

Symposium on Advancement of
Technologies for Utilizing Big
Data of Marine Life

Exploring Recent Trends in the UN Decade of Ocean Science

Japan Science and Technology Agency(JST)
Center for R&D Strategy (CRDS)
Environment and Energy Unit

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Ayako TSUBOI

Osamu FUJII



The Role of CRDS

Activities

Research on science & technology fields and policies
Analysis of societal needs and global trends

Outputs

Strategic proposals and reports
Public lectures and publications

Utilization

Used by government, academia, and industry
Supports policy planning and R&D strategies



<https://www.jst.go.jp/crds/report/by-category/index.html>

accessed on November 27, 2025

Stakeholders

Ministries, universities, research institutes, industries, and overseas R&D organizations

Today's Agenda



1. Introduction

UN Ocean Decade, Key Nation's Ocean Policy

2. Ocean Science Trends and Challenges

① Ocean DX : Monitoring, Biologging, Big Data Platform and Application Modeling

② Blue Economy : Resource Management, Marine Biotechnology
Blue Carbon Estimation, Offshore Wind Energy

③ Plastic Pollution: Current Status and Impacts,
Technical Challenges
JST's Initiative

3. Summary

Ocean Data Integration, AI-driven Research, JST Program, Global Data Sharing

1. Introduction

UN Ocean Decade: Vision and Goals



United Nations Decade of Ocean Science for Sustainable Development 2021-2030

A global initiative to advance ocean science and achieve sustainable development goals through improved knowledge and collaboration.

<https://www.unesco.org/en/decades/ocean-decade> accessed on November 27, 2025

Seven Ocean Decade Outcomes

Clean Ocean

Healthy & Resilient Ocean

Productive Ocean

Safe Ocean

Accessible Ocean

Predicted Ocean

Inspiring & Engaging Ocean

<https://oceandecadenortheastpacific.org/about/un-decade-ocean-science> accessed on November 27, 2025

SUSTAINABLE DEVELOPMENT GOALS



14. LIFE BELOW WATER
Protect Oceans and Marine Life.

<https://www.un.org/sustainabledevelopment> accessed on December 9, 2025

The content of this publication has not been approved by the United Nations and does not reflect the views of the United Nations or its officials or Member States.

1. Introduction

Major UN Ocean Decade Actions



Programme

**GLOBAL OCEAN DECADE
PROGRAMME FOR
BLUE CARBON**

Global initiative to protect and restore blue carbon ecosystems for climate mitigation, biodiversity

<https://oceandecade.org/actions/global-ocean-decade-programme-for-blue-carbon/> accessed on December 9, 2025

The NIPPON FOUNDATION-GEBCO
**SEABED
2030**

A global initiative relentless in our pursuit of achieving a complete map of the ocean floor by 2030.

<https://seabed2030.org/> accessed on December 9, 2025

Activity

Not for Public Release

5th edition of the Ocean Literacy Dialogues at the 2024 Ocean Decade Conference

<https://icsf.net/newss/ocean-literacy-dialogues-at-the-2024-ocean-decade-conference/> accessed on December 9, 2025

Project

DITTO
Digital Twin of the Ocean

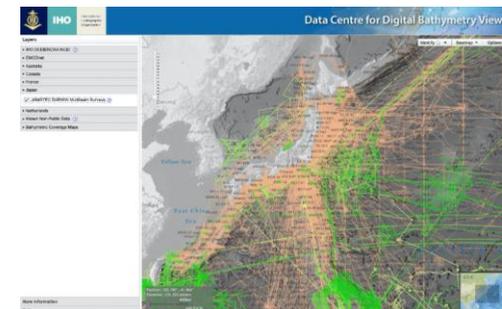
<https://ditto-oceandecade.org/>

Not for Public Release

Costal Predict-Observing and Predicting the Global Costal Ocean

<https://www.coastpredict.org/> accessed on December 9, 2025

Contribution



The Nippon Foundation's Contribution to Seabed 2030

<https://www.jamstec.go.jp/seabed2030/e/> accessed on December 9, 2025

1. Introduction

International Policies and Japan's Strategy



Global Ocean Policy - Key Points

- UN** : Ocean Decade, SDGs 14, Ocean Observation, Maritime Security
- Japan** : **4th Basic Plan on Ocean Policy**
- USA** : **NOAA Ocean Policy Committee**
Maritime Security, Ocean Observation, Data Integration
- EU** : **Horizon Europe FP9→FP10**
Marine Ecosystem, Marine Litter
Blue Economy, Marine Renewable Energy, Spatial Planning
- China** : **Maritime Power Strategy**
14th Five-Year Plan for Marine Economy
Marine Tech Development, Resource Control

Japan's 4th Basic Plan on Ocean Policy



<https://www.msil.go.jp/msil/htm/topwindow.html>
accessed on November 27, 2025

NEW FOCUS



Figure created by CRDS using Generative AI.
<https://www.nedo.go.jp/fuusha/haikai.html>
accessed on November 27, 2025



Figure created by CRDS using Generative AI.
<https://ippjapan.org/archives/4799>
accessed on November 27, 2025

2. Ocean Science Trends & Challenges



Trends

Challenges

Ocean DX

Real-time monitoring with satellites, bio-logging, AI, Use of Big Data

Blue Economy Growth

Offshore wind, marine biotech, eco-tourism.

