Long-term evaluation of FIO-COM: predictive skill, biases, and future outlook

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Abstract

FIO-COM (First Institute of Oceanography surface wave-tide-circulation Coupled Ocean Model) is a state-of-the-art ocean general circulation model (OGCM) based on MOM5, incorporating non-breaking surface-wave-induced mixing and parameterized tidal mixing into the KPP vertical mixing scheme. Since its operational deployment in May 2016, FIO-COM has been continuously developed and has demonstrated improved simulations including temperature, salinity, eddy kinetic energy, major current paths, and global tides. The model has also been shown to accurately capture large-scale mixed layer depth structures and seasonal variability in tropical oceans.

This study presents a long-term evaluation of FIO-COM over the 2022–2025 period, focusing on its predictive skills and systematic biases. Following the IV-TT CLASS4 metrics framework, we compare model outputs against the CLASS4 reference datasets, including GHRSST/OSTIA SST, AVISO satellite altimetry, and Argo profiling floats. Key variables assessments include sea surface temperature, sea surface height, temperature/salinity profiles, and mixed layer depth etc. Particular attention is given to the model's performance in regions of the tropical Pacific and the Kuroshio Extension, where its unique wave-tide-circulation coupled dynamics are expected to be most relevant.

We quantify the model's strengths and weaknesses through statistical metrics and discuss the underlying causes of major biases. The implications for operational forecasting and model development are also discussed. Finally, we highlight the potential of integrating AI-based techniques to improve bias correction and validation efficiency. This work contributes to the OceanPredict IV-TT community by providing a performance baseline for FIO-COM and identifying directions for future improvements.