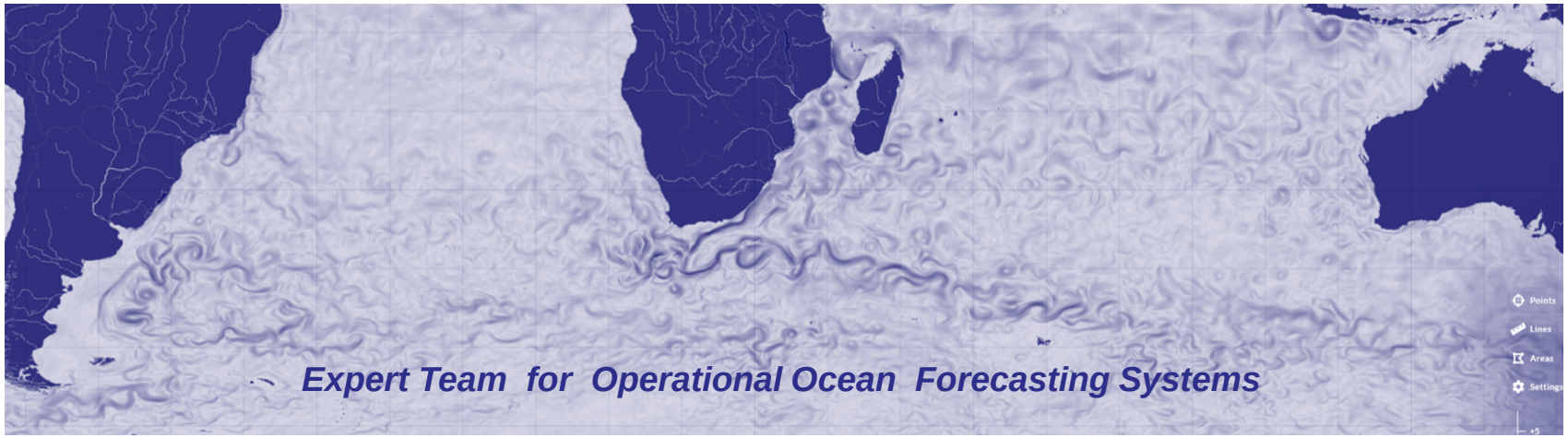
The Global Ocean Observing System
www.goosocean.org

Reports from GOOS components

ETOOFS

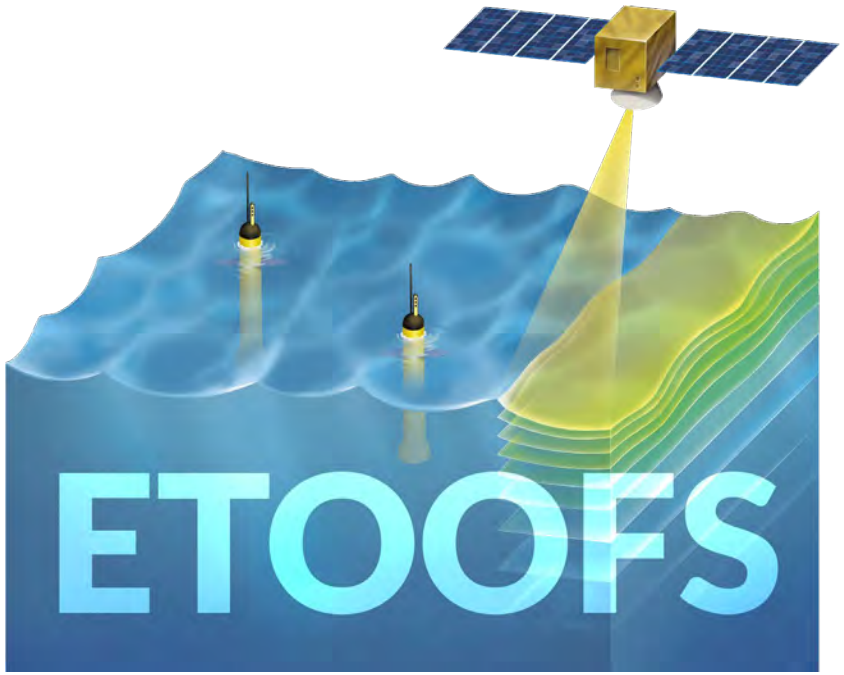


Pierre Bahurel[1], Enrique Alvarez Fanjul[2], Denis Chang-Seng[3] , Romane Zufic[1]

[[1]Mercator Ocean International, [2]Puertos del Estado, [3]IOC]

