

Numerical simulation of Cs-137 activity in the North Pacific using two atmospheric deposition fluxes estimated by atmospheric chemical transport models

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We investigated the difference in the ¹³⁷Cs activity in the North Pacific Ocean (NPO) water after the Fukushima Dai-ichi Nuclear Power Plant (1F NPP) accident using two atmospheric deposition fluxes estimated by atmospheric chemical transport models; Model of Aerosol Species IN the Global Atmosphere (: MASINGAR MK-II) (Aoyama et al, 2015) and Meteorological Research Institute Passive-tracers Model for radionuclides (MRI-PM/r) (Kajino et al, 2012). The difference between both models is the total deposition amount into the NPO water in March and April 2011; 6.4 PBq for MASINGAR, 5.0 PBq for MPI-PM/r. In addition, The MASINGAR estimated larger (smaller) total deposition in north (south) of Kuroshio Extension than MPI-PM/r.

We conducted two five-ensemble simulations of ¹³⁷Cs activity in the North Pacific Ocean (NPO) from 2011 to 2020 due to the direct discharge (Tsumune et al., 2013) from the power plant and the atmospheric deposition flux by using the Regional Ocean Model System (ROMS) with variable mesh of 1/12°-1/4° in horizontal.

Since the calculated ¹³⁴Cs using the original atmospheric deposition fluxes showed smaller than the observations in the surface water in almost whole NPO from 2011 to 2014, we calculated the magnifications for the fluxes by the regression analysis between the observed and calculated ¹³⁴Cs. The magnifications provided the increase in the total amounts of ¹³⁴Cs and ¹³⁷Cs activity in NPO water after the accident, which is 16±1.5 PBq for MASINGAR, 21±2 PBq for MPI-PM/r. The Comparison between the observations and the ¹³⁷Cs calculated with the magnified fluxes represented that the correlation coefficient and the root mean square error are 0.86 and 5.7 Bq/ m⁻³ for MASINGAR, 0.75 and 7.3 Bq/ m⁻³ for MPI-PM/r.

The vertical distributions of the ¹³⁷Cs for the model with MPI-PM/r flux represented relatively larger in the Subtropical Mode Water in 165 °E in 2012 than that for the model with MASINGAR flux. The model with MPI-PM/r flux consequentially represented that the ¹³⁷Cs activity was able to be detected west of Okinawa Islands until 2014, while MASINGAR until 2012.

Keywords: Cs-137, North Pacific ocean, atmospheric deposition fluxes