On large-scale transport of suspended particulate matter on the continental shelf break off Fukushima, Japan.

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The Fukushima Dai-ichi Nuclear Power Plant (FNPP1) was damaged by the catastrophic tsunamis as the aftermath of the 2011 off the Pacific coast of Tohoku Earthquake occurred on March 11, 2011, leading to accidental leakages of radionuclide to the environment. Previous studies have investigated the released radionuclides to the ocean through the direct discharge at FNPP1 and the initial atmospheric deposition to monitor and quantify the amount of radioactivity in seawater, marine sediments, and marine organisms. Among others, the sediment trap data at two offshore stations, one at ~100 km east of FNPP1 (Otosaka et al., 2014) and the other at ~100 km southeast of the FNPP1 (Buesseler et al., 2015), have detected a substantial amount of suspended radiocesium absorbed into marine particles such as sediments originated from the FNPP1 accident, even in the deep ocean at depths of 500-1000 m. These results suggest that large-scale transport and dispersal of suspended radionuclides at O (100 km) could have occurred in the offshore direction to reach the continental shelf breaks. A high-resolution numerical ocean modeling study by Yamanishi et al. (2016) also reported that there might be sediment transport over the shelf break off FNPP1.

This study aims to demonstrate occurrences of such sediment transport to the deep ocean, and to identify possible mechanisms responsible for large-scale processes. To this end, a STEAMER-ROMS ocean circulation model in a double nested configuration forced by the MOVE-WNP oceanic reanalysis was developed, coupled with the multi-class sediment transport model along with a two-layer stratigraphy model of the marine bed and the SWAN spectral wave model. The inner-most ROMS-L2 model, which encompasses the coastal ocean from Ibaraki up until Iwate and stretches eastward beyond the Japan Trench, was exploited to conduct a reanalysis of 3-D oceanic sediment transport for 14 months after the FNPP1 accident at a horizontal grid resolution of 600 m. The ROMS-L2 model clarifies that large-scale sediment transport has occurred extensively. In particular, clay-class sediments have frequently extended to the offshore sediment trap sites, due primarily to eddy-induced transport. Four typical sediment transport pathways are identified: 1) entrainment in offshore migrating topographically-generated mesoscale eddies enhanced by the southward coastal currents, 2) entrainment in mesoscale pinch-off eddies detached from or on the Kuroshio and its extension jet, 3) intermittent onshore transport of deep-ocean sediments resuspended over deep seamount topography on the Japan Trench, and 4) local resuspension on the continental shelf slope under influences of internal tides.

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