GOOS 10th Steering Committee meeting [online], April 2021

Outlines

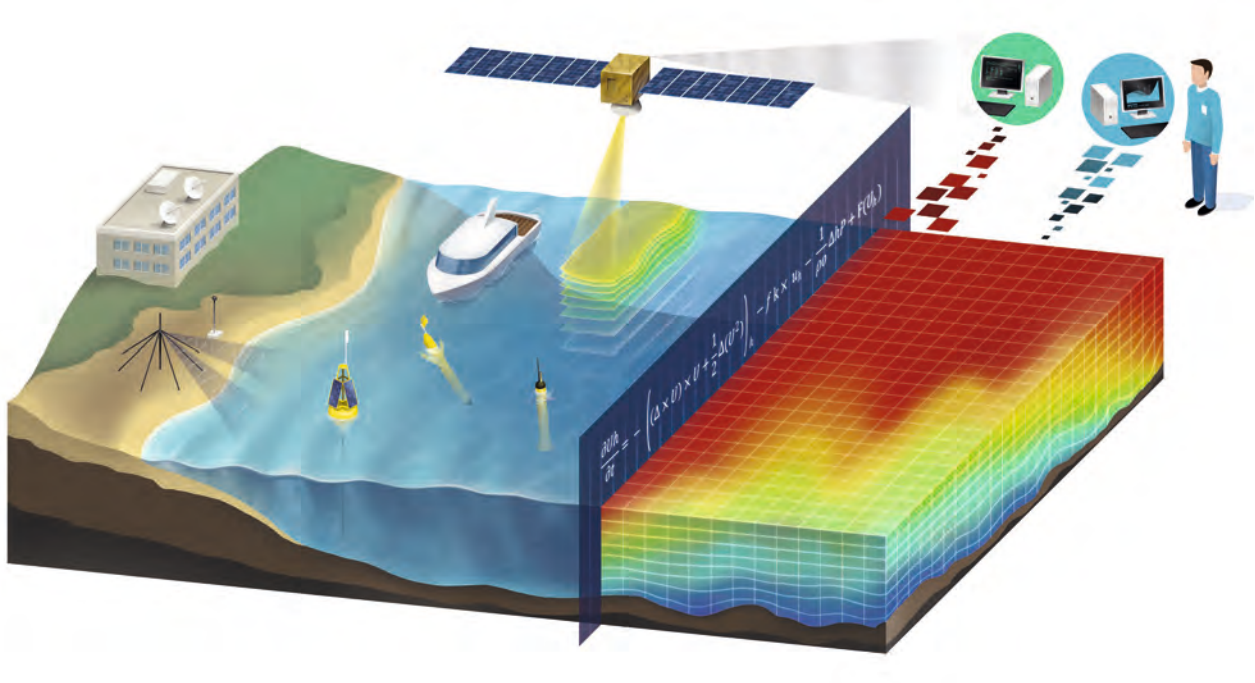


- Presentation of ETOOFS (reminder)
- **Progress made since last SC / April 2020**
  - OOFS **guide** kicked off, OOFS **booklet** ready, OOFS **workshop** booked
- **Future plans** as identified contributions to the GOOS IP

Introduction

Expert Team on Operational Ocean Forecast Systems (ETOOFS)

Objectives: To improve capacity, quality and interoperability of **ocean forecast products** to supports climate, operational maritime services, biodiversity and blue economy.



Expert Team on Operational Ocean Forecast Systems (ETOOFS)

MISSIONS	
	Manage and maintain the guide, scope and requirement documents,
	Manage and maintain an overview of OOFS service portfolio
	Manage and promote the adoption of an international standard to support interoperability
	Guide and initiate actions at international level
	Promote and facilitate the support for OOFS development
	Provide advice on OOFS related matters
	Liaise with and gather input from other Expert Teams

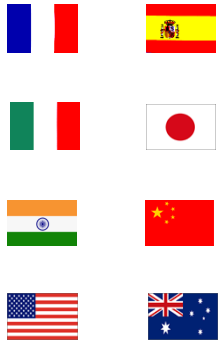
EXPERT TEAM

Chair and co-chair

1. **Pierre BAHUREL**, Mercator Ocean International, France
2. **Enrique ALVAREZ FANJUL**, Puertos del Estado, Spain

Experts

3. **Stefania CILIBERTI**, CMCC, Italy
4. **Shiro ISHIZAKI**, JMA, Japan
5. **Sudheer JOSEPH**, INCOIS, India
6. **Guimei LIU**, NMEFC, China
7. **Avichal MEHRA**, NOAA, US
8. **Aihong ZHONG**, BoM, Australia
9. **Lotfi AOUF**, Météo-France, France



IOC/GOOS

- **Denis CHANG SENG,** IOC, ETOOFS officer

Expert Team on Operational Ocean Forecast Systems (ETOOFS)

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2021 OBJECTIVES

Objective 2021#1 : release the first « Guide to Operational Ocean Forecasting Systems »

initiated by the previous ETOOFS group, to be continued and finalized this year

➔ Enlarge the ETOOFS group to form a expert writing team for the Guide and involve committed experts in GOOS/OceanForecasting

Objective 2021#2 : organize the first OOFS international training to reach out to a widen community

promote the guide, operational practices and standards, support a OOFS operational community

➔ develop communication material to promote the GOOS brand with Ocean Forecasting

PROGRESS MADE SINCE LAST SC

1) A GUIDE *TO SUPPORT OOFS IMPLEMENTATION*

Guide: Objectives

Objectives:

- Provide a guide on international standards and best-practices for setting up OOFS
- Promote the development of new marine forecasting systems
- Promote the improvement of the existing ones, as well as its socio-economic impact

Guide: Audience

- The main target of the book is a person with knowledge on Earth science, but with a weak background on ocean forecasting
- The level of technical difficulty will be mild. This guide will not contain all the knowledge, but it will serve as a **Gateway** to get it.
- The level of technical depth will depend on the chapter:
  - Core chapters are expected to be more technical, including mathematical formulation
  - The rest of the book will be milder in this aspect.
- The inclusion of relevant references is vital to fulfill this guide mission.

