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Ocean integration:
How can we improve coordination between ocean observing activities?

Adèle Révelard, on behalf of all co-authors

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This work has led to the position paper:

Révelard A, Tintoré J, Verron J, Bahurel P, Barth JA, Belbéoch M, Benveniste J, Bonnefond P, Chassignet EP, Cravatte S, Davidson F, deYoung B, Heupel M, Heslop E, Hörstmann C, Karstensen J, Le Traon PY, Marques M, McLean C, Medina R, Paluszkiewicz T, Pascual A, Pearlman J, Petihakis G, Pinardi N, Pouliquen S, Rayner R, Shepherd I, Sprintall J, Tanhua T, Testor P, Seppälä J, Siddorn J, Thomsen S, Valdés L, Visbeck M, Waite AM, Werner F, Wilkin J and Williams B (2022) **Ocean Integration: The Needs and Challenges of Effective Coordination Within the Ocean Observing System.** Front. Mar. Sci. 8:737671. doi: 10.3389/fmars.2021.737671

Outline

Ocean integration…

1. What does it mean?
2. Why do we need it?
3. Why is it challenging?
4. How to achieve? A proposal for collective action

Ocean integration: what does it mean?

Ocean = complex system ➡ need to combine data from:

- multiple disciplines *(physics, geochemistry, biology)*
- multiple *in situ* platforms *(buoys, moorings, gliders, ships, etc.)*
- multiple remote platforms *(satellites, HF Radar)*
- multiple numerical models

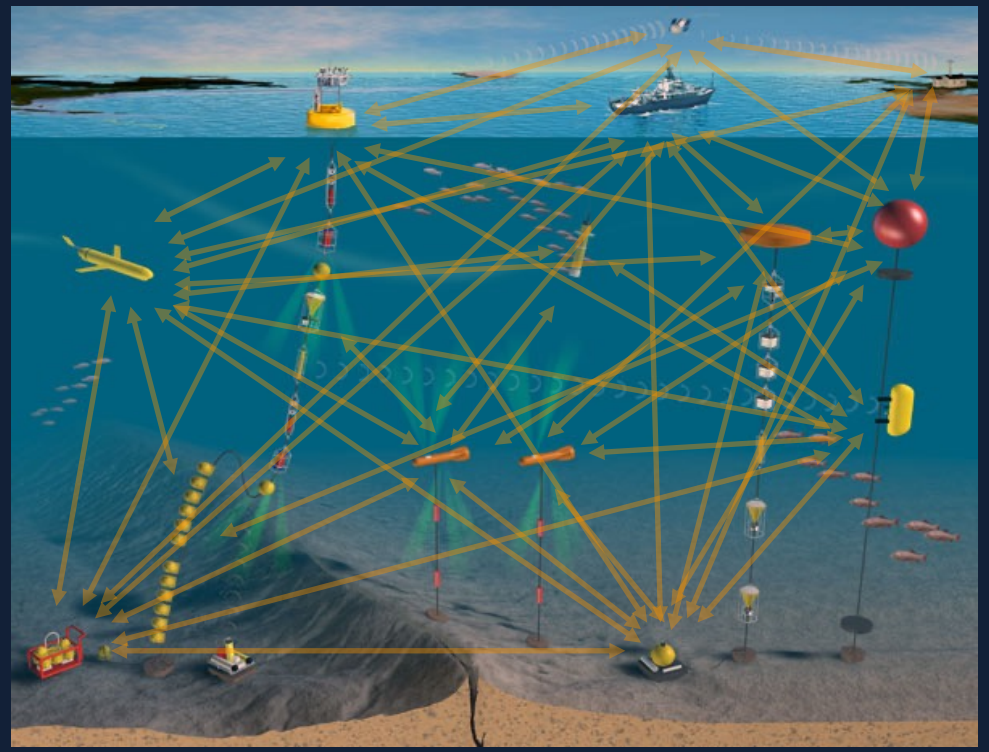
Ocean integration

=

optimally coordinate all these elements

so they are **shaped to each other**

and **form a coherent whole**



Adapted from NOAA

Ocean integration: what does it mean?

