Geophysical Research Abstracts
Vol. 15, EGU2013-536-4, 2013
EGU General Assembly 2013

Radiological assessment by compartment model POSEIDON-R of radioactivity released in the ocean following Fukushima Daiichi accident

Roman Bezhenar (1), Vladimir Maderich (1), Rudie Heling (2), Kyung Tae Jung (3), and Jung-Goo Myoung (3)
(1) Ukrainian Center for Environmental and Water Projects, Kiev, Ukraine, (2) NRG, Arnhem, the Netherlands, (3) Korea Institute of Ocean Science and Technology, Ansan, Republic of Korea

The modified compartment model POSEIDON-R (Lepicard et al, 2004), was applied to the North-Western Pacific and adjacent seas. It is for the first time, that a compartment model was used in this region, where 25 Nuclear Power Plants (NPP) are operated. The aim of this study is to perform a radiological assessment of the releases of radioactivity due to the Fukushima Daiichi accident. The model predicts the dispersion of radioactivity in water column and in the sediments, and the transfer of radionuclides throughout the marine food web, and the subsequent doses to the population due to the consumption of fishery products. A generic predictive dynamical food-chain model is used instead of concentration factor (CF) approach. The radionuclide uptake model for fish has as central feature the accumulation of radionuclides in the target tissue. Three layer structure of the water column makes it possible to describe deep-water transport adequately. In total 175 boxes cover the Northwestern Pacific, the East China Sea, and the Yellow Sea and East/Japan Sea. Water fluxes between boxes were calculated by averaging three-dimensional currents obtained by hydrodynamic model ROMS over a 10-years period. Tidal mixing between boxes was parameterized.
The model was validated on observation data on the Cs-137 in water for the period 1945-2004. The source terms from nuclear weapon tests are regional source term from the bomb tests on Atoll Enewetak and Atoll Bikini and global deposition from weapons tests. The correlation coefficient between predicted and observed concentrations of Cs-137 in the surface water is 0.925 and RMSE=1.43 Bq/m3.
A local-scale coastal box was used according POSEIDON's methodology to describe local processes of activity transport, deposition and food web around the Fukushima Daiichi NPP. The source term to the ocean from the Fukushima accident includes a 10-days release of Cs-134 (5 PBq) and Cs-137 (4 PBq) directly into the ocean and 6 and 5 PBq of Cs-134 and Cs-137, respectively, from the atmosphere. The predicted background concentration of Cs-137 in water, bottom sediments and fish in the area around the Fukushima NPP agrees well with observations before accident (1984-2010).
Calculated concentration of Cs-137 in the water, bottom sediments and marine organisms in the coastal box after accident is close to measurements performed by the Japan authorities. The dynamical food web model reproduces the measurements better than CF approach based models. The model predicted that the concentration of Cs-137 in the water rapidly decreases after the accident and reaches the background concentration in beginning of 2012. However, due to delay of transfer throughout the foodweb, the concentration of Cs-137 for non-piscivorous and piscivorous fish returns to background concentration only in 2015 and 2017, respectively. For 2011, the calculated individual dose rate due to consumption of fishery products in prefecture Fukushima is 2.36 microSv/year. It is close to the maximal individual dose rate observed in 1959. The collective dose rate due to ingestion of fishery products for Japan is 14.9 manSv/year for 2011, 3 times higher than for 2010 (4.6 manSv/year).