Platforms, Digital Infrastructure & Interoperability

Thu. Nov 12, 2026 4:00 PM - 5:30 PM JST | Thu. Nov 12, 2026 7:00 AM - 8:30 AM UTC | Room B (Kujaku) (2F)

Oral B3 Ocean Digital Twins for Coastal Resilience, Ecosystems and Ocean Health

Chair: Ruoying He, Hakase Hayashida

4:00 PM - 4:15 PM JST | 7:00 AM - 7:15 AM UTC

[_NIQuy3K-01] Empowering Africa's Blue Economy: Co-Designing the African Digital Twins of the Ocean

*Hassan Moustahfid [1] (1. UN Ocean Decade Africa Task Force/IOOS (USA))

4:15 PM - 4:30 PM JST | 7:15 AM - 7:30 AM UTC

[_NIQuy3K-02] A Digital Twin System for Smart Aquaculture in Sansha Bay

*Qiang Deng (1. Fujian Ocean Innovation Center / Xiamen University (China))

4:30 PM - 4:45 PM JST | 7:30 AM - 7:45 AM UTC

[_NIQuy3K-03] Enabling Nature-Based Coastal Adaptation through Digital Twin-driven What-if Scenarios for coastal vegetation restoration

*Benjamin Jacob[1] (1. Helmholtz-Center Hereon (Germany))

4:45 PM - 5:00 PM JST | 7:45 AM - 8:00 AM UTC

[_NIQuy3K-04] An Interactive Coastal Digital Twin of the Ocean for User-Driven What-If Scenarios and Nature-Based Coastal Resilience

*Ivan Federico[1] (1. CMCC - Euro-Mediterranean Center on Climate Change (Italy))

5:00 PM - 5:15 PM JST | 8:00 AM - 8:15 AM UTC

[_NIQuy3K-05] Digital Ocean Twins as a Medium for Scientific Communication

*Armando Jr Benavidez[1] (1. Institute Of Science Tokyo; Nakamura Lab (Japan))

5:15 PM - 5:30 PM JST | 8:15 AM - 8:30 AM UTC

[_NIQuy3K-06] Enhancing Marine Biodiversity through Integrated Conservation Strategies: An Academic Framework for Digital Twin Integration

*LIBAN MOHAMUD JAMA[1] (1. Darul Hikmah University (Somalia))

© 2026 DITTO Summit Local Organising Committee. All rights reserved.

Platforms, Digital Infrastructure & Interoperability

Thu. Nov 12, 2026 4:00 PM - 5:30 PM JST | Thu. Nov 12, 2026 7:00 AM - 8:30 AM UTC | Room B (Kujaku) (2F)

Oral B3 Ocean Digital Twins for Coastal Resilience, Ecosystems and Ocean Health

Chair: Ruoying He, Hakase Hayashida

4:00 PM - 4:15 PM JST | 7:00 AM - 7:15 AM UTC

[_NIQuy3K-01] Empowering Africa’s Blue Economy: Co-Designing the African Digital Twins of the Ocean

*Hassan Moustahfid [1] (1. UN Ocean Decade Africa Task Force/IOOS (USA))

Africa faces pressing marine challenges, from coastal vulnerabilities to sustainable fisheries management and climate adaptation. Digital Twins of the Ocean (DITTO) offer a transformative, user-driven approach to addressing these issues. Globally, operational digital twins integrate real-time observations, AI, and advanced modeling to empower decision-makers, enhance disaster resilience, and drive sustainable blue economy innovation. However, translating these global principles into a sovereign, interoperable African digital ecosystem requires a dedicated, regionally led co-design strategy.

To bridge the gap from concept to capability, the African Ocean Decade Taskforce and OceanPrediction DCC are convening a pivotal implementation workshop in Cotonou, Benin, in October 2026. Acting as a collaborative hub, this multi-stakeholder gathering will bring together African governments, researchers, operational agencies, industry partners, and Early Career Ocean Professionals (ECOPs) to construct an actionable DITTO roadmap tailored to the continent's unique environmental and economic landscape.