Example:

The optimal combination of

ARGO + satellite altimetry + numerical model

=

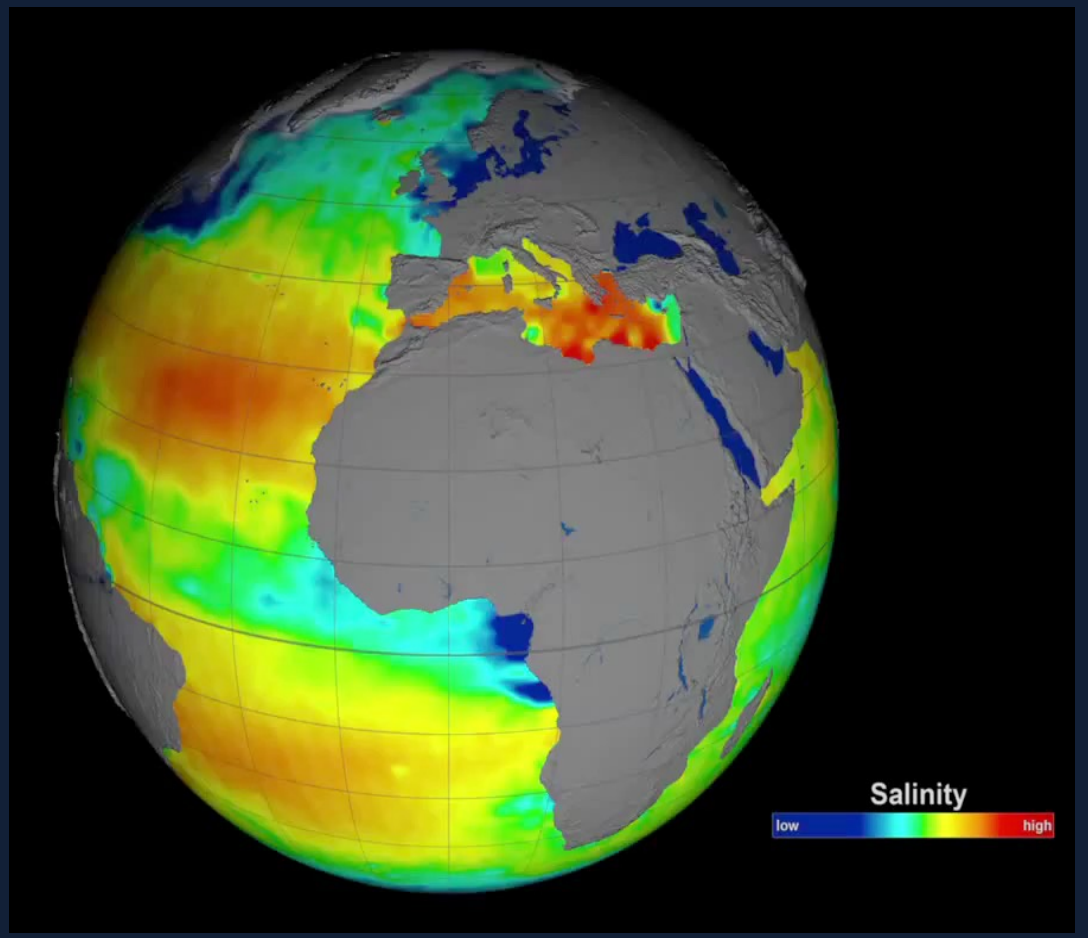
large-scale open ocean circulation

Initiated by the GODAE initiative (Smith and Lefebre, 1997; Bell et al. 2009)

A **major breakthrough** that led to the development of:

- Operational Oceanography
- Copernicus Marine Service

(Le Traon, 2013, 2017)



Ocean integration: why do we need it?

