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Improving Marine Heatwave Simulation Through Realistic Representation of the Kuroshio in High-Resolution Regional Ocean Model Ensemble

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Marine heatwaves (MHWs), marked by extended periods of unusually warm seawater, significantly impact marine ecosystems and human communities. They have notably increased in the recent decades especially in the Northwest Pacific, a complex coastal region rich in biodiversity and economic activities. To develop effective policies for sustainable and resilient marine ecosystems in this region, high-resolution and reliable ocean climate information is essential. In this study, we simulate the long-term (1982–2014) North Pacific ocean climate using a high-resolution Regional Ocean Modeling Systems (ROMS) driven by eight relatively low-resolution Coupled Model Intercomparison Project 6 (CMIP6) models through dynamical downscaling. The ensemble median of eight ROMS simulations reduces warm biases of CMIP6 sea surface temperature by 20–69%. It also improves the spatio-temporal variation of MHW properties, with up to 80–97% improvement in winter MHW frequency in the Northwest Pacific. This improvement is attributed to a more realistic representation of the Kuroshio and its extension, which increases warm water advection from lower latitudes. This result highlights the importance of high-resolution ocean modeling in providing reliable ocean climate productions, especially for local extreme ocean events strongly influenced by regional ocean circulations in future climate projections.

Keywords: Marine Heatwave, Kuroshio, High-Resolution Regional Ocean Modeling System

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