Guide: Structure of the index

Introductory chapters

1. Introduction
2. Motivation and scope of ocean monitoring and forecasting capacity
3. Definition of ocean forecasting systems: temporal and spatial scales solved by marine modeling system

Main overview chapter

4. Architecture of ocean monitoring and forecasting systems

Detailed description chapters

5. Circulation modeling
6. Sea Level and storm surge modeling
7. Wave modeling
8. Biogeochemical modeling

Way forward chapters

9. Coupled Prediction: Integrating Atmosphere-Wave-Ocean forecasting
10. Challenges and Future perspectives in ocean modeling

Guide: experts involved

GUIDE			
N°	**Chapters**	**Chapter coordinators**	**Section coordinators**
1	Introduction	Enrique Alvarez Fanjul	
2	The international context; CMEMS and other initiatives	Pierre Bahurel	
3	Definition of the temporal and spatial scales solved by ocean modeling system	Enrique Alvarez Fanjul	Marcos Garcia; John Willkin
4	Architecture of ocean modeling systems	Avichal Mehra	Marina Tonani; Aihong Zhong; Antonio Repucci; Sudheer Joseph; Vinaychandran; Marcos Garcia; Marie Drevillon; Aihong Zhong; Laurence Crosnier; Renaud Dussurget
5	Circulation modeling	Stefania Ciliberti	Simona Massina; Yann Drillet
6	Sea level and storm surge modeling	Fujiang Yu	Rick Leuticch;
7	Wave modeling	Lotfi Aouf	Joanna Staneva; Fabrice Ardhuin
8	Biogeochemical modeling	Elodie Gutcknecht	Giampiero Cosserin; Stephano Ciavata
9	Coupled Prediction: Integrated Atmosphere – Wave – Ocean forecasting	John Siddorn	Øyvind Breivik; Steve Penny; Gilbert Brunet; Natacha Bernier
10	Downstream applications: From data to products	Giovanni Coppini	Joao Chambel; Glenn Nolan
11	Future perspectives in ocean modeling	Fraser Davidson	Gregg Smith; Ronan Fablet; Eric Chassignet

Status:

- Well on track for a publication in 2021

PROGRESS MADE SINCE LAST SC

2) A BOOKLET *TO PROMOTE GOOS OOFS CAPACITY*

2- The Booklet

Objectives:

- Presents the Guide's major characteristics
  → in a synthesised way (16 pages)
  → suitable for a general audience
- Uses the same structure and summarises each one of its chapters in one page

P. 4 **TOWARD A FORECASTING CAPACITY**
Operational oceanography has been driven by a great international momentum of scientists and engineers to build what is today a worlwide solid service infrastructure.
Introduction 4
Motivation and Scope of Ocean Monitoring and Forecasting Capacity 5
Architecture of an Ocean Monitoring and Forecasting System 6

P. 9 **MODELING THE OCEAN**
While there are common grounds for modeling the ocean, from the collection of ocean observations to final ocean forecasts, each type of model has its own specificities to make ocean forecasts the most accurate.
Temporal and spatial scales solved by Ocean Monitoring and Forecasting Systems 8
Ocean circulation modeling 9
Sea level and storm surge modeling 10
Wave modeling 11
Biogeochemical modeling 12
Coupled modeling 13

P. 14 **A USER-DRIVEN SERVICE**
Operational oceanography supplies routine and relevant products and information to its users along with relevant services driven by user requirements.
Downstream applications: from products and services to outreach 14
Future perspectives in ocean modeling 15

Status:

- Ready for dissemination: Early May

2- Booklet: Content

The Global Ocean Observing System

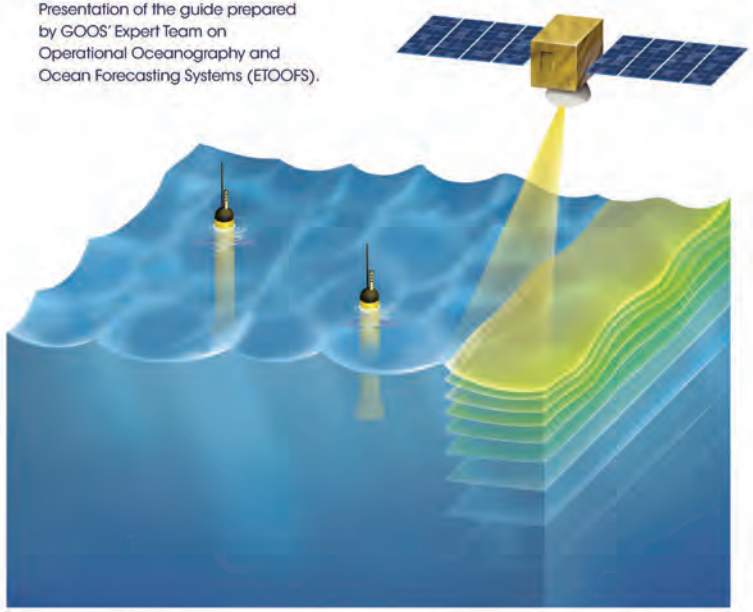
United Nations Educational, Scientific and Cultural Organization

Intergovernmental Oceanographic Commission

WORLD METEOROLOGICAL ORGANIZATION

Implementing Operational Ocean Monitoring and Forecasting Systems

Presentation of the guide prepared by GOOS' Expert Team on Operational Oceanography and Ocean Forecasting Systems (ETOOFS).

