Keynote

Thu. Nov 12, 2026 9:00 AM - 10:30 AM JST | Thu. Nov 12, 2026 12:00 AM - 1:30 AM UTC | Room B (Kujaku) (2F)

Keynotes B2

Chair: Yasumasa Miyazawa, Bente Lilja Bye

9:40 AM - 10:00 AM JST | 12:40 AM - 1:00 AM UTC

## [s8HxLUFw-03] Agentic Earth System Digital Twins: From Prediction to Collaborative Scientific Discovery

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The landscape of Earth system modeling has advanced significantly with the advent of AI, giving rise to AI emulators, differentiable models, physics-informed models, and foundation models. These approaches are changing not only how we model and predict the Earth system, but also how AI can participate in the scientific process. As these capabilities mature, an increasingly important challenge is how to coordinate heterogeneous models, observations, experiments, and scientific reasoning across domains and scales. Agentic AI offers a new paradigm in which AI can progress from a scientific tool or assistant toward a collaborator capable of designing experiments, coordinating analyses, evaluating evidence, and helping scientists explore new hypotheses.

Within this emerging paradigm, we consider how Earth system digital twins can evolve from predictive representations toward environments for collaborative scientific discovery. We present an agentic digital twin framework that treats scientific questions as executable workflows. Scientific questions are interpreted to identify the observations, models, and computational experiments needed to investigate them. Agents coordinate these workflows by acquiring data, executing and evaluating models, comparing experiments, and synthesizing results. When existing capabilities are insufficient, the framework can dynamically construct new AI models, allowing the digital twin’s modeling capabilities to evolve as new scientific questions emerge.

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We demonstrate this approach through an Earth system tipping-point digital twin that coordinates reduced-order models with AI-based methods for discovery and forecasting to investigate abrupt transitions and interactions across ocean, atmosphere, and land systems. Current applications include the Atlantic Meridional Overturning Circulation, the Amazon, and the West African Monsoon, providing environments for exploring hypothetical and counterfactual scenarios and, ultimately, interactions and cascading behavior across Earth subsystems. These capabilities point toward a broader role for digital twins in AI-enabled science: not only predicting how the Earth system may evolve, but enabling scientists and AI to collaboratively ask questions, conduct experiments, evaluate evidence, and discover new understanding.

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