Researchers construct high-resolution physical-biogeochemical model in Indo-Pacific ocean

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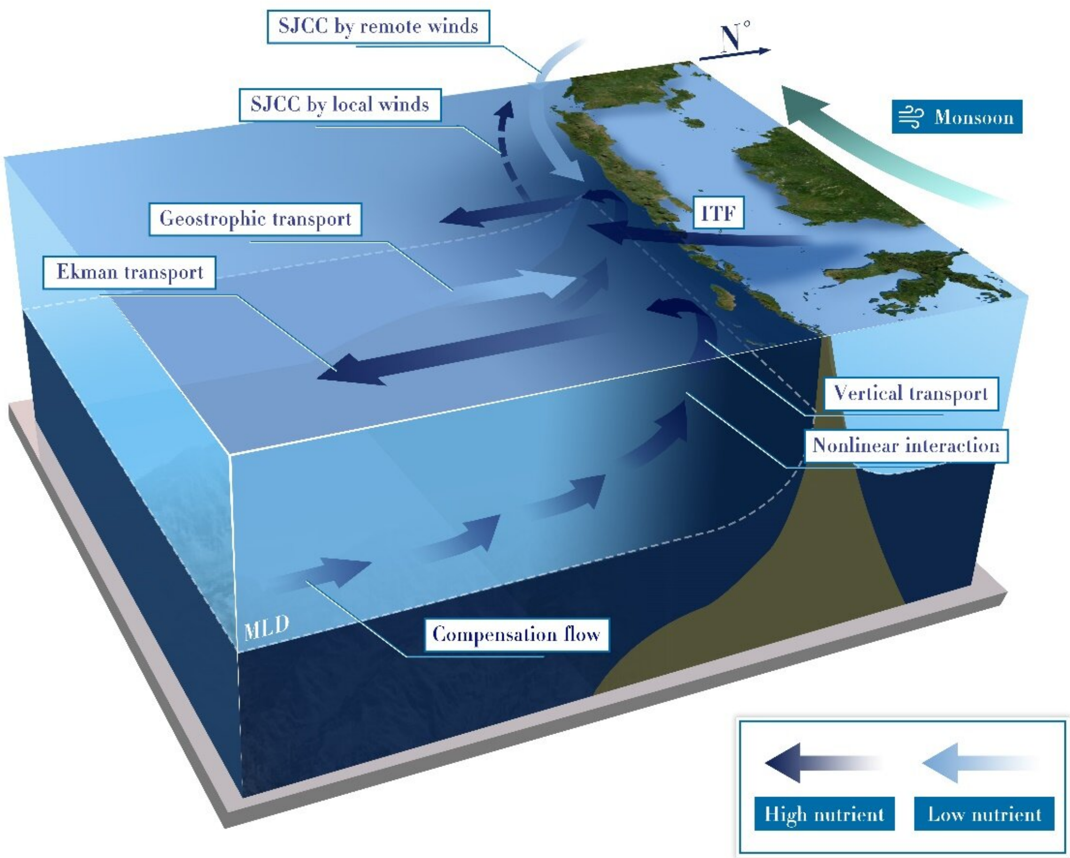

Schematic plot of the physical drivers behind the nutrient transport that affect the chlorophyll blooms. Credit: IOCAS

The Indo-Pacific region is a convergence zone with the largest biodiversity in the global ocean. However, previous models were not refined enough to resolve the complex topography of main straits.

Recently, a research team led by Prof. Yin Baoshu from the Institute of Oceanology of the Chinese Academy of Sciences (IOCAS) constructed a high-resolution physical-biogeochemical model that covers the whole Indo-Pacific region. The physical model can characterize multiscale ocean dynamics processes and reproduce seasonal variation of transport at main straits.

The study was published in *Journal of Geophysical Research: Oceans* on Oct. 29.

Large uncertainties exist in an ecosystem model, as the function forms describing biological processes are empirically determined via observation. The accuracy of biogeochemical dynamics in numerical modeling largely depends on the setting of biological parameters, which must be specifically tuned in various regions. Generally, tens of sensitivity experiments must be conducted to optimize only one biological parameter.

A physical-biogeochemical model often consists of several key parameters with high sensitivities; therefore, theoretically, 10,000 or more numerical experiments are required to achieve a set of optimal biological parameters. Obviously, the corresponding computing resources are unaffordable when running a three-dimensional and high-resolution physical-biogeochemical model.

Thus, the researchers applied the conditional nonlinear optimal perturbation (CNOP) method in a realistic physical-biogeochemical model run, which optimized the parameters in remarkably fewer experiments.

Based on the improved model results, they examined the physical mechanisms controlling the seasonal variation of surface chlorophylls in the Lombok Strait region. The mixed-layer depth varied significantly and the ocean dynamics were heterogeneous in and below the mixed layer, so the results from the mixed-layer and fixed-depth budget were different and should be combined to discuss the behind physical mechanism.

Under the joint influence of equatorial Kelvin waves and local wind forcing, the coastal current varied and affected the nutrient transport semi-annually. In the mixed layer, the high nutrient water was formed mainly by the offshore Ekman transport rather than direct local upwelling.

"This study is the first high-resolution biogeochemical simulation optimized by CNOP method," said Dr. Gao Guandong, first author of the study.

"Our research has unraveled the physical mechanisms of high primary productivity in the Lombok Strait region. It laid the model and theory foundation for understanding the large biodiversity in Indo-Pacific region," said Prof. Yang Dezhou, corresponding author of the study.

More information: Guandong Gao et al, A Biological-Parameter-Optimized Modeling Study of Physical Drivers Controlling Seasonal Chlorophyll Blooms off the Southern Coast of Java Island, *Journal of Geophysical Research: Oceans* (2022). DOI: 10.1029/2022JC018835

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