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3D model of radionuclide dispersion in coastal areas with multifraction cohesive and non-cohesive sediments

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We developed new radionuclide dispersion model that may be used in coastal areas, rivers and estuaries with non-uniform distribution of suspended and bed sediments both cohesive and non-cohesive types. Model describes radionuclides concentration in dissolved phase in water column, particulated phase on suspended sediments on each sediment class types, bed sediments and pore water. The transfer of activity between the water column and the pore water in the upper layer of the bottom sediment is governed by diffusion processes. The phase exchange between dissolved and particulate radionuclides is written in terms of desorption rate a_{12} (s^{-1}) and distribution coefficient $K^w_{d,i}$ and $K^b_{d,i}$ (m^3/kg) for water column and for bottom deposit, respectively. Following (Periáñez et al., 1996) the dependence of distribution coefficients is inversely proportional to the sediment particle size.

For simulation of 3D circulation, turbulent diffusion and wave fields a hydrostatic model SELFE (Roland et. al. 2010) that solves Reynolds-stress averaged Navier-Stokes (RANS) equations and Wave Action transport equation on the unstructured grids was used. Simulation of suspended sediment concentration and bed sediments composition is based on (L. Pinto et. al., 2012) approach that originally was developed for non-cohesive sediments. In present study we modified this approach to include possibility of simulating mixture of cohesive and non-cohesive sediments by implementing parameterizations for erosion and deposition fluxes for cohesive sediments and by implementing flocculation model for determining settling velocity of cohesive flocs.

Model of sediment transport was calibrated on measurements in the Yellow Sea which is shallow tidal basin with strongly non-uniform distribution of suspended and bed sediments. Model of radionuclide dispersion was verified on measurements of ^{137}Cs concentration in surface water and bed sediments after Fukushima Daiichi nuclear accident.

References

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