Satellite-Based ENSO Monitoring and Prediction: A Foundation for Ocean Digital Twin Applications

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The El Niño–Southern Oscillation (ENSO) profoundly influences global climate variability, with cascading impacts on regional precipitation, marine ecosystems, and socioeconomic systems. Reliable monitoring and early prediction of ENSO are thus essential for supporting next-generation ocean decision-making frameworks, including future Digital Twin of the Ocean (DTO) systems. This presentation introduces our recent efforts in developing satellite-based approaches for real-time ENSO monitoring and seasonal forecasting. Leveraging multi-source remote sensing data—such as sea surface temperature, outgoing longwave radiation, salinity, and wind—we have developed robust indices and machine learning-based prediction models, which showed promising performance during the 2023–2024 El Niño event. Although not yet implemented as an operational digital twin module, our work lays critical groundwork for future integration. In particular, we highlight potential interfaces with ocean-atmosphere coupling modules, climate impact assessment tools, and early-warning systems for extreme rainfall and typhoon risks in the Western Pacific. We aim to explore collaborations toward embedding these capabilities into a broader digital twin context and welcome exchange with researchers from physical oceanography, Earth system modeling, and socio-ecological disciplines.

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