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Biogeosciences Discussions

Interactive comment on "Ecosystem model-based approach for modelling the dynamics of ^{137}Cs transfer to marine plankton populations: application to the western North Pacific Ocean after the Fukushima nuclear power plant accident" *by* M. Belharet et al.

Anonymous Referee #2

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General comment This paper delineates the bio-environmental-kinetics of radiocesium in a plankton community by employing a developed dynamic model coupled with an ecosystem model. It is challenging and original that this new complex model has been applied to the contaminated waters off Fukushima. The derived conclusion based on the modeling analysis has revealed a possible theoretical explanation for the temporal and special variability of radiocesium concentrations in the plankton community of the western North Pacific Ocean. The evaluated dose rate to plankton community of this area represents the most up to date information on the degree of radiation exposure to this ecosystem. Though all of contamination sources from the Fukushima nuclear power plant have not yet been identified, this paper is important in that it represents the latest estimation of radiation dose to this marine fauna resulting from the Fukushima accident. The paper is also valuable because of its theoretical explanation of radiocesium dynamics in the plankton community of the western North Pacific Ocean. To better clarify the logic structure and rationale for the model validation, the following points are recommended to be reconsidered and/or corrected. In addition, some editorial changes are suggested to better help the reader's understanding.

1) The output from the simulated result is regulated by the contamination source input to the model. Thus it is necessary to show the information of what kind/amount of the radiocesium source (e.g. atmospheric: 2.0?? PBq within radius of ??km, initial liquid release 3.5?? PBq) was introduced into the model as the source input for this study analysis. At the same time, it should be stated what other possible sources (e.g. re-distributed by river discharge, late continuous release etc.) were not considered in this study. Otherwise, the reader cannot identify limits of the authors result, the applicability of which is regulated by the source used in this modeling study. 2) Bio-kinetics parameters in the model are calibrated by the measured concentrations in zooplankton collected from Sendai Bay (MEXT?). As Kaeriyama et al., (2015) discussed about the biota data from these coastal waters, the analyzed values of zooplankton samples collected by Bongo/sledge nets were higher variable, probably because they contained suspended particles with or within the zooplankton. A similar tendency for higher variability in concentrations in collected plankton samples has been pointed out in the conference presentations by Aono (NIRS) and Ishimaru (Tokyo Univ MST)(unpublished data). The effect of this kind of variability in the data on model calibration is more or less significant for the final calculated output. One may use a bias-based calibrated parameter as an apparent (calibrated) value, especially in the model simulation carried in an area of similar conditions such as the coastal waters around Fukushima. However, in contrast, the application of bias-based calibrated parameters will generate overesti-

mations in the case when applied to the North Pacific Ocean where the contribution of contaminated suspended particles is negligible. Thus, in this paper the authors should mention that their result of the Ocean simulation may be overestimated. Or if possible, they should consider deriving a correction factor (see. Tateda et al., 2015). If this cannot be done, mention of the extent of the assumed error would be helpful to avoid the reader's misunderstanding about the result being a maximum value or bias-based estimation. 3) The significant findings in this paper are that the time-dependent radiocesium concentration in zooplankton is theoretically explainable by temporal changes of plankton biomass and the food ingestion/composition rates reconstructed from the ecosystem model. In addition, it is worth reporting that limited oceanic winter food condition reduces the radiocesium concentration in zooplankton, though it should be evaluated by multi-year simulation by validation with filed observations (Kitamura, Nishikawa unpublished data). On the other hand, the sensitivity of the model output affected by parameter deviation (Fig. 5), ratio of concentration in phytoplankton and zooplankton (Fig. 7), and seasonal dynamics of concentration in a non-accident situation (Fig. 10), etc. are understood as just the calculated results defined by model characteristics. Without any validation data to compare with, they are just functions of the given input, and not the proven findings. It is therefore recommended to consider including some discussion of the above-mentioned points in this paper. 4) The order of appearance of some tables and figures do not correspond to the order they are discussed in the text. Since tables and Fig. 2 are not necessary to shown in the main text, it is suggested to put them in an Appendix at the end of the paper, or in Supplementary Material.

Specific comments 9499 21 "assess the radionuclide concentration in marine biota" -> "assess the radionuclide distribution between marine biota and the environment"? or "reconstruct the radionuclide concentration in marine biota"? 9502 5 missing (ZP) in "predatory zooplankton (ZP) such as krill and/or jellyfish" 9505 6 The source information used for the simulation has to be shown, such as atmospheric, initial effluent and continuous release (if included in this paper). 9505 13 If the radionuclide contribution from terrestrial runoff is not estimated and included in this simulation, this