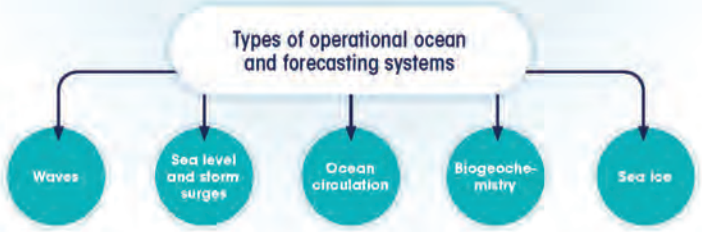


WITH THE SUPPORT OF MERCATOR OCEAN INTERNATIONAL

A Guide on Operational Ocean Monitoring and Forecasting Systems

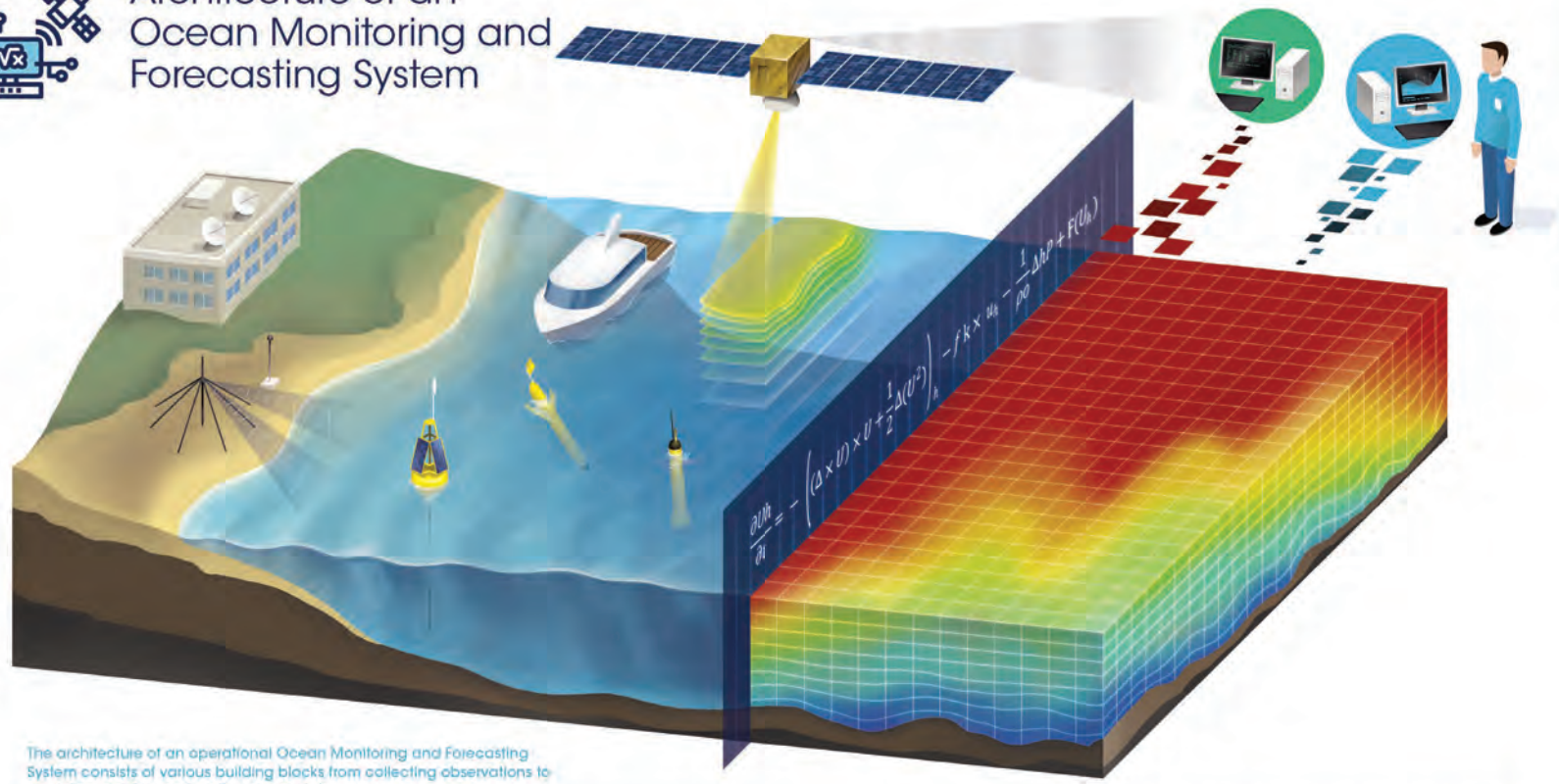
At the request of the Intergovernmental Oceanographic Commission of the UNESCO (IOC-UNESCO) and the World Meteorological Organization (WMO), the Global Ocean Observing System (GOOS) and its Expert Team on Operational Oceanography and Forecasting Systems (ETOOFS) have prepared a guide on international standards and best-practices for setting up an operational oceanography and forecasting systems service. This document is a summary of the Guide on Operational Ocean Monitoring and Forecasting Systems and presents its major characteristics in a synthesised way.

Today, every single country in the world with a coastline, or not, is likely to engage in marine activities for national security, environmental protection and maritime economic development. Such activities require the monitoring and forecasting of the physical, biogeochemical and sea ice state of the ocean on a daily basis. Operational Oceanography relies on expertise and brings the relevant ocean data for monitoring an assesment. The scientific and technical knowledge assembled in the guide serves to facilitate the implementation of an efficient Operational Oceanography and Forecasting service.



2- Booklet: Content

Architecture of an Ocean Monitoring and Forecasting System



The architecture of an operational Ocean Monitoring and Forecasting System consists of various building blocks from collecting observations to modeling and forecasting the ocean state.

Pre-processing phase › **Initialisation** › **Forward integration and post-processing**

1/ COLLECTING DATA ABOUT THE OCEAN STATE

In-situ and satellite data collected describe the state of the ocean, such as temperature or salinity.

They are acquired thanks to different observation systems: satellites, buoys, ocean research vessels and underwater gliders to name a few.

2/ MODELING

Numerical ocean models employ specific mathematical formulae based on the fluid dynamics equations. They can describe the ocean state now and in the past and also predict the ocean state in the future. Such equations first need to be fed with initial and boundary conditions of the ocean state, i.e. start and surrounding information on the ocean state. Continuous equations have to be discretized, i.e. transferred from continuous formulae into discrete model grid formulae, in order to be solved by a computer; an adequate time and space step has to be selected.

Different techniques can be used such as:

- ensemble modeling where 3 or more related models analyze at the same time nearly the same process. Later their slightly different results are averaged, and their difference is used to give an estimation of the error,
- coupled models where 2 model fields are run at the same time and can interact with one another.