This presentation will unveil the immediate, fresh outcomes of the October workshop. The session will detail the co-designed regional architecture, exploring how it builds on Africa’s existing high-performance computing (HPC) capabilities while harnessing complementary infrastructure from global partners, cloud ecosystems, and regional observing systems to support maritime development. Furthermore, we will present the workshop’s consensus on priority cross-sector applications, such as fisheries management, hazard forecasting, and coastal infrastructure resilience, alongside proposed governance frameworks grounded in FAIR data principles and African data sovereignty.

By sharing these forward-looking strategies, this work will highlight how inclusive, regional co-design accelerates the deployment of functional, Earth-to-Society digital platforms. The anticipated Cotonou roadmap will provide a replicable model for developing user-driven, operational digital twins that directly empower Africa's blue economy, support resilient coastal communities, and solidify the continent’s leadership within the UN Ocean Decade.

© 2026 DITTO Summit Local Organising Committee. All rights reserved.

Platforms, Digital Infrastructure & Interoperability

Thu. Nov 12, 2026 4:00 PM - 5:30 PM JST | Thu. Nov 12, 2026 7:00 AM - 8:30 AM UTC | Room B (Kujaku) (2F)

Oral B3 Ocean Digital Twins for Coastal Resilience, Ecosystems and Ocean Health

Chair: Ruoying He, Hakase Hayashida

4:15 PM - 4:30 PM JST | 7:15 AM - 7:30 AM UTC

[_NIQuy3K-02] A Digital Twin System for Smart Aquaculture in Sansha Bay

*Qiang Deng (1. Fujian Ocean Innovation Center / Xiamen University (China))

This project, based on the needs of high-quality development of the marine economy in Fujian Province, takes Sansha Bay as a demonstration sea area and addresses multiple environmental risks such as extreme temperatures, sudden salinity changes, and red tides. It has constructed a digital twin system for intelligent prevention and control of aquaculture environmental disasters in bay areas. By integrating a high-precision three-dimensional monitoring network of temperature salinity profiles, a three-dimensional hydrodynamic ecological coupled model, a data driven short term early warning model, and the DeepSeek large language model, the system possesses real time dynamic simulation and multi source data assimilation capabilities. It can forecast water temperature, salinity, and red tide probability for the next three days, and automatically generate tiered prevention and control strategies based on an intelligent knowledge base, forming a whole chain coordination mechanism of "monitoring—early warning—prevention and control—decision making". At the same time, the project establishes a three tier interactive platform for decision makers, managers, and farmers, enabling precise dissemination of risk prevention and control measures. Through full process application demonstration in Sansha Bay, it accumulates practical experience and explores promotion models, providing a demonstration model for bay type aquaculture areas to achieve a win win situation of "ecological security and production efficiency enhancement", and contributing to the creation of a new growth pole for the blue economy.

© 2026 DITTO Summit Local Organising Committee. All rights reserved.

Platforms, Digital Infrastructure & Interoperability

Thu. Nov 12, 2026 4:00 PM - 5:30 PM JST | Thu. Nov 12, 2026 7:00 AM - 8:30 AM UTC | Room B (Kujaku) (2F)

Oral B3 Ocean Digital Twins for Coastal Resilience, Ecosystems and Ocean Health

Chair: Ruoying He, Hakase Hayashida

4:30 PM - 4:45 PM JST | 7:30 AM - 7:45 AM UTC

[_NIQuy3K-03] Enabling Nature-Based Coastal Adaptation through Digital Twin-driven What-if Scenarios for coastal vegetation restoration

*Benjamin Jacob[1] (1. Helmholtz-Center Hereon (Germany))