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should be mentioned in the text. (See Nagao, S., Kanamori, M., Ochiai, S., Tomihara, S., Fukushi, K., Yamamoto, M., 2013. Export of 134Cs and 137Cs in the Fukushima river systems at heavy rains by Typhoon Roke in September 2011. Biogeosciences 10, 2767-2790.; Tateda, Y., Tsumune, D., Tsubono, T., Aono, T., Kanda, J., Ishimaru, T., 2015. Radiocesium biokinetics in olive flounder inhabiting the Fukushima accident-affected Pacific coastal waters of eastern Japan. J. Environ. Rad. 147, 130-141) 9505 17 Instead MEXT (2014), Kaeriyama et al., (2015) should be cited. See "Kaeriyama, H., Fujimoto, K., Ambe, D., Shigenobu, Y., Ono, T., Tadokoro, K., Okazaki, Y., Kakehi, S., Ito, S., Narimatsu Y., Nakata K., Morita, T., Watanabe T., FukushimaâĂŚderived radionuclides 134Cs and 137Cs in zooplankton and seawater samples collected off the JobanâĂŚSanriku coast, in Sendai Bay, and in the Oyashio region Fish Sci (2015) 81, 139–153" 9505 20 For the geographical positions, see the above paper. 9508 5 Corresponding wet weight should be shown in the text, to compare with those of zooplankton (approximately, 200–600 ? mg w.w.m-3). In that case, please cite the reference for the Organic matter/Chl ratio used for the wet weight calculation. 9509 3 Calibrated elimination rate 0.03 – 0.11 d-1 for zooplankton is likely to be lower than the experimentally derived elimination rate 0.8 d-1 in zooplankton (the rotifer, Brachionus plicatilis) in Japan (Aomori Prefecture. 1990. Heisei-gannen Marine Environmental Radioactivity General Review Report. Aomori Prefecture, Aomori, 91pp. (in Japanese). 9509 10 The calibrated accumulation rate of 5 x 10-4 L g-1 d-1 (being approximately equivalent to 1.0 d-1 if assuming 500mg w.w.m-3) for zooplankton is also likely to be smaller than the experimentally derived elimination rate of 50 d-1 in zooplankton (Brachionus plicatilis) in Japan (Aomori Prefecture. 1990). If the calibrated transfer rates in Table 1 are derived by fitting the simulated result to the observed result, they should be described as "apparent". 9509 26 Unify the term to "accumulation rate" instead of "uptake rate". 9512 7 "the simulated zooplankton" -> "simulated large ? zooplankton" 9512 10-16 Are these discussion points for "large" or weight averaged ZS, ZL and ZP? 9512 21 Missing (R) in "calculated a ratio (R) of the 137Cs concentration. . .. 9513 23 The vertical removal and transport of radionuclides to bottom layers is an important process in the open ocean as discussed in this paper. However, at present there is no quantitative proof for a significant contribution of this process around 1FNPP. Other processes are suggested as being critical in the Fukusima coastal waters, e.g. continuous releases, river discharged particles from highly contaminated land areas, etc. 9513 25 Is “Concentration ratio” appropriate to use as a term in the dynamic model study paper? Under the dynamic simulation, the obtained ratio is considered to be an as apparent concentration ratio (aCR) as suggested by Kaeriyama et al., (2015). 9514 24 “poor” ->”oligotrophic”? 9515 8 “The time needed for . . .”-> “The time derived from the modeling analyses for these . . . 9516 Section 3.8 Is the term “TTF” is worth discussing? Discussed here is the apparent TTF (aTTF) under transition conditions. In addition, the TTF for Hg has completely different characteristics. The transfer time constant of Hg is extremely long or infinite. Thus TTF is appropriate concept for Hg transfer in the marine ecosystem, while the TTF concept is not useful for Cs. 9522 17 Add JODC data archive location in the web. 9523 23 The MEXT reference should be replaced by Kaeriyama et al., 2015.

Fig. 3. Unify the case of letters in fig (A – F) and in figure caption (a - f). Add to the legend a mention of the three different taxonomic compositions (ZS,ZL, ZP?) in sub-fig B, D, F.

Fig. 4. Reference Kaeriyama et al., (2015) should be cited in the legend as a data source.

Fig. 5. The parameters on the X-axes are small and are unreadable. Add planton composition PS, PL, ZS, ZL, ZP to the legend.

Fig. 6. Unify the case of letters in fig (A – D) and in figure caption (a - d). Show the unit (Bq kg d.w.-1) for the contour legend. For sub-figures B and C, are they not Buesseler et al. (2012) and C, Kitamura et al., (2013), respectively?

Fig. 8. Missing (PS)(ZL)(ZP) in “. . . small phytoplankton (PS), large zooplankton (ZL) and predatory zooplankton (ZP) in the . . ...”. The scale of the Y-axis in subfigure ZP is

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different from the others. Unify the Y-scales of all subfigures.

Fig. 11. Y-scales in subfigure ZP are different. Unify the whole study area and 0-30km from FNPP.

Fig. 12. What do the red bars and marks on the two figures represent?

Interactive comment on Biogeosciences Discuss., 12, 9497, 2015.