Data, Observation & Modelling

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

Oral A3 Data-Driven Emulators

Chair: Alain Arnaud, Deanesh Ramsewak

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

[hyhteQZr-06] A Physics-Guided Deep Learning Approach for Kuroshio Extension Prediction

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The Kuroshio is a strong, warm current flowing past southern Japan. After leaving the coast, it continues eastward as the Kuroshio Extension (KE), whose path shifts north and south over years. These shifts redistribute ocean heat, affecting ecosystems, fisheries, and climate, making advance prediction valuable. The KE position depends on its recent state and remote winds over the central and eastern North Pacific. These winds generate slow ocean disturbances called Rossby waves that travel westward and can shift the KE east of Japan, offering an early signal. Testing this possibility is difficult because satellite records began in the early 1990s and contain few such shifts.

Therefore, we use monthly output from a completed 520-year simulation with the high-resolution, eddy-resolving Community Earth System Model (CESM-HR), from which a 370-year segment provides the long record needed to learn how KE latitude and remote wind forcing are connected. We predict the upstream KE latitude between 142° and 150°E at lead times of 6-48 months, after smoothing the monthly variations with a six-month running mean. The wind influence is represented by Ekman pumping, which describes wind-driven vertical ocean motion. Broad spatial patterns and slow variations are extracted, then combined with 48 months of KE latitude in a long short-term memory (LSTM) network. Satellite altimeter observations and atmospheric reanalysis winds are used for evaluation and forecast initialization.

CESM-HR tests show that a wind pattern raises correlation by 0.14 at 27 months across 10 initializations. At 48 months, a preselected wind-informed model reaches a correlation of 0.43 and reduces mean-square error by 18% compared with a persistence forecast. Initialized through July 2026, the models suggest a consistent southward tendency, although its robustness requires further evaluation. This physics-guided approach could support longer multiyear KE prediction and earlier warning of impacts on ecosystems, weather patterns, and fisheries around Japan.

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