Offline Fennel: An Offline Biogeochemical Model within the Regional Ocean Modelling System (ROMS)

Ocean biogeochemical models are crucial for understanding ocean processes and predicting changes in marine ecosystems. In this study, we present the Offline Fennel model, an offline biogeochemical model implemented within the Regional Ocean Modeling System (ROMS). We evaluate its performance compared to a fully coupled physical-biogeochemical (online) application in the northern Gulf of Mexico. By leveraging physical hydrodynamic outputs, we run the offline model using different calculation time-step ('DT') multiples from the coupled configuration, significantly enhancing computational efficiency. Specifically, this offline configuration has reduced simulation time from 6 hours to about 30 minutes. In addition, we assess the accuracy of the offline model using three different mixing schemes: the Generic Length Scale (GLS), the Large–McWilliams–Doney, and the Mellor and Yamada 2.5. The offline model achieves an average skill score of 93%, with minimal impact on overall performance from the choice of time-step. GLS configurations deliver highest accuracies, but all three mixing schemes perform well in the study area. Although the offline model shows some differences compared to the coupled simulations, our results indicate that these discrepancies are smaller than those observed when employing different mixing schemes within the same application. Finally, the model was also applied to the northwestern Mediterranean Sea as a test case for another basin. The Offline Fennel model once again successfully reproduced seasonal, spatial, and vertical patterns consistent with observational data. These promising results validate Offline Fennel model's capability and efficiency, offering a powerful tool for researchers aiming to conduct extensive biogeochemical simulations without needing to rerun the hydrodynamic component, thereby significantly reducing computational demands. Moreover, it also offers a practical method for fine-tuning model parameters and testing sensitivities while saving valuable time and computational resources.

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