Plastic Pollution

Over 11 million tons/year, could be double or triple by 2040 (w/o intervention)

<https://oceanconservancy.org/blog/2020/07/28/world-track-triple-ocean-plastic-pollution-2040/>

Climate Change & Carbon Cycle

Global Warming, Acidification, Blue Carbon

Global Cooperation

BBNJ & PSMA agreements, expanding protected areas.

Climate & Ocean Ecosystems

Climate impact studies, Carbon cycle, blue carbon, biosphere

Overfishing & Biodiversity Loss

IUU, Declining fish stocks, weak enforcement.

Aging Infrastructure & Data Gap

Outdated vessels, fragmented data

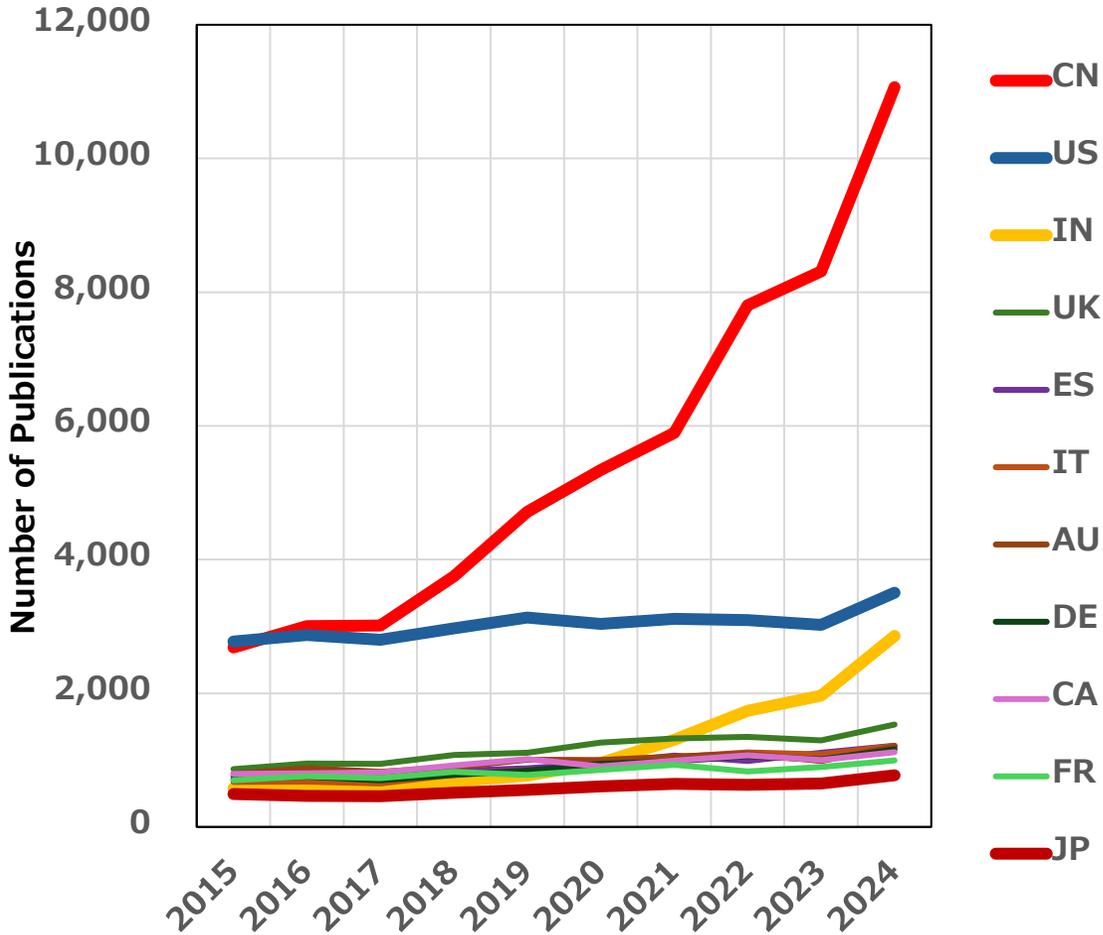
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PSMA (Port State Measures Agreement): An international agreement that requires port states to implement strict entry and inspection measures on foreign fishing vessels to combat illegal, unreported, and unregulated (IUU) fishing.

