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

2:30 PM - 2:45 PM JST | 5:30 AM - 5:45 AM UTC

## [p9SreT9v-03] Earth System Digital Twins: A New Frontier for Ocean Understanding

*Laura J. Rogers

We are entering a pivotal moment in Earth science. Rapid environmental change, rising coastal risks, and intensifying societal demand for trusted Earth intelligence are reshaping how we observe, analyze, and understand our planet. Emerging Earth System Digital Twins (ESDTs) are opening the door to an entirely new class of scientific capability - dynamic, data-assimilative frameworks that merge measurements, models, and intelligent analytics to reveal how Earth systems behave in real time and how they may evolve under different futures.

NASA's diverse portfolio places it at the center of this transformation. From spaceborne and airborne missions to field or ship based campaigns, from physics-based models to machine-learning emulators, and from advanced cloud architectures to open-data ecosystems, we now have the ingredients to generate more complete and more responsive representations of ocean and Earth system dynamics. Across hydrology, coastal processes, biogeochemistry, and atmosphere–ocean coupling, new missions and modeling approaches are producing richer, more continuous, and more interoperable streams of information. Advances in AI-enabled prediction, quantum-inspired sensing concepts, and adaptive observing strategies are accelerating what digital twins can capture and how quickly they can respond.

These breakthroughs reveal a rapidly expanding opportunity space. ESDTs can transform how we deliver environmental intelligence, enabling clearer insights for resource management, hazard planning, and real-time decision support. They promise to make complex systems more transparent, reproducible, and accessible to scientists, stakeholders, and communities.

Yet critical challenges remain. Interoperability across global data systems, unified standards for model-data fusion, scalable uncertainty characterization, and robust calibration frameworks are essential for reliable twin ecosystems. Supporting global, high-resolution systems requires major computational and architectural innovation. And as these technologies advance, so must our attention to equity, transparency, and accessibility.

This talk explores these opportunities and challenges, and highlights how today's scientific progress is shaping the next era of Earth system understanding.

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