Near-inertial resonance and upper-ocean stirring due to typhoons in the northwestern Pacific margin

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ABSTRACT

Typhoons alter the upper ocean dynamics and thermal structure, giving rise to feedback on the atmosphere. Intense ocean surface wind and barometric effects induce rough waves and storm surges that occasionally cause severe coastal disasters. For rigorous oceanic modeling under typhoon conditions, we implement the inverse barometer effect and the COAMPS bulk formula into ROMS (Shchepetkin and McWilliams, 2005). A submesoscale eddy-resolving oceanic modeling is configured at a horizontal resolution of 2 km based on the JCOPE2-ROMS downscaling system forced by the JMA GPV-MSM atmospheric reanalysis. A retrospective, synoptic reanalysis is carried out with a particular focus on the two consecutive super typhoons Phanfone (#1418, Category 4, the lowest pressure was 935 hPa) and Vongfong (#1419, Cat. 5, 900 hPa) in the fall 2014. Both the typhoons have landed on the Japanese territory in Shizuoka (Phanfone) and in Kagoshima (Vongfong) Prefectures, traveling long distance along the Honshu Island. The model successfully reproduces increased eddy kinetic energy below the typhoons with intense cyclonic positive vorticity driven by torque of the wind stress curl, not only at surface but also at depth down to 100 m deep. These cyclones are cold-core mesoscale eddies with SST decrease by about 3^{o}C associated with prominent mixed layer deepening. A distinct peak appears at around the inertial frequency in rotary spectra of the clockwise velocity component, suggesting that near-inertial gravity waves are generated below the typhoon track. Inertial resonance evidently occurs on the right side of the typhoon with intensified vertical mixing and associated mixed-layer deepening. Once the typhoons reach the Kuroshio, the typhoon tracks are approximately aligned with the Kuroshio path to travel northeastward. In the vertical cross-section off Tosa Bay, the position of the Kuroshio main body in the upper ocean is substantially altered by the approaching typhoons, resulting in near-inertial oscillations that last for several days after the passage of the typhoons.