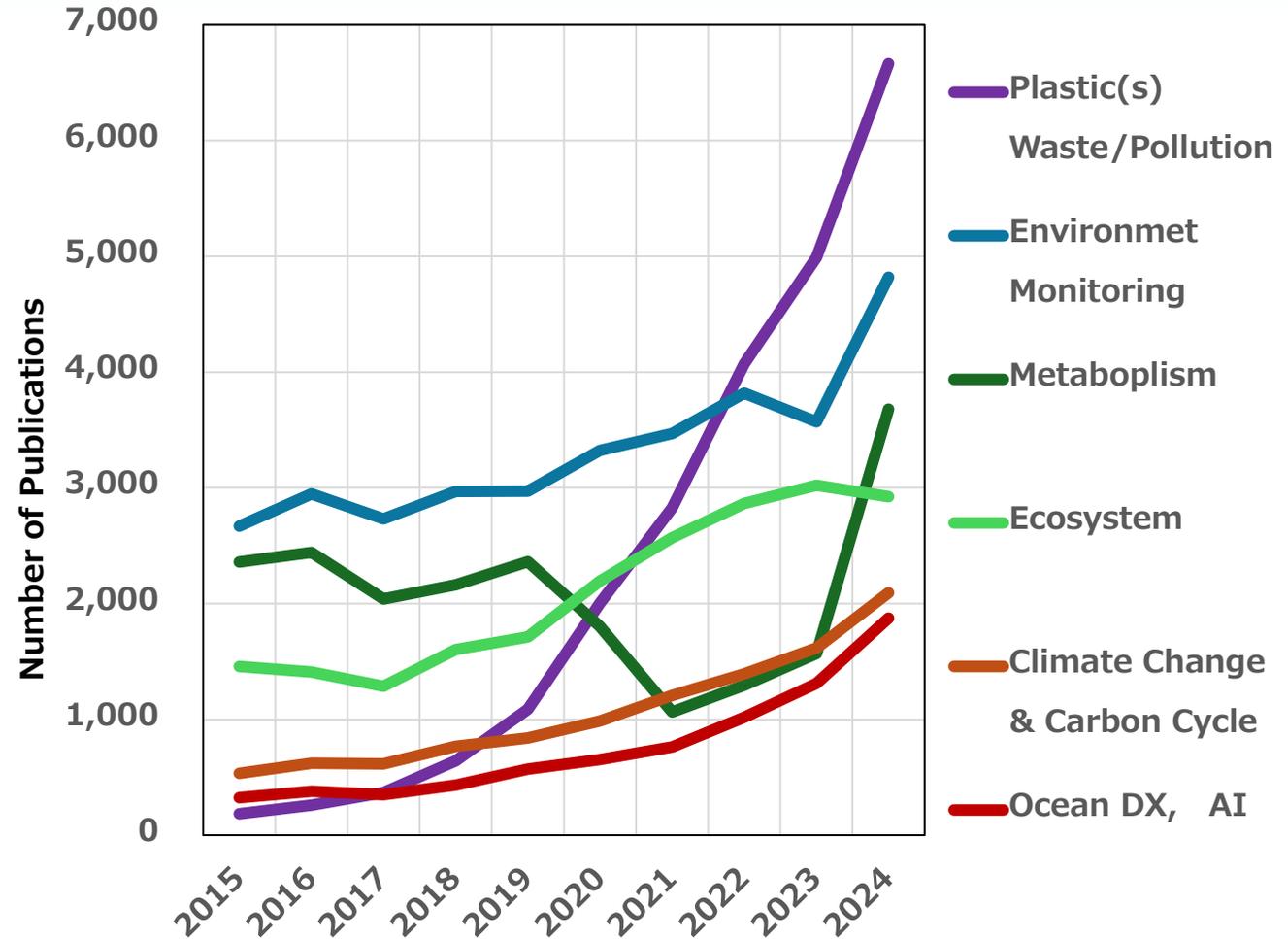
2. Ocean Science Trends & Challenges



■ Publication Trends in Marine Science (2015–2024)



Marine Science Publications by Country



Trends of Frequent Keywords

2. Ocean Science Trends & Challenges



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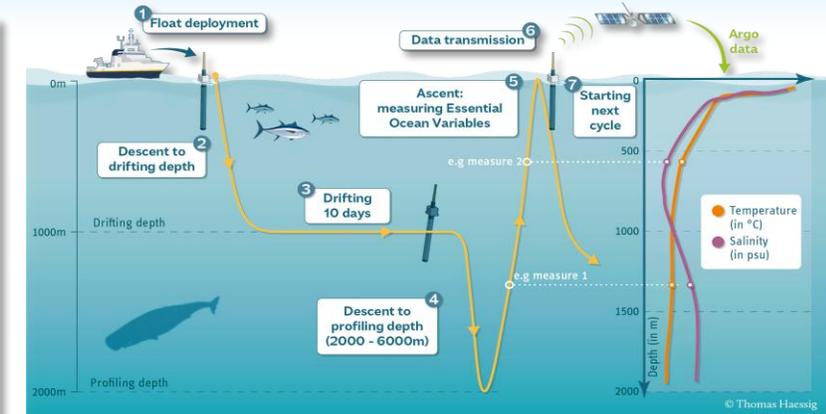
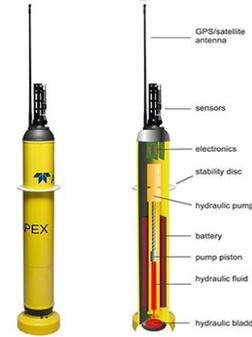
2. Ocean Science Trends & Challenges

① Ocean DX : Monitoring Technology



Year	Name	Overview	Country
2000	<u>Argo Project</u>	Global floats for Temperature/Salinity	Intl. (US, JP, FR etc.)
2010	<u>TAO/TRITON</u>	Moored buoys for tropical climate	Intl. (JP, US)
2015	<u>Bio-Argo</u>	Floats with bio & chemical sensors	Intl. (FR, JP etc.)
2018	<u>GO-SHIP</u>	High-precision oceanographic data collection	Intl. (US, AU etc.)
2001 →2020	JCOMMOPS → <u>OceanOPS</u>	Global coordination and observation platforms	Intl. (WMO, IOC)
2020	<u>Deep Argo</u>	Floats for deep ocean (to 6000m)	Intl. (US, JP)
2021-2025	<u>Atmosphere-Ocean Monitoring</u>	Long-term monitoring of GHG's	Japan

Argo Project



These images are taken from the Euro-Argo website.

