

## ***Interactive comment on “Horizontal distribution of Fukushima-derived radiocesium in zooplankton in the northwestern Pacific Ocean” by M. Kitamura et al.***

**M. Kitamura et al.**

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We thank the referee for the constructive and detailed comments. Our responses are below.

Reply to comments by anonymous Referee#2

This is a nice paper showing interesting new data. It is unusual well under built with biological details. It is presented in an efficient way. Unfortunately, in spite of good data it is difficult to explain some of the patterns. That means normal hard life for field studies, which are tricky to publish. The paper might be improved if there are data on vertical particulate (POM, POC) and dissolved organic matter (DOM, DOC)

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are available. This could give a hint on if there is a biological activity which can explain the peaks in the vertical dimension or at least feed a discussion on it.

Answer: We appreciate the useful comments for further improvements of the manuscript. Unfortunately, we have no data on POM, POC, DOM or DOC. We could not discuss whether these explain the horizontal distribution pattern of radiocesium contamination on zooplankton or not.

It is not clear from the methods if the water is filtered or not, ie that the measured activity is not found in POM, this needs to be clearer described in the methods section.

A: The seawater was filtered using a 0.45  $\mu\text{m}$  membrane filter and acidified by 40-cm<sup>3</sup> of concentrated nitric acid within 24 hours after sampling on board. We will add this description in the methods section.

I don't understand fig 3d, e, f may be the labels are wrong on the axis. Furthermore is not clearly described that it refers to the density of the water. Neither in figure nor in text.

A: We will add the explanation of the potential density anomaly in the figure caption. The potential density is the density a parcel of water would have if it were raised adiabatically to the surface without change in salinity. The potential density anomaly,  $\sigma_\theta$  (kg/m<sup>3</sup>) is calculated using potential temperature ( $\theta$ ) and salinity (s) as follows;  $\sigma_\theta$  (s,  $\theta$ , 0) = (s,  $\theta$ , 0) – 1000, where indicates seawater density (kg/m<sup>3</sup>) and 0 (zero) means “at sea surface”.

There are some typos in the text p6153 top radioceium should read radiocesium. Table 1 is missing explanation of SST. Table 2 also and the last two columns have some data not properly aligned.

A: We will correct the typo and align the data on the last two columns in Table 2. SST means “sea surface temperature”, we will add the explanation in the figure caption.

Reply to comments by anonymous Referee#4

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The paper describes the contamination of seawater and biota samples collected on cruise along a south-north section of R/V MIRAI within a WOCE cruise about 10 months after the accident at Fukushima Daiichi nuclear power stations. The paper presents interesting features, because the contamination of zooplankton is not related to the concentration of radiocesium found in seawater. This finding might also contribute to the question of the dynamic of marine food web contamination. The paper should be published after minor corrections of some typing errors and some grammatical corrections of some sentences.

A: Thank you for your kind and positive words on our manuscript. We will correct the typing and grammatical errors according to your comment. We will also brush up the English in the manuscript.

Some more specific comments you may take into account: Abstract: Please reformulate the following sentence, because it is not correct and difficult to understand: Biological characteristics of zooplankton community possibly influenced how large was contamination of radiocesium in the community but it is still unknown what kind of biological factors were important.

A: We will rewrite this part as follows; Activity concentrations of radiocesium in zooplankton might be influenced not only by the environmental radiocesium activity concentration but also by other factors, which are still unknown.

1 Introduction: ... in airborne (release and subsequent) fallout ... community included (would be) [was] needed. 2 Methods: ... frozen at  $-20^{\circ}\text{C}$  after [sorting out] (separation from) fish. ... are previously describ[v]ed in Kumamoto ... agreed with the certificated values within the (provided uncertainties) [errors]. Because the radioactivity of  $^{134}\text{Cs}$  in the two samples ... → Due to the activity of  $^{134}\text{Cs}$  in the two samples ... these were re-analysed using a ... because the (error) [counting uncertainty] of  $^{134}\text{Cs}$  activities was [too] high ... agreed with the certificated values within the errors. → ... with the certified values within the given uncertainty range.

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A: We will correct these errors according to these comments.

4 Discussion: ... Honda et al., 2012) [. A] (a)nd the lowest one was observed ... ... As for concerns in the subtropical area, dilution of seawater by advection, diffusion, and vertically mixing, or vertical transportation of radiocesium attached with the sinking particles into deep layers [were] (would be) possible explanations ... Do you mean dilution of seawater by different water bodies with different T/S-signatures or do you mean "dilution of radiocesium"? This sentence should be reformulated, it is not so clear. As far as the subtropical area is concerned, dilution of radiocesium by advection, diffusion ... ???

A: We mean dilution of seawater by different water bodies with different T/S-signature. We will correct this sentence as follows; As for concerns in the subtropical area, dilution of seawater by different water bodies with different T/S-signature or vertical transportation of radiocesium attached with the sinking particles into deep layers would be possible explanations for the low radiocesium activity concentrations in surface seawater.

.. be derived (not only) from [not only] surface but ... ... NPSMW was [an] important source ... ... did not necessarily [follow] (correlate with) higher radiocesium activity in zooplankton. (So) [Consequently], it is difficult to explain the high Cs

A: We will correct these grammatical errors according to the comments.

... Fukushima derived high radiation (?) located between 20 N and 30 N one month ... Do you mean radiation or radioactive contamination?

A: Huh et al. (2012) reported that east-west band of high radiation, which due to radioactive aerosols moved by boundary layer transport, was located between 20°N and 30°N one month after the FNPP1 accident based on an atmospheric model simulation. This suggests high atmospheric deposition of radiocesium into ocean at around 25°N before our research cruise. We will add this explanation in the text.

Finally, we discuss (on) [a] potential impact of the radioce[s]ium ...

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A: We will correct this grammatical error and typo according to the comments.

Please reformulate the following sentence for better understanding: In the subarctic/transition regions, accumulated radiocesium in the migrant's bodies might be transported downward and (uptake of) [consequently accumulate ???] radiocesium into the mesopelagic food web (through) [by] biological activities (was) [. This would be a] possible [explanation of this process]. I understood, what I have indicated by my changes.

A: According to these comments, we will reformulate this sentence as follows; In the subarctic/transitional regions where radiocesium activity concentrations in surface seawater was higher than that in the subsurface layer, accumulated radiocesium in the migrant's bodies might be transported downward and consequently radiocesium might be accumulated into the mesopelagic food web.

... mesopelagic communities should be (researched) [investigated] in [the] future. 5  
Conclusions: ... 25°N that was not corresponded with ... → 25°N which does not correspond with ...

A: We will make the corrections according to these comments.

Please reformulate the following sentence, because it was not clear for me and the grammatical structure is also not correct: Activity concentrations of radiocesium in zooplankton might be influenced not only [by the ???] environmental radiocesium activity concentration but also other [by] factors, which are (that is) still unknown.

A: We will correct this sentence as follows; Activity concentrations of radiocesium in zooplankton might be influenced not only by the environmental radiocesium activity concentration but also by other factors, which are still unknown.

Table 1 and 2: Are the given uncertainties of the radiocesium activity at 1 sigma or 2 sigma?

A: The uncertainties are given at 1 sigma. We will add this description in the figure caption.

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Interactive comment on Biogeosciences Discuss., 10, 6143, 2013.

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