Data, Observation & Modelling

Fri. Nov 13, 2026 2:00 PM - 3:30 PM JST | Fri. Nov 13, 2026 5:00 AM - 6:30 AM UTC | Room A (Oshidori) (2F)

Oral A5 Ocean Digital Twins, Data Architectures and AI-Enabled Approaches

Chair: Philipp S. Sommer, Tomoki Tozuka

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

[7MgO-EqD-03] Understanding and Predicting Ocean–Climate Variability through Dynamical Models and Data-Driven Approaches

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Ocean–climate variability arises from complex interactions across a wide range of spatial and temporal scales, posing fundamental challenges for both physical understanding and prediction. In this presentation, I will highlight our recent efforts to address these challenges using complementary dynamical and data-driven approaches. First, long-term, high-resolution climate model simulations provide “virtual oceans” in which ocean–atmosphere interactions and rare events can be investigated beyond the limitations of the observational record. Examples include interactions between the Kuroshio Extension, the atmosphere, and the tropical Pacific, as well as the dynamics of rare Kuroshio large-meander events. Second, reduced-order data-driven models provide an efficient framework for exploring climate variability and its underlying interactions. Using a cyclostationary linear inverse model of the Indo-Pacific climate system, we examine how changes in interbasin coupling alter the characteristics of El Niño–Southern Oscillation, illustrating how data-driven models can be used not only for prediction but also for hypothesis testing through virtual experiments. Finally, neural-network-based prediction of winter temperature variability around Japan demonstrates how artificial intelligence can help identify important predictors and motivate subsequent investigation of the underlying physical mechanisms. Together, these studies illustrate the complementary strengths of dynamical models, reduced-order models, and artificial intelligence. Integrating these approaches with observations may provide a pathway toward ocean digital twins that not only reproduce and predict ocean states, but also facilitate exploration and understanding of the processes governing ocean–climate variability.

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