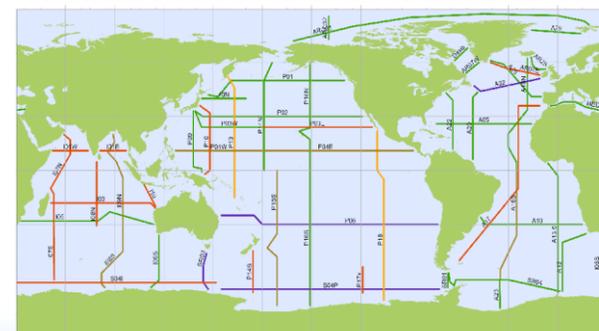
Information protected - All rights reserved - Euro-Argo

https://www.bsh.de/EN/TOPICS/Monitoring_systems/Argo_floats/argo_floats_node.html
accessed on November 27, 2025



<https://www.ocean-ops.org/board>
accessed on November 27, 2025

GO-SHIP



GO-SHIP Floating status of GO-SHIP (55 Core Lines) November 2023



http://www.go-ship.org/RefSecs/goship_ref_secs.html
accessed on November 27, 2025

2. Ocean Science Trends & Challenges

① Ocean DX : Ocean Biologging



Year	Name	Overview	Country
2005	TOPP (Tagging of Pacific Predators)	Marine predators as mobile sensors	USA
2010	MEOP (Marine Mammals Exploring the Oceans Pole to Pole)	Seals for polar ocean data	Intl. (NO, FR, JP)
2015	Bio-logging Science Symposium	Global standards and data sharing	Intl.
2017	JAMSTEC-JST CREST Project	Biologging for fish and turtles	Japan
2019	JAMSTEC-Tokyo Univ. Sea Turtle Forecasting	Turtles improve seasonal predictions	Japan
2023 ~	BIP-Earth	Global data sharing And ecosystem observation	JP-led Intl.

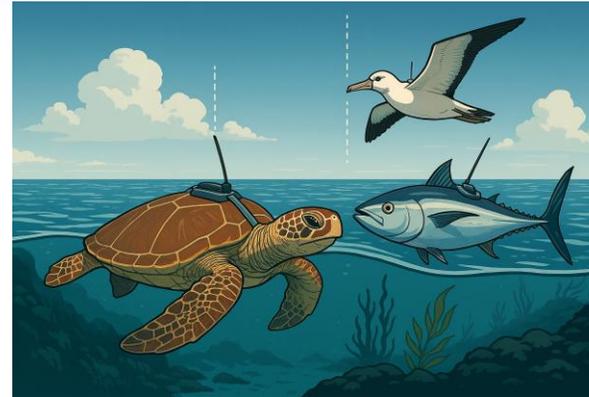


Figure created by CRDS using Generative AI.
<https://sanctuarysimon.org/dbtools/project-database/project-info-ajax.php?ID=100137>
 accessed on November 27, 2025

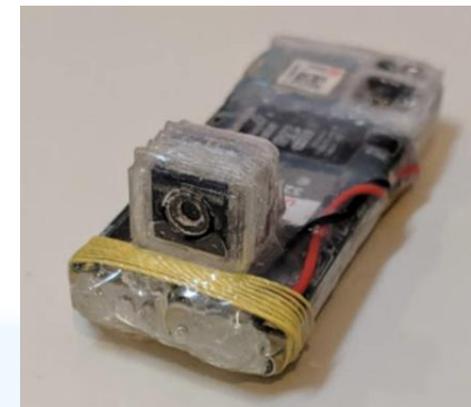
TOPP: An early large-scale project that introduced marine animals as mobile ocean sensors.



Biologging intelligent Platform

BiP

<https://www.bip-earth.com/ja>
 accessed on November 27, 2025



AI on Animals:
 A View of the World Through the Eyes of Wildlife-Embedded AI

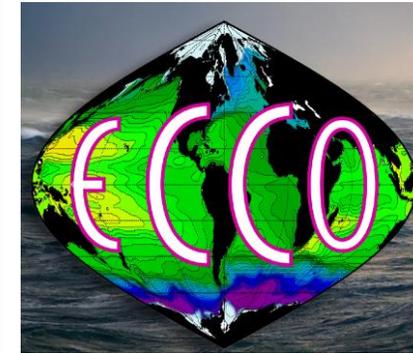
<https://www.youtube.com/channel/UCHoNDV6sBOt4d8A2jralEg>
<https://www.terumozaidan.or.jp/labo/technology/53/index.html>
 accessed on November 27, 2025

