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Making the Digital Twin of the Ocean fit for Global Marine Governance

Ethics, Politics, and Transformative Power

Auditorium, Institut de la Mer, Villefranche-sur-Mer

12 June 2025, 6 p.m.



Environmental
Politics
Research
Group



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Side-Event at UNOC 2025

Making the Digital Twin of the Ocean fit for Ocean Governance

Time and Place: Auditorium at the Institut de la Mer in Villefranche sur Mer

Chairs

Alice Vadrot, Professor for Environmental Politics and International Relations at the University of Vienna, Principal Researcher of the ERC Project “TwinPolitics”.

Nicolas Pade, Executive Director of the European Marine Biological Resource Centre (EMBRC)

Panelists

Pascal Lamy, Vice-President of Paris Peace Forum, Coordinator of the Jacques Delors Think Tanks (Paris, Berlin, Brussels), Former DG of WTO, Former Trade Commissioner (European Commission), Co-Chair of the Blue Economic and Finance Forum in Monaco

Andrei Polejack, Director of Research and Innovation, National Institute for Ocean Research – INPO, Brazil

Angelique Pouponneau, Ocean Lead Negotiator of the Alliance of Small Island States (AOSIS)

Vanessa Yepes-Narváez, Scientific Researcher, Marine and Coastal Research Institute “José Benito Vives de Andrés” (INVEMAR), Colombia

Nicolas Pade, Executive Director of the European Marine Biological Resource Centre (EMBRC)

Moderation

Alice Vadrot, Professor for Environmental Politics and International Relations at the University of Vienna, Principal Researcher of the ERC Project “TwinPolitics”

Executive Summary:

The panel highlighted the urgent need for stronger collaboration across science, policy, and global regions to realize the potential of the Digital Twin of the Ocean (DTO). There was broad agreement that while technological capabilities are advancing rapidly, the institutional, financial, and social structures required to support them remain fragile and uneven.

Several speakers underscored that research infrastructures—especially observation and data systems—are foundational to any DTO, acting as the connective tissue between local measurements and global modeling efforts. These infrastructures must be standardized, interoperable, and inclusive to ensure that data collected are fit for multiple purposes—scientific, policy, and industrial.

Participants agreed that a science-policy interface is essential, but currently underdeveloped. Many emphasized the importance of boundary organizations that can translate between scientific language and diplomatic priorities, allowing each sector to operate effectively while staying aligned through trusted intermediaries.

The discussion also emphasized the need for a multilateral, UN-based framework—like the Intergovernmental Oceanographic Commission (IOC)—to coordinate global efforts, rather than regionally siloed initiatives. This ensures a level playing field and facilitates buy-in from all regions, particularly the Global South.

Speakers called for a paradigm shift in scientific culture: from extractive, one-way data gathering in under-observed regions to equitable, long-term partnerships with local actors. Achieving this will require sustained investment, capacity building, and a clear financial strategy that also includes industry co-funding, given the private sector's interest in reliable ocean forecasts.

Finally, the panel sounded a cautionary note: the global ocean observation system is currently "paper thin", propped up by a few dedicated individuals and vulnerable to political and economic shifts. Without stable, long-term funding and investment is needed by countries to ensure the DTO is grounded in real world data. Without a strong *in situ* observation system the DTO risks being disconnected from the reality it seeks to represent—an impressive digital model, but lacking the ground-truth necessary to inform policy and action and a strong grounding in reality.

Introduction by Alice Vadrot and Nicolas Pade

The head of the Environmental Politics Research Group and Principal Investigator of TwinPolitics, Alice Vadrot, and the Executive Director of EMBRC and coordinator of MARCO-BOLO, Nicolas Pade, welcomed the audience. He briefly outlined EMBRC's role as a research infrastructure supporting marine biology and ecosystem research across Europe. He emphasized the recent focus on integrating biodiversity and biological data

into global ocean observation systems, using diverse techniques such as DNA, autonomous vehicles, and remote sensing.