3/ OBSERVATIONS ARE THEN ASSIMILATED

The model is constrained or guided by observations to stay as close as possible to the observations. This is called Data Assimilation.

4/ VALIDATION AND VERIFICATION

The model is evaluated against the available ocean observations to verify its reliability and quality.

5/ FORWARD INTEGRATION

The model can describe the ocean state in-real-time, in forecast or reanalysis mode.

6/ OUTPUT

An operational system routinely provides these predictions on a routine basis and with sufficient latency to support user's decisions.

7/ USER MANAGEMENT AND OUTREACH

Ocean products are then delivered to users at international, national or regional levels. User requirements are taken into account to improve the products. A state-of-the-art service and user management has to be set up to ensure the quality of the service.

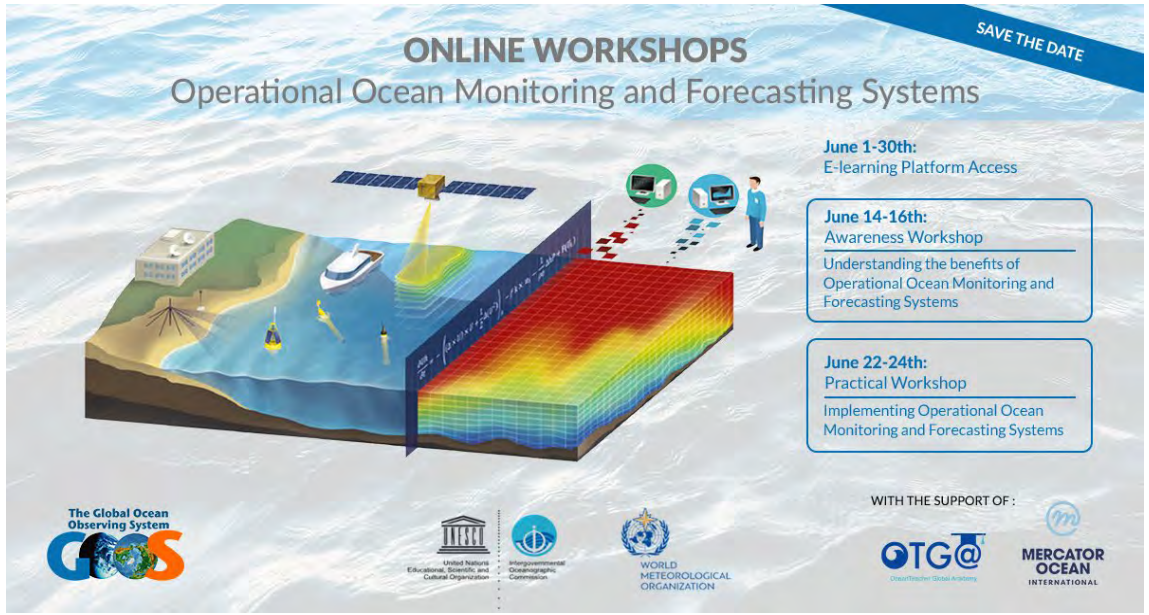
PROGRESS MADE SINCE LAST SC

3) A WORKSHOP *TO EXPLAIN AND PRACTICE OOFS*

3 - Online Workshops 14-16 June 2021 + 22-24 June 2021

Objectives:

- Capacity-building workshops on OOFS
- Promote the Guide
- Network building, spreading operational oceanography
- Mapping interested operational oceanographic centres



Content:

- **Awareness Workshop**, June 14-16th :
  - Interactive sessions: roundtables, presentations, interviews, quizzes…
  - Unlimited amount of participants
- **Practical Workshop**, June 22-24th:
  - Technical sessions: presentations, tutorials, exercises
  - On application, open to 100 participants
- **E-Learning platform**:
  - Open throughout June to participants,
  - Provides course material about the Guide (summaries, videos, authors biographies, articles, quizzes, forum)

In cooperation with IODE/OTGA

Awareness Workshop – Highlights from draft agenda

Day 1 – June 14th: **Motivations and international context**

- Welcome (GOOS and IOC)
- Presentation of the guide and initial chapters
- Interview session on benefits from OOFS activities

Day 2 – June 15th: **Modeling the ocean; operational systems**

- Roundtable on OOFS system architecture
- Roundtable on modeling the ocean (waves, sea level…)

Day 3 – June 16th: **Dissemination the OOFS information**

- Interview session on downstream applications
- Roundtable on ways forward

Practical Workshop – Highlights from draft agenda

Day 1 – June 22nd: **Products and outreach**

- Lectures
- Hands on exercises on graphical user and command line interface tools

Day 2 – June 23rd: **Models inter-comparison and assimilation impact**

- Lectures
- Hands on exercises with Jupyter notebook on Models inter-comparison and assimilation impact