2. Ocean Science Trends & Challenges

① Ocean DX: *Big Data platform* and Application Models



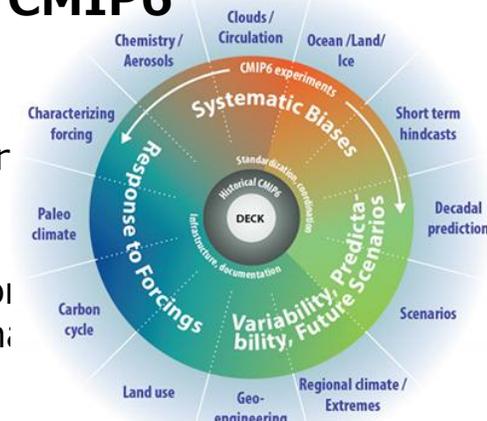
Year	Name	Overview	Country / Organization
2000	<u>ECCO</u> <i>(Estimating the Circulation and Climate of the Ocean)</i>	Global ocean state estimation (4D-Var)	USA (NASA/JPL)
2005	OFES <i>(Ocean General Circulation Model for the Earth Simulator)</i>	High-res global ocean circulation model	Japan (JAMSTEC)
2006	ROMS <i>(Regional Ocean Modeling System)</i>	High-res regional ocean model with ecosystem	USA (UCLA)
2007	HYCOM <i>(Hybrid Coordinate Ocean Model)</i>	Hybrid-coordinate ocean model	USA (NRL, NOAA)
2010	CMIP5	Climate model intercomparison framework	Intl. (WCRP)
2015	NEMO <i>(Nucleus for European Modelling of the Ocean)</i>	European ocean modeling framework	EU (CNRS, Mercator Ocean)
2020	<u>CMIP6</u>	Enhanced climate model intercomparison	Intl. (WCRP)
2021	<u>Data Assimilation Systems</u> <i>(EnKF, 4D-Var)</i>	Advanced assimilation (EnKF, 4D-Var)	Intl. (JAMSTEC, NOAA, ECMWF)
2022	ODIS <i>(Ocean Data and Information System)</i>	Global ocean data integration system	Intl. (IOC/UNESCO)
2023	SynObs <i>(Synthesis Observations)</i>	Integrated model-observation synthesis	Japan (JAMSTEC)



- Global Ocean Modeling
- 4D-Var Data Assimilation
- For Climate Change & Sea Level Rise Research

<https://ecco-group.org/>
accessed on November 27, 2025

CMIP6



- Standardized Framework for Climate Model Comparison
- Multi-Decadal Simulation for Future Climate Scen:

[Copernicus Climate Change Service, Climate Data Store, \(2021\): CMIP6 climate projections.Copernicus Climate Change Service \(C3S\) Climate Data Store \(CDS\).DOI: 10.24381/cds.c866074c](https://www.copernicus.eu/en/copernicus-climate-change-service-climate-data-store)

1. (Accessed on December. 22, 2025)

