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# 福島沖における原子力発電所事故後一年間の放射性物質海洋拡散シミュレーション
# One-year, regional-scale simulation of radiocaesium-137 radioactivity in the ocean following the Fukushima Daiichi Nucle

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A series of accidents at the Fukushima Dai-ichi Nuclear Power Plant following the earthquake and tsunami of 11 March 2011 resulted in the release of radioactive materials to the ocean by two major pathways, direct release from the accident site and atmospheric deposition. A 1-year, regional-scale simulation of $^{137}$Cs activity in the ocean offshore of Fukushima was carried out, the sources of radioactivity being direct release, atmospheric deposition, and the inflow of 137Cs deposited on the ocean by atmospheric deposition outside the domain of the model.

The rates of direct release of $^{131}$I, $^{134}$Cs, and $^{137}$Cs were estimated for 1 year after the 1F NPP accident by comparing simulated results and measured activities. The estimated total amount of directly released $^{131}$I, $^{134}$Cs, and $^{137}$Cs by the end of February 2012 were 11.1 PBq, 3.52 PBq, and 3.55 PBq, respectively. Tsumune et al. (2012) previously estimated the total amount to be 3.51 PBq by the end of May 2011. The total amount of directly released $^{137}$Cs activity increased by 0.04 PBq between June 2011 and February 2012. We used an atmospheric transport model with atmospheric release rates to estimate atmospheric deposition onto the ocean.

We analyzed $^{131}$I/$^{137}$Cs activity ratios to investigate the contributions of each source of $^{137}$Cs (Tsumune et al., 2012) and compared simulated results and measured activities. The fact that simulated $^{137}$Cs activities attributable to direct release were in good agreement with measurements suggests that the estimated direct release rates were reasonable. Employment of JCOPE2 instead of HYCOM for nudging improved both the offshore transport result and the reproducibility of $^{137}$Cs activities 30 km offshore. Simulated $^{137}$Cs activities attributable to atmospheric deposition were underestimated relative to observations. The rate of atmospheric deposition onto the ocean was underestimated compared to measurements because of a lack of measurements of deposition itself when atmospheric deposition rates were estimated. Measured $^{137}$Cs activities attributable to atmospheric deposition helped to improve the ability of simulated atmospheric deposition rates to reproduce observations. Simulated $^{137}$Cs activities attributable to inflow of $^{137}$Cs deposited onto the ocean outside the domain of the model were in good agreement with measurements in the open ocean in the model domain after June 2012.

Although the contribution of inflow increased with time and was dominant by the end of February 2012, the activity associated with directly released $^{137}$Cs decreased exponentially with time and was present only in the coastal zone by the end of February 2012.

Keywords: Fukushima Daiichi Nuclear Power Plant, Accident, Regional Ocean Model, Radiocaesium, Release amount, Ocean dilution