福島第一原子力発電所事故により海洋に漏洩した^{137}Csの4年半の挙動

Behaviour of oceanic ^{137}Cs from the Fukushima Dai-ichi Nuclear Power Plant for four and a half years

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A series of accidents at the Fukushima Dai-ichi Nuclear Power Plant (1F NPP) 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. Additional release pathways by river input and runoff from 1F NPP site with precipitation and were also effective for coastal zone in the specific periods before starting direct release on March 26 2011.
We reconstructed spatiotemporal variability of ^{137}Cs activity in the regional ocean for four and a half years by numerical models, such as a regional scale (horizontal resolution is about 1 km) and the North Pacific scale (horizontal resolution is about 10 km) oceanic dispersion models, an atmospheric transport model and river runoff model.
Direct release rate of ^{137}Cs were estimated for four and a half years after the accident by comparing simulated results and observed activities very close to the site. The estimated total amounts of directly release was 3.7±0.7 PBq. Directly release rate of ^{137}Cs was the order of magnitude of 10^{14} Bq/day and decreased exponentially with time to be the order of magnitude of 10^{9} Bq/day by the end of September 2015. Estimated direct release rate have exponentially reduced with constant rate since November 2011. Apparent half-life of direct release rate was estimated to be 346 days. Simulated ^{137}Cs activities attributable to direct release were in good agreement with observed activities, a result that implies the estimated direct release rate was reasonable, while there is no observed data of ^{137}Cs activity in the ocean from 11 to 21 March 2011. Observed data of marine biota should reflect the history of ^{137}Cs activity in this early period. The comparisons between simulated ^{137}Cs activity of marine biota by a dynamic biological compartment and observed data also suggest that simulated ^{137}Cs activity other than attributable to dirent release was underestimated in this early period. We reconstructed the history of ^{137}Cs activity in this early period with direct release, atmospheric deposition, river input, runoff from 1F NPP site with precipitation. River runoff process is still unknown in the early period because there were no observed data. We assumed that 10% of deposited ^{137}Cs on each river basin run off thorough rivers along the Miyagi, Fukushima and Ibaraki coasts. The simulation with overestimated river runoff rate (10 %) suggests that the river flux of ^{137}Cs to the ocean was not effective to the ^{137}Cs activity in the ocean in this early period. We estimated the release rate of ^{137}Cs with rain water runoff from the 1F NPP site from the observed ^{137}Cs activity before 26 March 2011 and precipitation data close to 1F NPP site. Simulation with additional release of ^{137}Cs from the 1F NPP site suggests that additional release from 1F NPP site was effective to the ^{137}Cs activity adjacent to 1F NPP and 2F NPP. Simulated atmospheric depositions of ^{137}Cs on a reginal ocean by 9 regional atmospheric transport models still have huge uncertainties. It is also important to estimate the deposition process on a regional ocean to understand contamination process of marine biota.
In the North Pacific scale, ^{137}Cs activity in the intermediate water increased due to the Subtropical Mode Water (STMW) formation. ^{137}Cs is a useful tracer to detect the STMW formation. Not

only the direct release but also the atmospheric deposition are essential for the distribution of ^{137}Cs activity in the North Pacific. Five-member, ensemble simulation with high resolution can represent the increase of ^{137}Cs activity in the intermediate water.

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