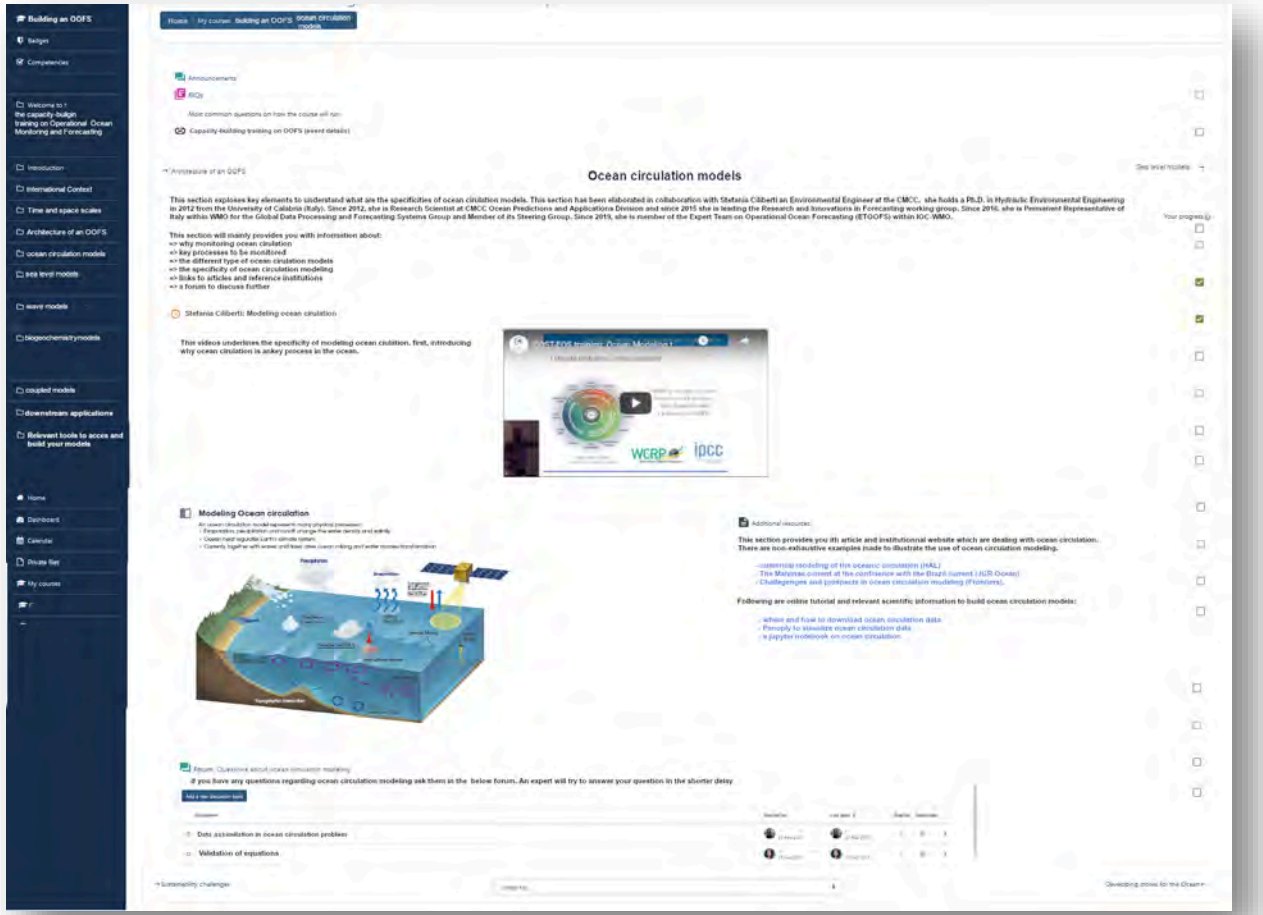
Day 3 – June 24th: **Downscalling**

- Lectures
- Hands on exercise on SURF platform for model downscalling

E-Learning platform (hosted on IODE/OTGA)

One page per chapter with:

- **Summary** of the chapter
- Short **biography** of the main author
- 2-3 shorts **videos** of 5 min
- List of relevant **literature**
- **Quiz** of 3 questions about the lecture
- **Forum** for participants



Future plans of ETOOFS

FORESEEN CONTRIBUTIONS TO GOOS IP

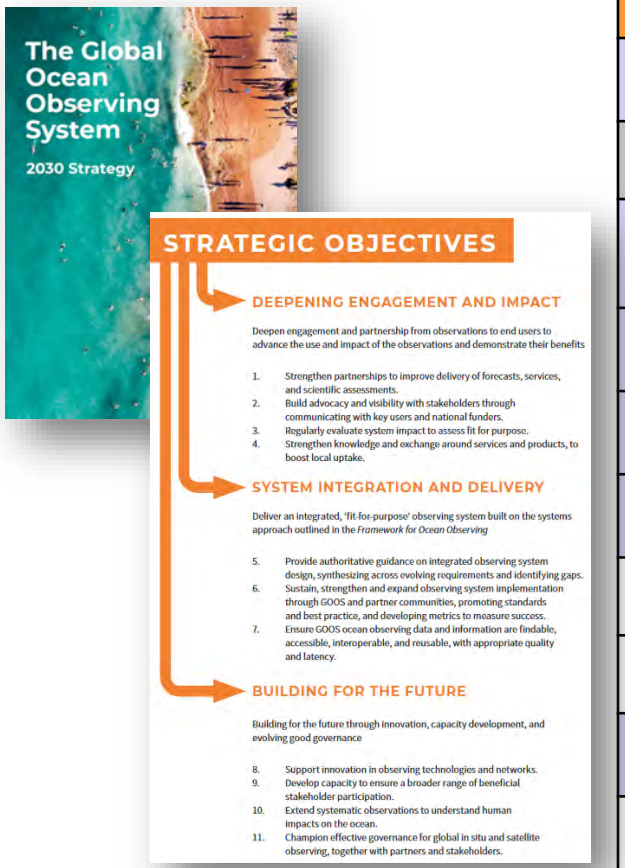
Future plans of ETOOFS

To further integrate the **GOOS « Modelling & Digital / Ocean Forecasting » component** within the GOOS infrastructure and strenghten it

To work with GRAs, with Ocean Predict, with OOFS centres worldwide to better reflect the Ocean Forecasting capacity of this community and reinforce its performance and impact with GEO Blue Planet, G7 FSOI and others