Climate hazards increasingly threaten coastal ecosystems through the intensification of storm events, coastal erosion, and ecosystem degradation. Nature-Based Solutions (NbS), such as seagrass, saltmarshes or mangrove restoration, are increasingly acknowledged as pathways to enhance coastal resilience by dampening driving mechnisms of coastal impacts, while simultaneously supporting biodiversity conservation and carbon storage.
Despite that, effective implementation requires actionable insights on how to choose design, location, and characteristics of restoration measures. These insights can help to maximize ecosystem services such as coastal protection under varying environmental conditions.
Here, we present a Digital Twin of the Ocean (DTO) system aimed at aiding in decision support by integrating observations, numerical models and artificial intelligence (AI) enabling the execution What-if Scenario (WiS) to assess coastal resilience via seagrass restoration:
The DTO system combines regional coupled hydro-wave-sediment simulations with high-resolution coastal morphodynamical modelling to evaluate erosion risks and impacts under different seagrass scenarios. Thereby, considering vegetation characteristics such as meadow location, extent, shoot density to investigate their influence on coastal ocean kinematics and sediment dynamics. An AI-based emulator further enhances computational efficiency allowing the exploration of multiple restoration pathways within the DTO.
These systems have been implemented within the European Digital Twin of the Ocean (EDITO), via downstream interactive user interfaces facilitating the exploration of different vegetation WiS.
The results demonstrate that the effectiveness of seagrass restoration is highly dependent on local environmental conditions and implementation strategies. For example, erosion mitigation potential was identified when seagrass was positioned in areas exposed to high wave roller energy. Overall, the results indicate the need for site-specific assessments rather than generalized restoration approaches.
By translating complex model outputs into actionable metric-based information, the DTO enables the visualization and comparison of different restoration scenarios to support sustainable NbS implementation.

© 2026 DITTO Summit Local Organising Committee. All rights reserved.

Platforms, Digital Infrastructure & Interoperability

Thu. Nov 12, 2026 4:00 PM - 5:30 PM JST | Thu. Nov 12, 2026 7:00 AM - 8:30 AM UTC | Room B (Kujaku) (2F)

Oral B3 Ocean Digital Twins for Coastal Resilience, Ecosystems and Ocean Health

Chair: Ruoying He, Hakase Hayashida

4:45 PM - 5:00 PM JST | 7:45 AM - 8:00 AM UTC

[_NIQuy3K-04] An Interactive Coastal Digital Twin of the Ocean for User-Driven What-If Scenarios and Nature-Based Coastal Resilience

*Ivan Federico[1] (1. CMCC - Euro-Mediterranean Center on Climate Change (Italy))

Coastal Digital Twins of the Ocean (C-DTOs) are evolving from numerical models into interactive decision-support systems that integrate Earth observations, in situ monitoring, physics-based simulations and Artificial Intelligence. Their objective is not only to reproduce coastal dynamics but also to enable users to explore what-if scenarios, evaluate adaptation strategies and support evidence-based coastal management.

We present an integrated Coastal Digital Twin architecture for coastal resilience. The framework combines multi-source observations, deterministic numerical models and AI-based services to represent the coupled dynamics of waves, hydrodynamics, sediment transport, coastal flooding and marine vegetation. Earth observations and in situ measurements underpin model calibration and validation, while AI accelerates computational workflows and scenario exploration. The architecture is relocatable across coastal environments and supports forecasting, event reconstruction and on-demand simulations.

The Digital Twin is implemented as an interactive, user-centred platform that enables users to configure, execute and visualize customized what-if scenarios through an intuitive graphical interface. Users can delineate intervention areas, modify nature-based or engineered coastal measures, define environmental forcing conditions and compare adaptation strategies. User-defined configurations are automatically translated into model-ready simulations, with results visualized through maps, time series and impact indicators for rapid evaluation of alternative interventions.

The framework is demonstrated through two operational applications. 1) The first supports seagrass restoration as a nature-based solution for coastal protection. Users can define the location, extent and characteristics of restored seagrass meadows and evaluate their effectiveness in reducing wave energy and circulation. 2) The second application focuses on natural dune systems, enabling users to investigate how different dune configurations influence coastal flood hazards by quantifying changes in inundation extent, water levels and flood dynamics.

These applications demonstrate how Coastal Digital Twins transform coastal models into interactive decision-support platforms where observations, process-based simulations and AI are integrated into a seamless workflow, enabling planners and coastal managers to efficiently evaluate adaptation options for resilient coastal management.

© 2026 DITTO Summit Local Organising Committee. All rights reserved.

