Large-eddy simulation of tidal bottom boundary layer and behavior of suspended particulate matter on the Okinawa Trough, Japan

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It is widely known that hydrothermal vents in the deep ocean form specific ecosystems as well as rich mineral resources. Revealing the surrounding fluid variations is essential to understand the habitat conditions in the hydrothermal fields and thus to assess the environmental impacts due to excavation activities of the submarine resources. Previous surveys installing 300-kHz acoustic Doppler current profilers (ADCPs) on the ocean floor around hydrothermal vents in the Okinawa Trough, Japan (the water depth ranges between 1000 and 2000 m) reported that the available velocity data were limited only up to 40-60 m from seabed, whereas the maximum record height was set to ~120 m. Although the result suggests that the suspended particulate matters required for the ADCP surveys would be distributed intensively in the lower layer, the underlying dynamics has not been fully investigated. To clarify the property of the deep-ocean fluid dynamics on the Okinawa Trough and its effect on the behavior of suspended particulate matter, we carry out large eddy simulation (LES) experiments on the bottom boundary layer process driven by tidal currents. An important simulated result is that the boundary layer thickness reaches up to 60 m at the end of the experiments, which is consistent with previous studies investigating scaling relations on the tidal bottom boundary layer. Furthermore, simple particle-tracking experiments using the vertical two-dimensional velocity data from LES indicate that most of the suspended particulate matters are finally distributed within the bottom boundary layer, regardless of the initial positions of the particles. These results provide a possible explanation to the observed result from ADCP and, at the same time, suggest the importance of the bottom boundary layer process as a physical factor controlling the environmental impacts caused by dispersion of harmful particles.

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