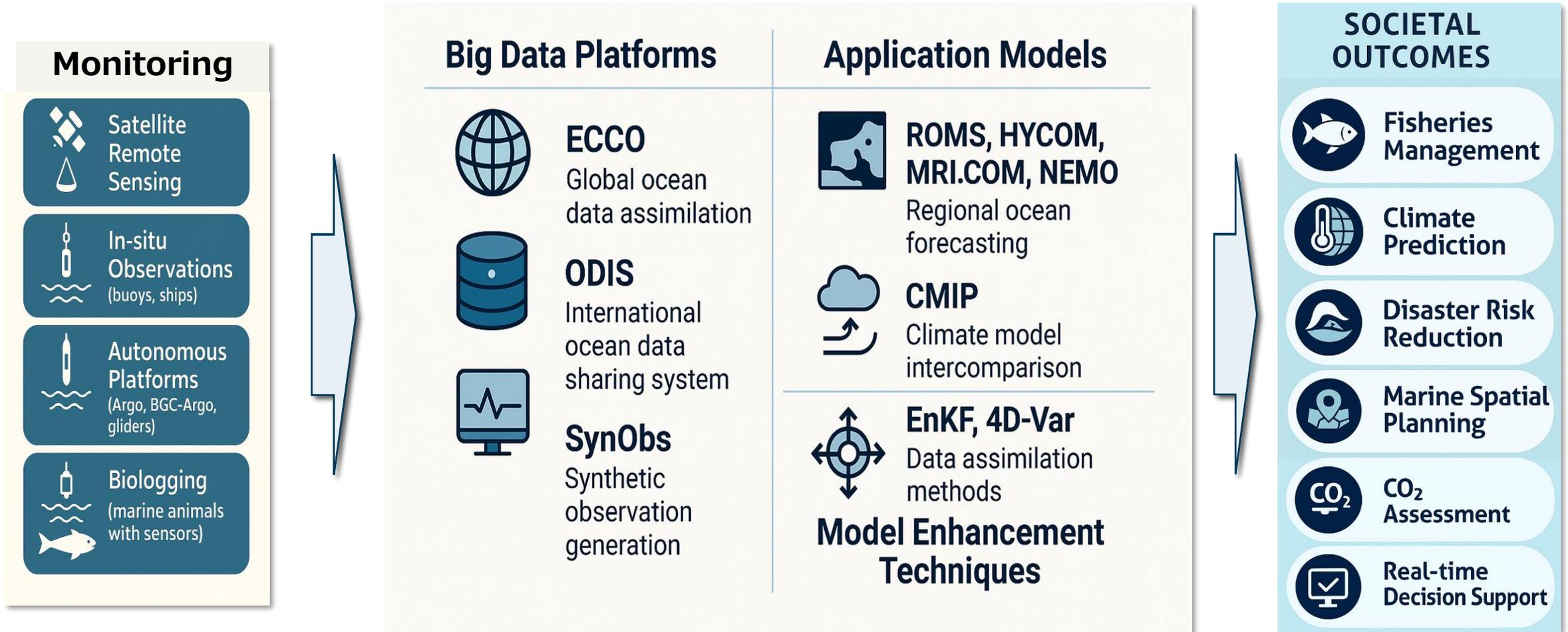


- Integrates Observational Data into Models
- Key to Accurate Ocean Forecasting

<https://journals.ametsoc.org/collection/4dvar-enkf>
accessed on November 27, 2025

2. Ocean Science Trends & Challenges

① Ocean DX Overview



Figures created by CRDS using Generative AI.

2. Ocean Science Trends & Challenges



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② Blue Economy : What is the Blue Economy?

The Blue Economy refers to efforts to achieve economic growth through the sustainable use of ocean resources.

It encompasses diverse sectors such as fisheries, marine biotechnology, ecotourism, renewable ocean energy, and blue carbon ecosystems.

