***

OUTREACH/IMPACT HIGHLIGHT

OceanPredict
Advancing the science of ocean prediction

Hypoxia forecasts:

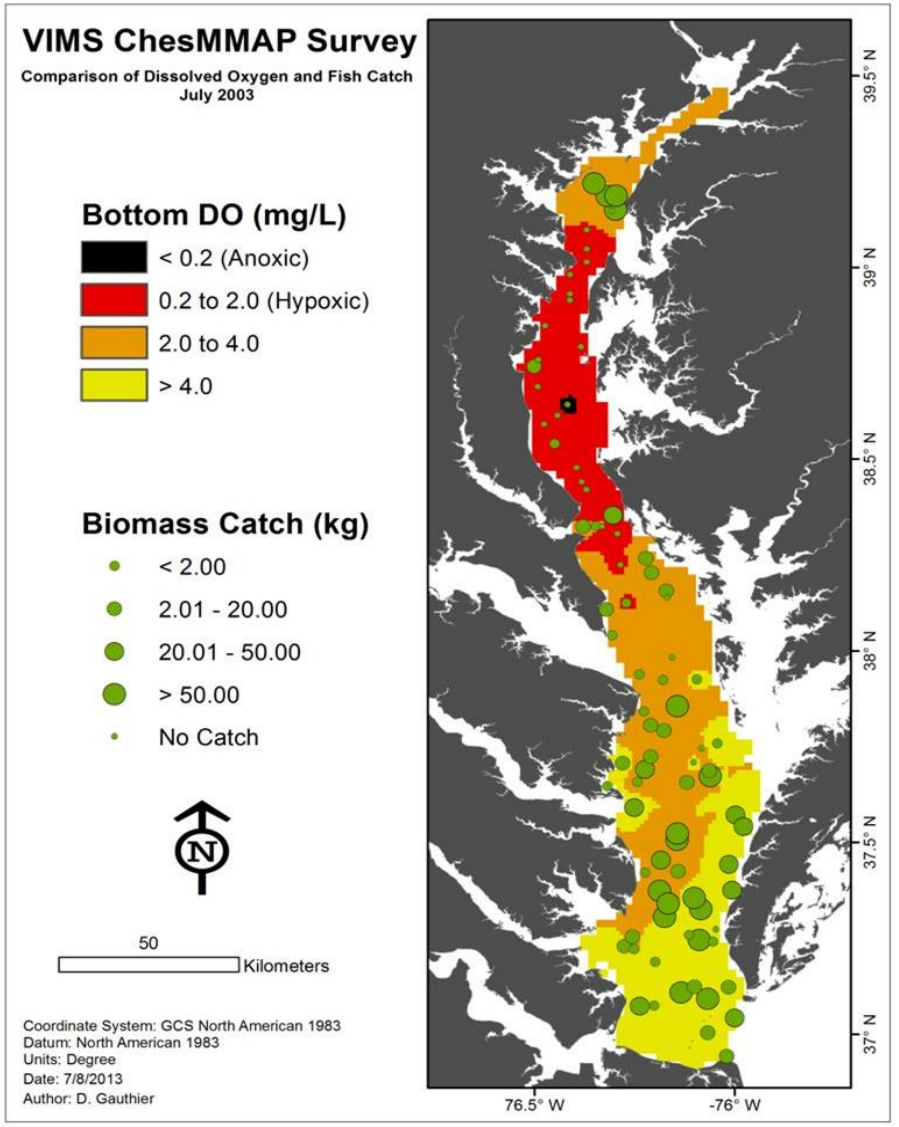
- Working with recreational/commercial fishers; charter boat captains
- Provide locations of poor habitat (low fish catches where DO < 3 mg/L)
  - Adjust location and depth where they focus

Acidification forecasts:

- Working with aquaculture industry; hatchery operators
- Providing early warning system for poor water quality
  - Delay spawning
  - Avoid supplying spawning tanks with Bay intake water

Vibrio/HAB forecasts:

- Working with beach managers
  - Additional in situ measurements
  - Beach closures



Switch to Paul's PDF

Agenda

12.00 - Welcome and objectives of the meeting

12.10 - ForeSea (**Eric Chassignet**, co-chair of the UN Decade Programme)

12.20 - SynObs (**Yosuke Fujii**, co-chair of the UN Decade Project)

12.30 - Marine life 2030 (**Frank Muller-Karger**, co-chair of the UN Decade Programme)

12.40 - Questions on UN Ocean Decade Programmes

12.50 - Flash-presentations by members (3 minutes each)

13.20 – Break

13.30 - Flash-presentations by members (3 minutes each) and Q&A

13.40 - "Assimilating remote sensing reflectance's into the Great Barrier Reef BGC model" by Emlyn Jones, CSIRO

14.00 - Discussion

14.30 - Closure

Agenda

14.00 - Discussion:

- MEAP contributions to UN Decade
- MEAP-TT plans beyond the UN Decade
- In-person meeting: @ ASLO 2023 Aquatic Sciences Meeting June 4-9, 2023 Palma de Mallorca, Spain
- Plan video-meeting every 2 months (next in September)
- AOB

14.30 - Closure