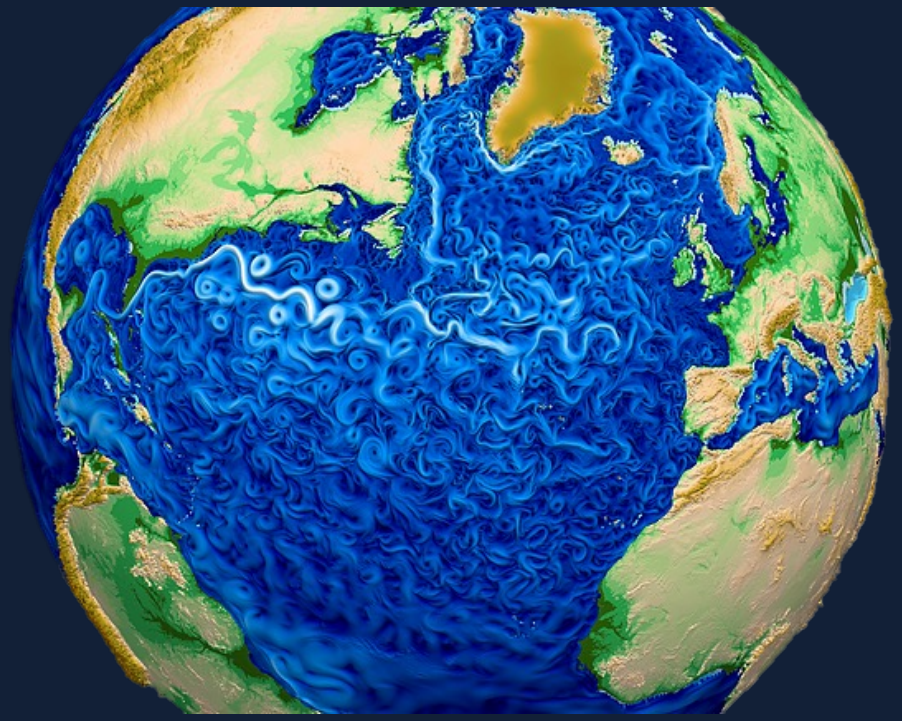
Today's challenge: the meso & submesoscale and the coastal regions

Essential for:

- **Climate** (heat transport, vertical exchanges)
- **Ocean health** (nutrients, spawning areas, jellyfish, etc.)
- **Operational response** (SAR, oil spills, plastics, etc.)

This requires the combination of harmonized multi-platform measurements in order to:

- Yield **sufficient vertical, horizontal and temporal resolution**
- For a set of **multidisciplinary lists of variables**
- Better characterize **the "initial state" of oceanic forecasts**



Ocean eddies contains the major part of ocean kinetic energy

Ocean integration: why do we need it?

Strong societal expectations

Ocean integration is **essential** to **commensurate** with the **ambition** of the **UN Decade of Ocean Science** and the **Digital Twin of the Ocean**

Ocean integration: why do we need it?

Current issues restricting our ability to advance faster:

- **Gaps in ocean observing coverage**
  - → Important processes insufficiently measured
  - → Observing networks only partially adequate for addressing new scientific challenges
  - → Observing networks do not resolve multiple spatiotemporal scales

Global Ocean Science Report, 2017; 2020
IOC, 2017;
NASEM, 2017; 2020
EOOS, 2018;
IPCC, 2019;
EMB, 2013, 2019,;
OceanObs'19;
Tanhua et al. 2019;
Davidson et al. 2019

- **Insufficient sharing**
  - → Lots of observations are not FAIR
  - → Most observations cannot be used to their full extent
  - → Difficulties in implementing data assimilation and model verification

- **Duplication of effort**
  - → Little communication between teams, institutions or nations
  - → Most observations are not fit-for-multiple purposes
  - → Non-optimum use of resources

Data do not exist
Data exist but they are not available
Data exist but they are not fit-for-use

(EOOS, 2018)

Ocean integration: why is it challenging?