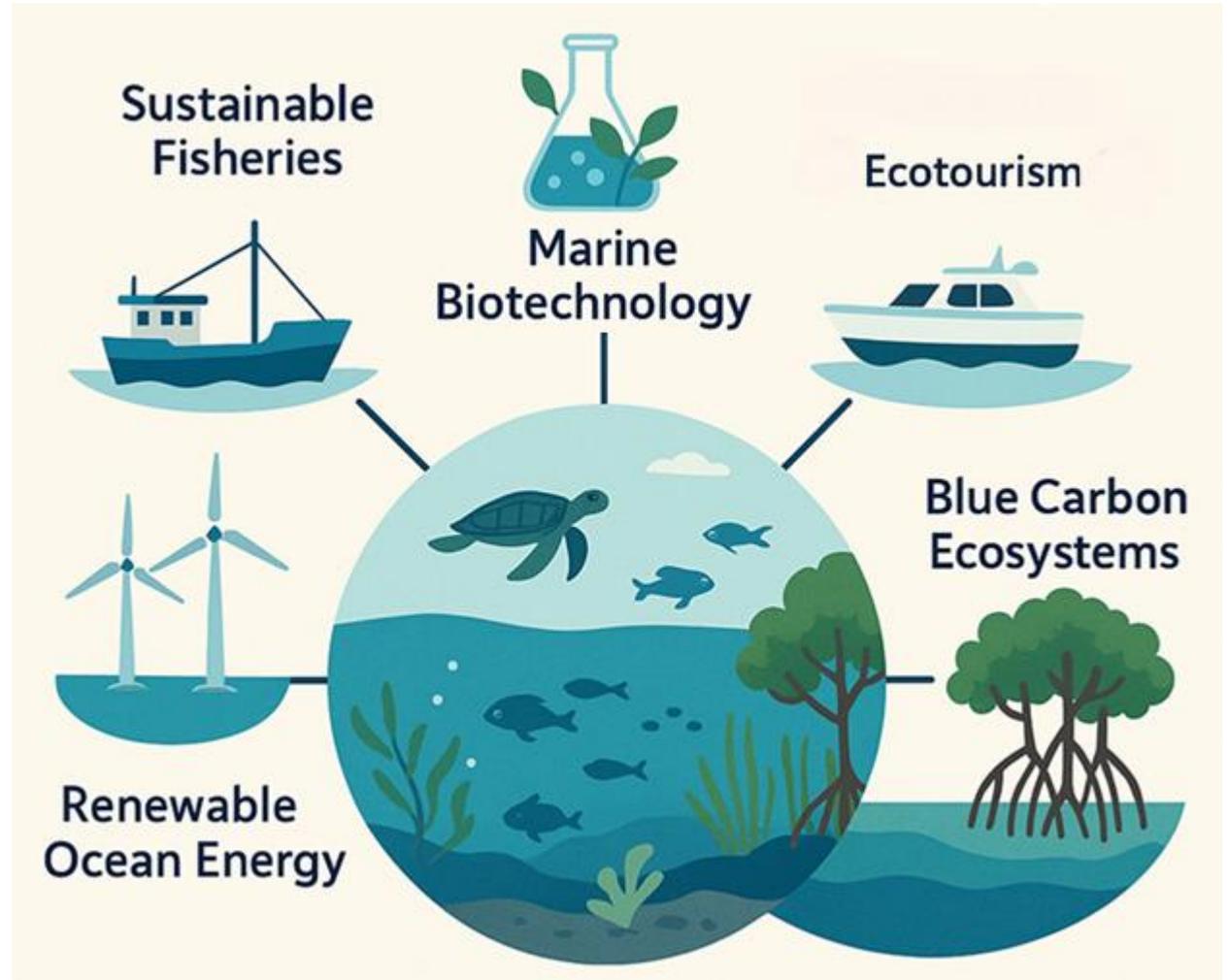


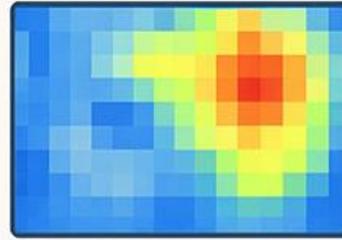
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2. Ocean Science Trends & Challenges

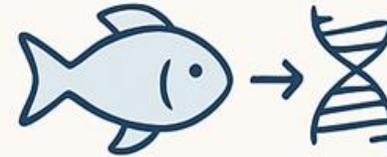
② Blue Economy : Big Data Application



Resource Management and Bycatch Mitigation



Fish Population Heatmap



Marine Biotechnology (Genetic Data)

Applications in Medicine and Industry

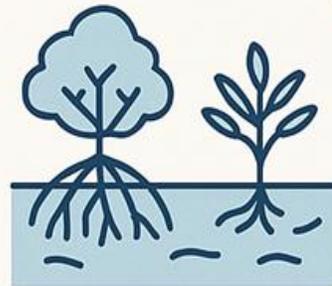
[Springer Nature Link Marine Biotechnology](#)
accessed on November 27, 2025

[Daily briefing: 'Glimmer of hope' at UN Ocean Conference as 50 countries ratify the High Seas Treaty \(Jun. 2025\)](#)
accessed on November 27, 2025

[Development Trends and Frontiers of Ocean Big Data Research Based on CiteSpace \(May 2020\)](#)
accessed on November 27, 2025

[Applications of species distribution modeling and future needs to support marine resource management. \(Mar. 2025\)](#)
accessed on November 27, 2025

Applied to Carbon Credit systems for Climate Change Mitigation etc.



Blue Carbon Estimation (Mangrove & Seagrass)



Offshore Wind Energy

Improve Power Generation Efficiency and assess impacts on Marine Ecosystems.

[WRDB: Wind Resource Database](#)
accessed on November 27, 2025

[Environmental Effects of U.S. Offshore Wind Energy Development: Compilation of Educational Research Briefs: U.S. Offshore Wind Synthesis of Environmental Effects Research \(SEER\)](#)
accessed on November 27, 2025

[Offshore Wind Energy: Assessing Impacts to Marine Life](#)
accessed on November 27, 2025

Figure created by CRDS using Generative AI.

PRESTO : Elucidating Interactions between the **Marine Biosphere and Climate**, and Steering Carbon Cycles

CREST : Unlocking Ocean Potential through Understanding the Relationship between the Ocean and CO₂



2. Ocean Science Trends & Challenges



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③ Plastic Pollution : Current Status and Impacts

Current Status

- 9–17 million tons of plastic enter the ocean annually
- Southeast Asia is a major source region due to mismanaged waste
- Microplastics are ingested by marine organisms and move up the food chain, potentially affecting ecosystem and human health



Figure created by CRDS using Generative AI

Impacts

- Ecosystem damage (ingestion, entanglement)
- Economic losses in fisheries and tourism
- Human health risks through food consumption

https://www.oecd.org/en/publications/global-plastics-outlook_de747aef-en.html

<https://ourworldindata.org/how-much-plastic-waste-ends-up-in-the-ocean>

Not for Public Release

Are microplastics bad for your health? More rigorous science is needed

(Nature, 10 March 2025)

<https://www.nature.com/articles/d41586-025-00702-2>
accessed on November 27, 2025

Technical Challenges

- ◆ Identifying and quantifying plastic leakage pathways
- ◆ Detection and separation technologies for microplastics
- ◆ Regionally adaptable waste management
- ◆ Utilization of marine biodiversity big data for impact assessment
 - Integrated analysis of species distribution and pollution data
 - AI-based modeling of ecosystem changes

JST's Initiative

SATREPS Case Study (Thailand)

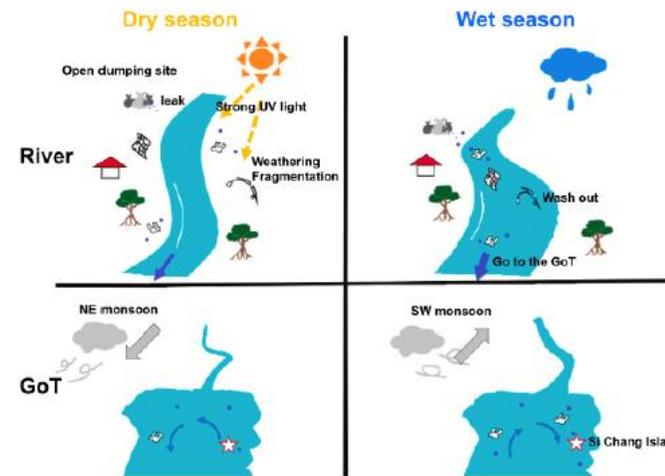
Principal Investigators:



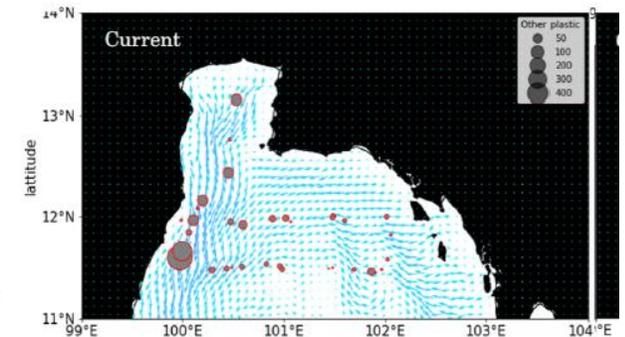
Prof. Atsuhiko Isobe (Kyushu Univ.)



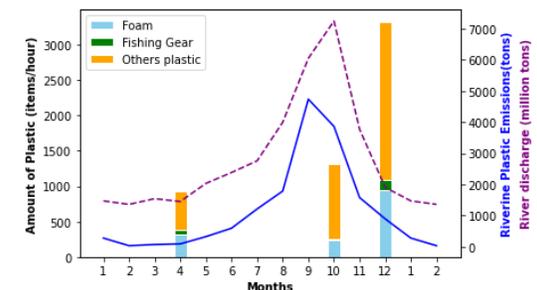
Prof. Voranop Viyakarn (Chulalongkorn Univ.)



MPs near Si Chang Island likely originate from rivers, not coasts, as shown by correlation with rainfall.



Distribution of floating plastic debris observed visually from vessels."



Debris sightings per time unit.

https://www.jst.go.jp/global/kadai/pdf/r0101_r5.pdf
accessed on November 27, 2025

3. Summary

- **Advances in observation, modeling, and data integration enable comprehensive responses to complex challenges**
- **Data-driven research using AI and machine learning is expanding in Blue Economy and plastic pollution fields**
- **JST programs (PRESTO, CREST, SATREPS) accelerate international collaboration and policy support**
- **Strengthening AI, IoT, and global data sharing to realize a sustainable ocean society**

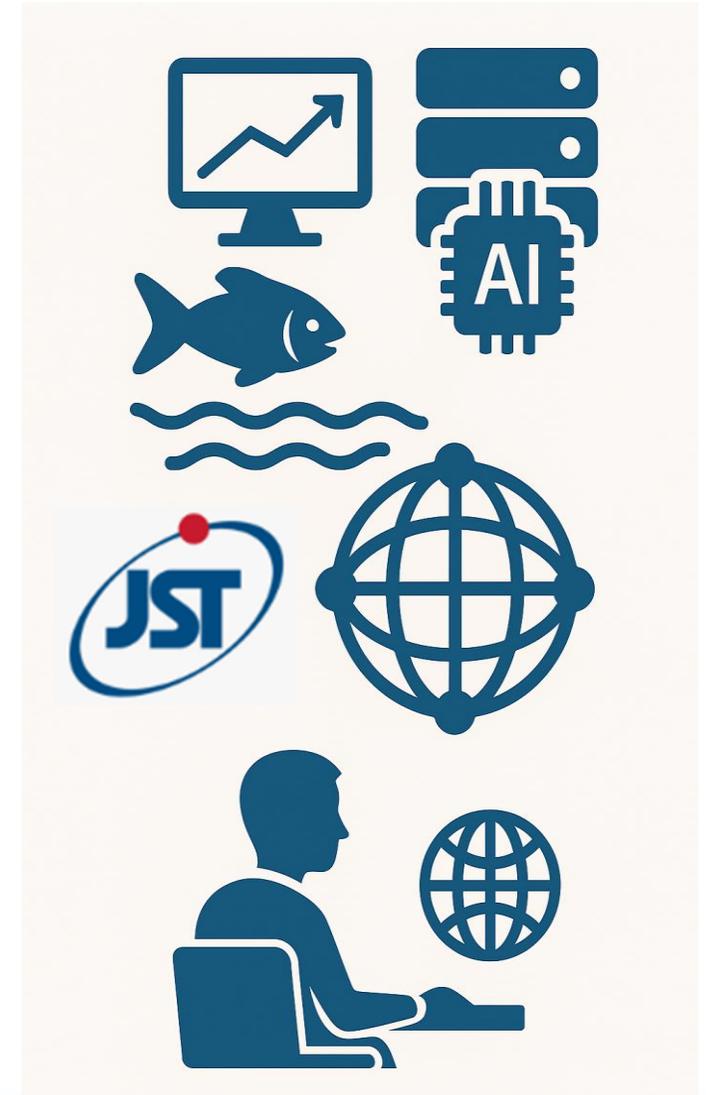


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Thank you for your attention.

Japan Science and Technology Agency (JST)
Center for R&D Strategy (CRDS)
Environment and Energy Unit

Naohiro HATANO

Web site: <https://www.jst.go.jp/crds/en/index.html>