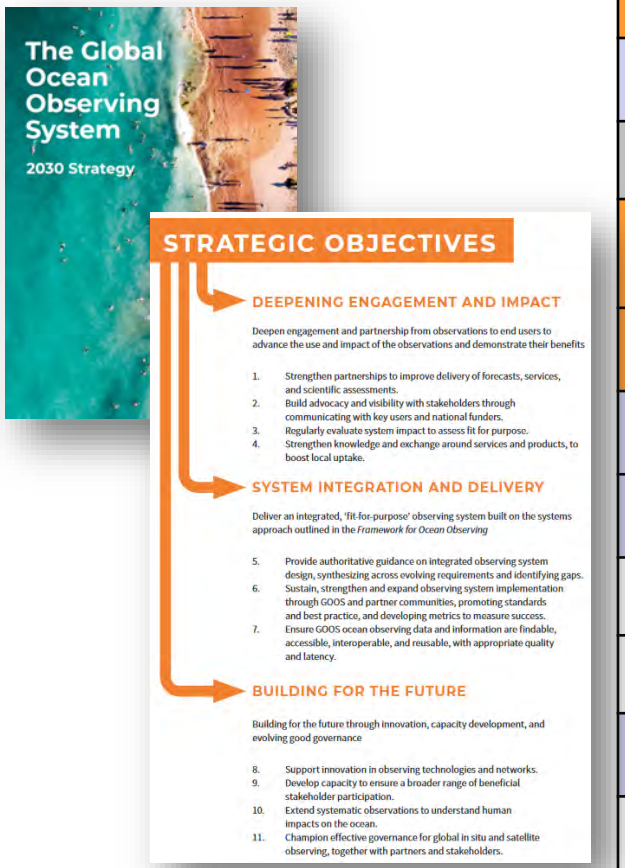
To offer a solid asset on modelling & digital to support GOOS and its UN Decade programs, such as Foresea, ObsCoDe, CoastPredict, Ditto, …

ETOOFS and GOOS IP



GOOS	Strategic Objectives	ETOOFS contribution	2020 2021	2022 2023	2024 2025
SO1	**Partnership**	Partnership with OceanPredict, EC/ Copernicus		Ocean Predict	Copernicus
SO2	Advocacy	*Support to GOOS office*			
SO3	**Assessment**	Guide for System Evaluation (metrics) with OceanPredict and Copernicus		OOFS Metrics	
		Inventory of OOFS centres (with GRAs)		OOFS centres	OOFS centres
SO4	**Uptake**	Guide for OOFS	OOFS Guide		
		GOOS portfolio for OOFS		GOOS 4OOFS	
SO5	Obs Guidance				
SO6	Obs Expansion				
SO7	**FAIR**	Guide of OOFS standards (production and share)		OOFS KPIs	OOFS Standards
SO8	Obs Innovation				
SO9	**Capacity Dev**	Awareness and Training OOFS workshops	OOFS Workshops	OOFS Workshops	OOFS Workshops
SO10	Human impact				
SO11	Governance				

ETOOFS and GOOS IP



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SO6	Obs Expansion				
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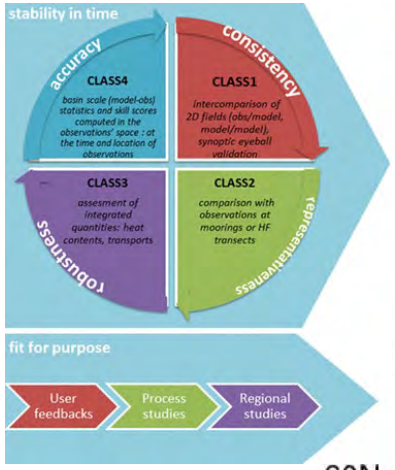
SO8	Obs Innovation				
SO9	**Capacity Dev**	Awareness and Training OOFS workshops	OOFS Workshops	OOFS Workshops	OOFS Workshops
SO10	Human impact				
SO11	Governance				

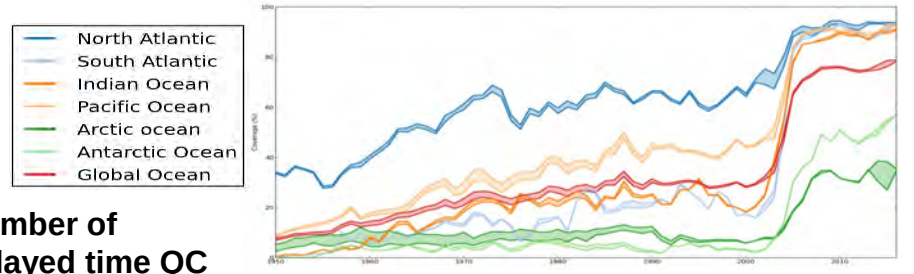
Future ETOOFS action:

OOFS Guide / Metrics for assessing products



OceanPredict
Advancing the science of ocean prediction

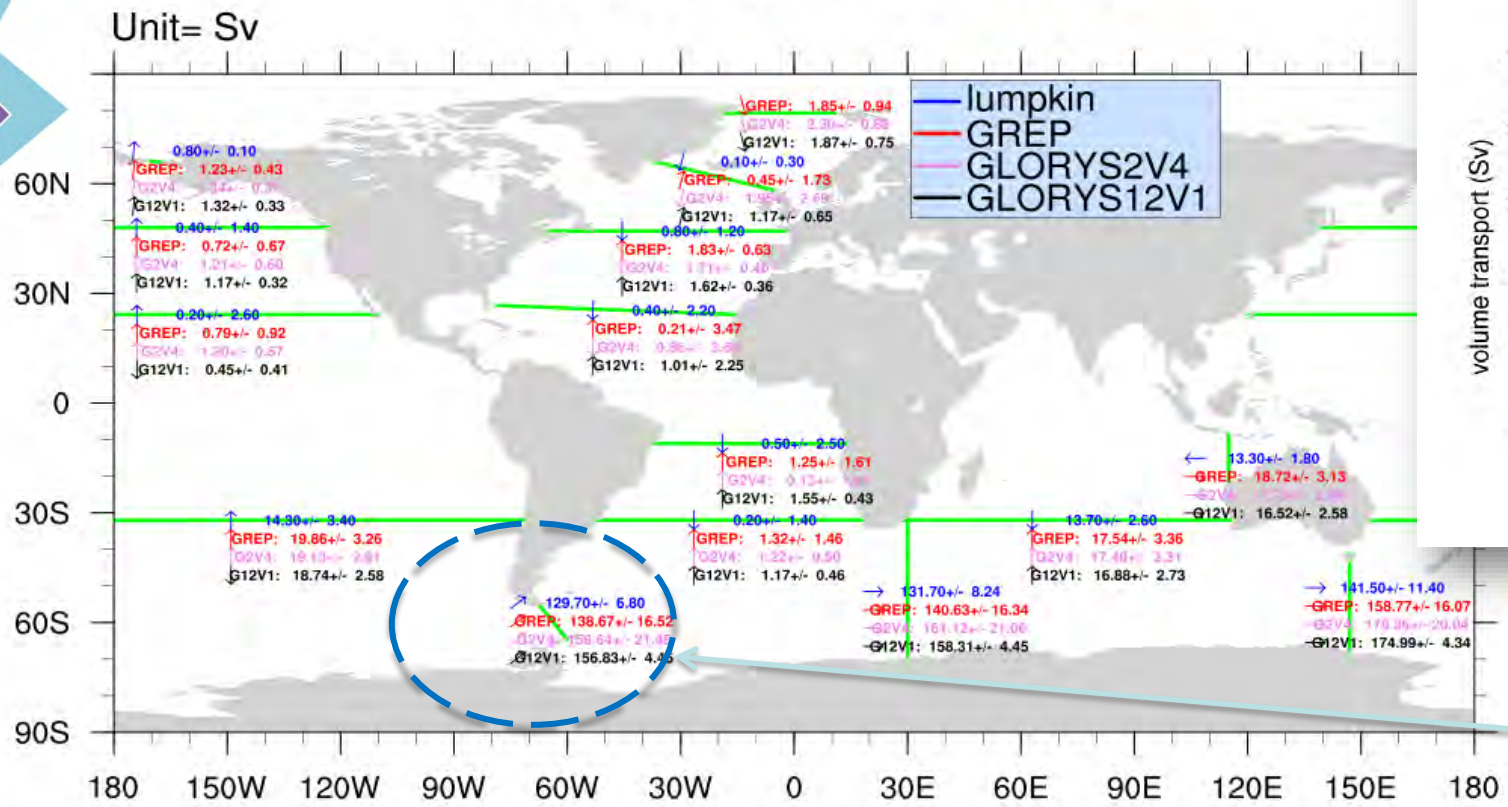
Copernicus Marine Service

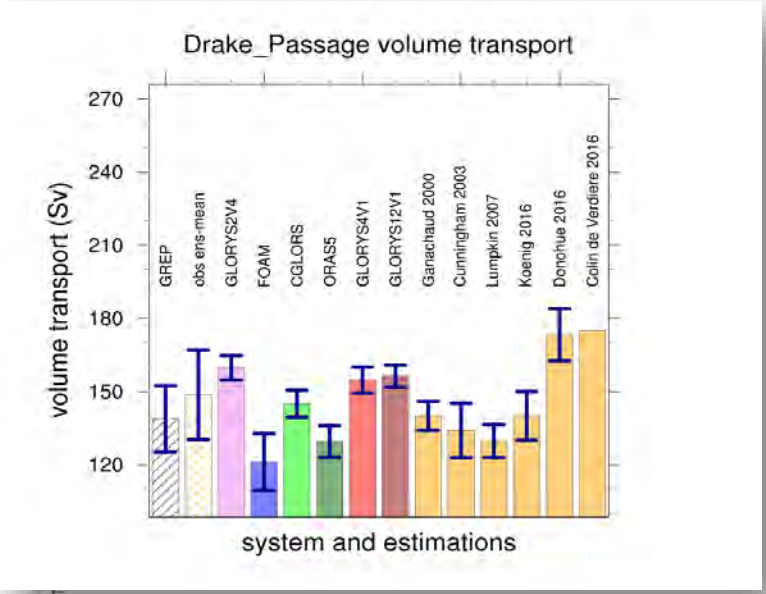


Number of <u>delayed time QC</u> observations

1950 **->2018**

1993-2017 volume transport



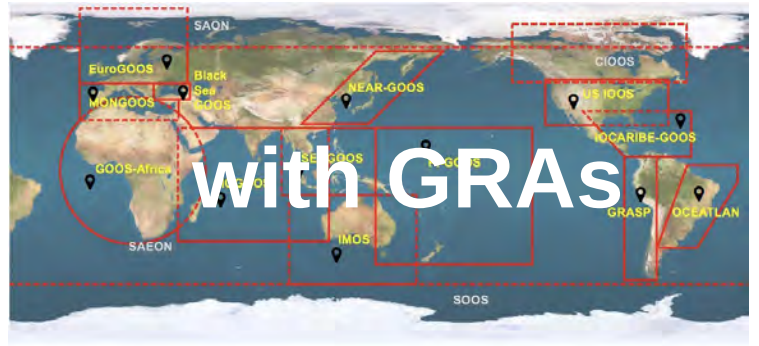


Drake volume transport, comparaison with different estimations

Volume transports comparison with Lumpkin estimations

Future ETOOFS action:

OOFS Centres mapping with GRAs



Rationale

- Build and maintain a comprehensive database about OOFS Centres around the world, describe their variety and specific value
- Use the GRAs framework for efficiency and consistency; cross-check with IOC and WMO networks
- Take benefit of OOFS workshops

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