Platforms, Digital Infrastructure & Interoperability

Thu. Nov 12, 2026 4:00 PM - 5:30 PM JST | Thu. Nov 12, 2026 7:00 AM - 8:30 AM UTC | Room B (Kujaku) (2F)

Oral B3 Ocean Digital Twins for Coastal Resilience, Ecosystems and Ocean Health

Chair: Ruoying He, Hakase Hayashida

5:00 PM - 5:15 PM JST | 8:00 AM - 8:15 AM UTC

[_NIQuy3K-05] Digital Ocean Twins as a Medium for Scientific Communication

*Armando Jr Benavidez[1] (1. Institute Of Science Tokyo; Nakamura Lab (Japan))

Scientific communication is moving toward immersive, interactive media, yet most reef and ocean research still reaches audiences as static figures and text. Digital ocean twins, navigable 3D representations that fuse underwater photomosaics with broader spatial context, are themselves a communication medium and not only an analytical one. They preserve the georeferencing and structure that scientific work requires, while presenting it in an environment a non-specialist can enter and explore without instruction.

A digital twin is natively three-dimensional, and that 3D structure is precisely what virtual and augmented reality are built to render. Where a photograph or map flattens a reef, a digital twin preserves its geometry, so that it can be navigated and experienced rather than merely viewed. VR and AR excel at exactly the spatial and volumetric content that digital twins produce, making the twin a ready-made asset for immersive interaction. Delivered through virtual and augmented reality, it allows coastal managers to convene inside a shared spatial scene for remote decision-making; researchers can present findings via AR-assisted teleconferencing; and students can discover underwater habitats in interactive VR space.

Presented this way, a digital ocean twin can give an audience the opportunity to move continuously across scales, from the structure of a single coral colony outward. The pairing of digital ocean twins with interactive VR and AR media offers a new channel to communicate reef science.

Ultimately, these photomosaic-based digital twins lower the engagement threshold, turning dispersed survey data into a cohesive experience that travels to entirely new audiences.

© 2026 DITTO Summit Local Organising Committee. All rights reserved.

Platforms, Digital Infrastructure & Interoperability

Thu. Nov 12, 2026 4:00 PM - 5:30 PM JST | Thu. Nov 12, 2026 7:00 AM - 8:30 AM UTC | Room B (Kujaku) (2F)

Oral B3 Ocean Digital Twins for Coastal Resilience, Ecosystems and Ocean Health

Chair: Ruoying He, Hakase Hayashida

5:15 PM - 5:30 PM JST | 8:15 AM - 8:30 AM UTC

[_NIQuy3K-06] Enhancing Marine Biodiversity through Integrated Conservation Strategies: An Academic Framework for Digital Twin Integration

*LIBAN MOHAMUD JAMA[1] (1. Darul Hikmah University (Somalia))

Marine biodiversity faces unprecedented threats from climate change, overexploitation, and habitat degradation, requiring robust and dynamic management frameworks. This presentation explores academic research into the implementation of integrated conservation strategies designed to safeguard marine ecosystems. Emphasizing data-driven methodology and regional oceanographic insights, the study highlights how combining rigorous ecological monitoring with strategic management models can enhance habitat resilience and protect critical marine species.

A central focus of this research is the potential for integrating localized marine biodiversity datasets into Digital Twins of the Ocean (DITTO) frameworks. Traditional conservation models often suffer from data fragmentation and delayed response times. By leveraging standardized observation data and academic research baselines, integrated conservation strategies can provide the foundational biological layers necessary for predictive modeling, real-time tracking, and scenario simulation. This linkage allows researchers and stakeholders to visualize the direct impacts of human activity and climate stressors on vulnerable marine protected areas.

Ultimately, this paper demonstrates that linking empirical fisheries science with digital infrastructure is essential for scalable ocean conservation. Integrating comprehensive biological datasets from university research initiatives into interactive digital twin platforms ensures that conservation strategies are not only proactive but also adaptive to rapidly shifting marine environments. This framework offers a scientifically rigorous pathway toward achieving global biodiversity targets through technologically empowered, evidence-based decision-making.

© 2026 DITTO Summit Local Organising Committee. All rights reserved.