He explained that the MARCO-BOLO project aims to enhance biodiversity observation for informed decision-making. The project focuses on five key areas: improving biodiversity models, advancing technology for data collection, enhancing data accessibility, better modelling tools, and fostering stakeholder collaboration across science, policy, and industry. Pade highlighted the importance of aligning data collection with the diverse needs of these communities.

Alice Vadrot emphasized the pivotal moment in ocean governance shaped by rapid technological advances. She highlighted how innovations like the Digital Ocean Twin (DTO) offer new ways to understand and manage marine environments. Referencing recent remarks by European Commission President Ursula von der Leyen—who identified DTOs as central to European marine governance—she explained that DTOs function as dynamic, data-rich digital models of ocean systems.

These virtual replicas, integrating data from satellites, sensors, and predictive models, allow users to simulate currents, track pollution, predict marine heatwaves, and assess climate impacts—transforming how decisions are made in ocean management.

Vadrot cautioned that the benefits of DTOs must be weighed against ethical, political, and infrastructural challenges. Many Global South nations—despite being most affected by climate change—lack the technological capacity to engage with DTOs.

She therefore questioned how DTO development can be made inclusive, ensuring meaningful participation and capacity building, particularly for small island and least developed states and warned of the potential to exacerbate digital divides and stressed the need to ensure that DTOs foster collaboration rather than marginalization.

She called for robust data governance frameworks and trust-building in scientific narratives, noting that today's discussion would further explore these critical themes.

Pascal Lamy's involvement with the EU's Starfish Mission—aimed at regenerating the hydrosphere by 2030 as part of the Horizon Europe program—began in 2019, when he was asked to chair the initiative. With a background in naval service and a long-standing interest in ocean issues, he was inspired by a suggestion to explore the concept of digital twins for the ocean. Recognizing the urgent need to accelerate our understanding of the ocean—given that we lack knowledge about two-thirds of it—he saw digital twins as a crucial tool to simulate and manage the regeneration of this complex system more effectively. Despite the slow development of AI at the time, the idea gained traction and became the flagship of the science pillar of the Starfish Mission, which also includes focuses on pollution, protection, blue economy, and governance. He highlights the progress made, including the unveiling of an EU digital twin ocean prototype in 2025 during UNOC3 and the rising prominence of supporting organizations like Mercator

Ocean. He acknowledges the ongoing challenges of data collection, political alignment, and scientific diplomacy—especially given how difficult it is to align the scientific community behind shared goals. He believes the European Digital Twin Ocean will continue to lead in scientific advancement, acting as an accelerator for essential questions that would arise regardless. By its very nature, the digital twin forces a systems-level perspective, demanding interdisciplinary, cross-regional, and cross-sectoral collaboration. However, this approach raises two key governance challenges: coordination and prioritization. Effective coordination, even within a single nation like France, has proven difficult—let alone across 27 EU members or globally. Once data becomes interoperable and accessible, the next step is setting priorities—deciding whether to focus on biodiversity loss, sustainable fishing, offshore energy, or other pressing concerns. He argues that this requires a global forum with proper authority, pointing to the International Oceanographic Commission (IOC) as the natural UN hub, though currently underpowered. Diplomatic engagement is essential but slow and complex. The EU has invested around €15 million annually in the digital twin initiative over the past few years, positioning itself as a technological leader. Still, global competition adds urgency to addressing these unresolved governance and funding questions.

Andrei Polejack, representing Brazil's newly established National Ocean Research Institute (NORI), highlights the country's commitment to advancing ocean science through international collaboration, notably with Mercator, to develop digital twins for informed decision-making. While digital twins hold great promise, they raise critical questions about data quality, transparency, trust, and equitable participation. He emphasizes the need for robust, localized ocean observing systems—particularly in under-sampled regions like the South Atlantic, which is vital to global climate regulation. Brazil faces challenges in accessing and maintaining oceanographic equipment, often relying on expensive foreign technologies. In response, the Institute is building national infrastructure for data integration, equipment calibration, and sensor development, including plans for a deep-sea research program. Positioned as a boundary organization, the Institute aims to bridge science and policy, ensuring that emerging tools like digital twins are both scientifically rigorous and practically applicable to decision-making.