Ocean integration requires to

transcend the traditional

silos of expertise

Illustration by Marc Hughes for PlannersWeb

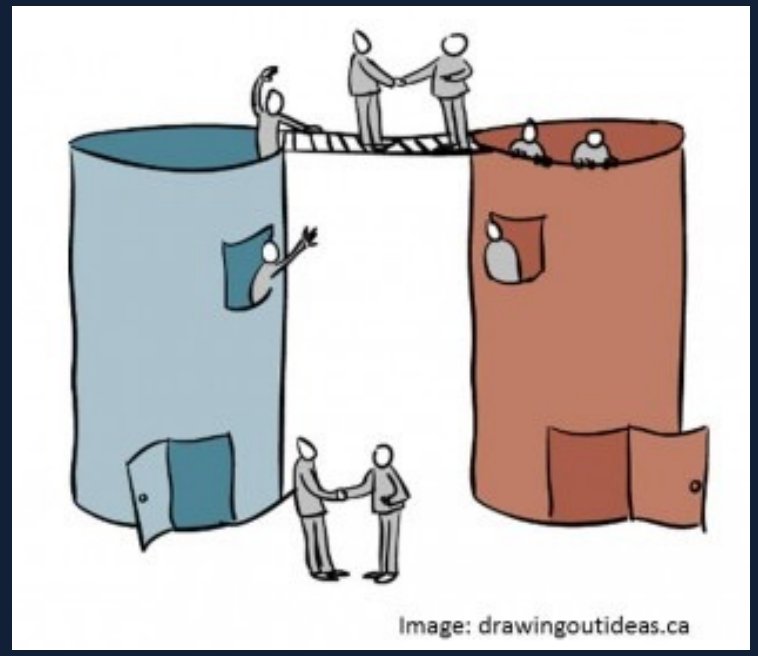
A challenge in many **transdisciplinary research areas**…

and also in **ecosystem management** and in **the private sector!**

Ocean integration: why is it challenging?

Common solutions for connecting silos:

1. Make integration **an integral part of the work**
2. Define a **common goal**
3. Share **moral and ethical standards**
4. Have **strong leadership**
5. Remove **internal competitiveness**
6. Redesign the **organizational structure**

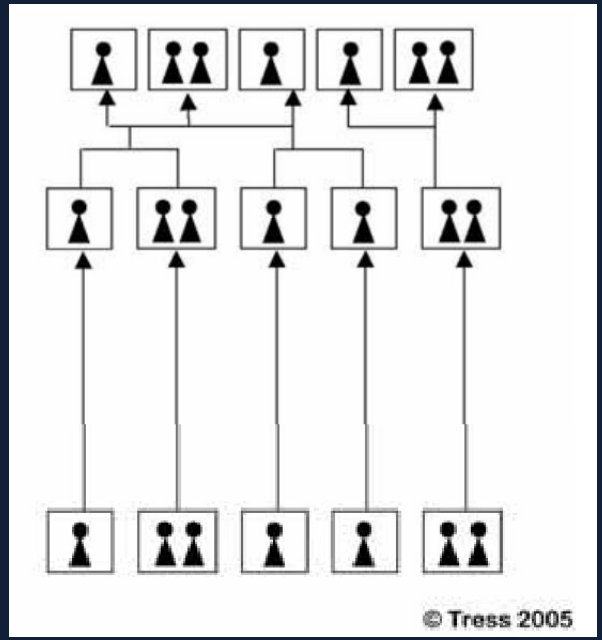


Wikson et al. 2006;
Tress et al. 2006, 2007;
Kragt et al. 2011;
Ostrom, 2009; 2012;
Newhouse and Spring 2010;
Kania and Kramer, 2011;
Weller et al. 2019;
OECD, 2020;
Marques, 2020, 2021;

Ocean integration: why is it challenging?

In ocean observing, there are **organisational silos** because:

- **Research-based** system, driven by discovery and understanding
- **Unpredictable short-term** research-based funding
- **Discipline/platform-oriented** organization
- **Disparate** landscape
- **Fragmented** governance, with weak leadership
- **Hypercompetitive** culture, driven by scientific "excellence"



➡ **Platforms/networks/disciplines tend to run in parallel**

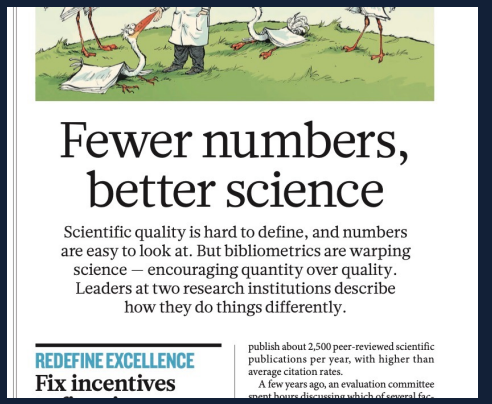
NASEM, 2017; 2020
IOC, 2017;
EOOS, 2018;
OceanObs'19;
Tanhua et al. 2019;
Davidson et al. 2019
EMB, 2021

Ocean integration: why is it challenging?

