Keynote

Wed. Nov 11, 2026 2:00 PM - 3:30 PM JST | Wed. Nov 11, 2026 5:00 AM - 6:30 AM UTC | Room B (Kujaku) (2F)

Keynotes B1

Chair: Joanna Staneva, Yoichi Ishikawa

2:15 PM - 2:30 PM JST | 5:15 AM - 5:30 AM UTC

[p9SreT9v-02] Ocean Forecasting and Digital Twins: Towards a Federated Predictive Ocean

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Digital Twins of the Ocean (DTOs) are opening new opportunities to understand, explore, and manage the ocean by bringing together observations, models, data, knowledge, and applications. Their ultimate value, however, will depend on their ability not only to represent the ocean as it is, but also to help us explore what may happen next. In this context, Ocean forecasting has a fundamental role to play.

At the same time, Digital Twins can become a powerful accelerator for the evolution of ocean forecasting. The needs emerging from DTO applications — higher spatial and temporal resolution, faster delivery, local information, uncertainty estimates, seamless integration across scales, and interactive exploration — are pushing Ocean forecasting technology forward. In this sense, the DTOs are the best possible catalyst for a needed revolution in Ocean Forecasting and observation.

This calls for a different way of thinking about the relationship between forecasting systems and Digital Twins. Rather than developing a dedicated forecasting system for every Digital Twin, we should move towards a globally built federation of interoperable forecasting services, where individual services can be discovered, accessed, combined and reused by multiple Digital Twins. A global, regional or coastal forecasting service should not belong to a single DTO: it should become a shared capability that can support many different applications and domains. Conversely, a Digital Twin may dynamically combine several forecasting services to address a particular decision or user need.

Artificial Intelligence will be an important enabler of this evolution. In particular, AI offers the potential to overcome one of the fundamental limitations of conventional forecasting: computational cost. By providing low-computing-cost capabilities, AI could make it possible to explore large-domain, high-resolution scenarios interactively. This would move us beyond the traditional question of “What will happen?” towards “What if?” — allowing users to investigate possible interventions, events and management strategies within the Digital Twin itself. And, in this new scenario, these “What if” questions could be solved in real time, not needing to rely on pre-established computations which could be ill-suited to the problem to solve.

The emerging vision is therefore of a globally built federated predictive ocean, in which observations, numerical models, AI and forecasting services are interconnected and can be shared across multiple Digital Twins. OceanPrediction DCC and other initiatives, such as FORESEA and CoastPredict, are already working in this direction. Many of these concepts will be tested in AFRICA, thanks to the OPERA (Ocean Prediction Enhancement in the Regions of Africa) project. Such an ecosystem would benefit both communities: Digital Twins would gain access to increasingly powerful predictive capabilities, while their demanding applications would drive the development of faster, more flexible, and more locally relevant forecasting services.

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Therefore, the challenge ahead is not simply to build more Digital Twins or better forecasts, but to connect these capabilities into an interoperable ecosystem that can turn predictions more easily into actionable exploration of the ocean's possible futures, exploiting more efficiently the limited computational and observational resources we have.

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