Angelique Pouponneau, a lawyer from Seychelles representing the Alliance of Small Island States in international ocean negotiations, underscores the critical need for equity and trust as digital tools like digital twins enter global decision-making processes. While impressed by the potential of these technologies, she raises serious concerns about their inclusivity, transparency, and accessibility for small island developing states (SIDS), which often lack the scientific capacity and resources of larger nations. She emphasizes that tools developed externally—without participation from SIDS—risk alienating those they aim to support. Effective implementation requires genuine partnerships, inclusive scientific cooperation, and robust capacity building, not just

token consultation or one-sided data feeding. She also warns of the burden placed on overworked SIDS representatives and the risk of decisions being made without adequate input from affected communities. Ultimately, she calls for fair frameworks of multilateral engagement, where SIDS have seats at the table, sufficient support, and the ability to meaningfully participate in shaping and using these tools intended to inform decisions on marine protected areas, environmental assessments, and beyond.

Vanessa Yepes-Narváez, an ocean professional from Colombia's Marine and Coastal Research Institute (Invemar), highlights the dual role of her institution in both national science-policy support and regional cooperation. Invemar produces publicly available, decision-oriented marine data for Colombia's environmental ministry, contributing to policies like marine protected areas and marine pollution monitoring. However, she stresses that many Latin American institutions lack comparable capacity, funding, or access to technology, which limits their ability to participate equally in global data initiatives like the EU's Digital Twin of the Ocean (DTO).

She identifies key challenges: lack of interoperability across datasets, uneven data standards, and insufficient human resources—often reduced to “a team of one or two.” While her institute is open to collaboration and data sharing, she calls for transparency on the origin and quality of data used in global tools like the DTO, and insists on crediting local data producers. She emphasizes the need for clear standards distinguishing data suitable for policy from less rigorous datasets, and calls for funding and technical support to enable broader participation. Ultimately, she envisions a cooperative, accessible data ecosystem—regionally and globally—where science-policy interfaces are strengthened through equity, trust, and shared technical understanding.

Nicolas Pade emphasizes the critical role of research infrastructures—including data infrastructures and physical sensors—in supporting the Digital Twin of the Ocean (DTO). While these infrastructures do not currently have a formal science-policy interface role, they are central to determining *what* data is collected, *how* it is standardized, and *where* it flows (e.g., from national to regional systems like EMODnet, and onward to global platforms like OBIS or GBIF).

He stresses the need for standardization and interoperability to ensure data systems can communicate and answer policy-relevant questions—like the impact of wind farms decades into the future. However, to achieve this, ongoing dialogue is essential between scientists, policymakers, and data collectors—moving beyond occasional panels to structured, sustained collaboration. He agrees with calls for a global, UN-based approach, like through the Intergovernmental Oceanographic Commission (IOC), rather than regionally siloed initiatives. UN-endorsed frameworks ensure equity, transparency, and global buy-in. Moreover, science must shift its mindset: rather than extract data from regions like the Global South, researchers should build genuine collaborations and co-develop research agendas with local partners, acknowledging funding and capacity asymmetries. He commends boundary organizations that bridge science and

diplomacy—entities that understand both languages and mediate between them. Without such interfaces, collaboration falters. He warns that despite the grand ambitions of DTOs, the underlying ocean observation systems are fragile, often underfunded, and reliant on a handful of committed individuals. Long-term investment and political stability are required for robust, policy-relevant data—otherwise, the DTO risks being a visually impressive but inaccurate simulation.

Photos



Links to the cooperation partners:

ERC-Project TwinPolitics: [Twin Politics – Digital Twins for Sustainable Ocean Futures](#)

EMBRC: [Advancing marine science | EMBRC](#)

MARCO-BOLO: [Home - Marco-Bolo](#)