Reforming the research assessment system, a strong claim since 2012

Research assessment should include:

- The **full range of research outputs** (publication, data, software, models, methods, theories, algorithms, protocols, strategies, policy contributions, etc.)
- The **diversity of research activities** (teaching, supervision, training, mentoring, data stewardship, public outreach, teamwork, etc.)
- **Team science & collaboration** (open science practices, leadership, contribution to the research ecosystem, contribution to knowledge generation, etc.)



The Metric Tide, 2015. Hicks et al., 2015; Benedictus and Miedema, 2016; Van Noorden, R. (2018); Nature editorial, 2018; Bleasdale, 2019; Coriat, 2019; Moher et al., 2020; OECD report, 2020, Lubchenco and Rapley, 2020; Hernández- Aguilera et al., 2021; Delgado-López-Cózar, 2021, EU scoping report, 2021

Ocean integration: how to achieve?

Ocean integration could be achieved through:

- **Building a mission-based organisation**
  - → Agreeing on a common agenda & principles
  - → Establishing clear design & implementation plan
  - → Redesigning a robust governance structure
- **Reaching sustainability**
  - → Elaborating mission-based funding strategies
  - → Efficiently communicating the value of ocean observing
  - → Facilitating the transition from research to operations
- **Promoting a culture shift**
  - → Connecting the diverse communities
  - → Fostering FAIR data and best practices
  - → Redefining scientific "excellence"

frontiers in Marine Science

POLICY AND PRACTICE REVIEWS
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Ocean Integration: The Needs and Challenges of Effective Coordination Within the Ocean Observing System

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Conclusion

This challenge will only be possible if

the **whole community is convinced**

to **collectively debate on how to proceed**


A Digital Ocean Forum For Europe

HIGHLIGHTS

MERCATOR OCEAN INTERNATIONAL

The European DTO is launched

At the One Ocean Summit hosted by the French Presidency of the Council of the EU in February 2022, more than 40 countries united to put the Ocean at the heart of the international political agenda.

To strengthen EU leadership in protecting the Ocean, European Commission President von der Leyen launched the European Digital Twin Ocean (DTO) to support the framework of the EU Mission Restore Our Ocean and Waters by 2030 and to enable the ambition of the European Green Deal.

At the One Ocean Summit, von der Leyen explained:

"The ocean is still largely a great mystery for humankind. That is why Europe is building a digital twin of the ocean. We are connecting our assets – like the Copernicus satellites, marine infrastructure like icebreakers, buoys and underwater drones, and high-performance computing. We will gather the raw data and turn it into real-time knowledge and longer-term predictions. We are putting the power of the digital revolution at the service of our climate. (...) Thanks to the EU and its Member States, a digital twin should be operational by 2024. It will make ocean knowledge open-access, available to citizens, scientists and policymakers around the world. It will be a platform for global cooperation. It is about putting the capabilities in place to achieve the commitments we make at this Summit. Together, with the digital twin, we will turn the lights on in the ocean."

The European Commission is investing €13 million to develop a core European DTO. This complements the €19 million project, *Iliad* funded under the Green Deal Call for research proposals to pilot the DTO concept.

On 20 April 2022, more than 70 experts from 20 countries across Europe came together in Paris to develop a common vision for a European DTO and agreements on how to move forward together to meet this transformational challenge.

EUROPEAN DIGITAL OCEAN FORUM – 20TH AND 21ST APRIL 2022 1

European Digital Ocean Forum
20-21 April 2022

"Building a Digital Twin Ocean will require **more than connecting and improving what we already have**"

It will require:

- "A **complete disruption and paradigm shift in the way we think and work**"
- "Building a **common vision and framework**"

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 862626

Thank you !

Please share your ideas on how to advance on this!

Send us your feedback at ocean.integration@socib.es

More information in this position paper:

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