

**Comments from G. Hong (C2585-C2587, 2014)**

***General comment: ‘Grain size is certainly one of the factors determining radio cesium concentration in the bottom sediment, however, the mode of association of <sup>137</sup>Cs on the sediment grain would be more strongly related to the mineralogy and chemistry of the host sediment grains. Therefore, bare sediment grain may have limited information’***

We agree that grain size is not the only factor but we do not have any additional mineralogical data to present at this time.

***Line 256,257,258 – “oS” appears to be typing error.***

It appears that the comment is referring to areas with degree symbols followed by ‘S’ for south (coordinates). The degree symbol appears in the final typeset version and all ‘S’ were changed to ‘N’.

***Lines 290-291. The sentence is difficult to follow. I suggest rewriting as follows. The values of D50, percent fines, and percent clay of sediment texture (or sediment grain size) results reflected wide variations in grain size over the coastal to offshore regions and relatively invariant consistent vertically in distributions with each core. (if it correctly delivers the authors’ message).***

The sentence has been edit to make the message more clear: ‘The average values for D50, percent fines, and percent clay reflected wide variations in grain size from the coastal to offshore regions, although for a given core the changes in grain size between individual layers from top to bottom were generally small.’

***Line 289: the usefulness of this sentence is questionable in the context of manuscript, such as mineral composition, adsorption coefficient of Cs.***

We assume that the comment is referring to the following sentence, ‘The two OZ cores were very fine-grained and had relatively similar D50 and percent clay values of approximately 18 μm and 12.5%, respectively.’ The values for the OZ are reported for comparison and to illustrate the large change between the average grain size values in the near shore and offshore cores. Therefore, no changes were made.

***Line 400. If the zones are not divided based on the any variable affecting Cs concentration, the intra-zonal variability estimation would be meaningless.***

We divided the sediment reservoir into five zones based on inventories, grain size, and mixing rate estimates from our 20 sediment cores (discussed in Section 3.2). Isobaths were used for eastern and western boundaries. The results suggest that grain size, water depth, and distance from FDNPP could have influenced inventory distributions and therefore the zones were divided based on factors that could affect Cs concentrations in the sediments. Therefore, we have not made any changes in response to this comment.

***Line 512-513: Inventory dependency on the water depth may be fortuitous and the authors may arrive at the same conclusion as the inventory is plotted against the distance from the FDNPP.***

In the manuscript, we suggest that water depth is a contributing factor but we acknowledge that distance (proximity) to the FDNPP also plays a role and is related to water depth (See Sections 3.5 and 3.9). We also concluded that because of the interplay of distance, depth, and grain size

effects, that it is hard to definitively show that one factor is strongly correlated with cesium inventories and the  $R^2$  values were included to illustrate a lack of strong ‘inventory dependence’ (values <0.5).

### **Comments from Anonymous Referee #3 (C2328-C2329, 2014)**

***General comment: ‘The author should estimate the potential of penetration or provide data for the deeper sedimentary layers in the NCZ’***

Figure 2 shows all the samples that were collected and therefore, we cannot provide any additional deeper sedimentary layer data at this time. While we anticipate that cores 15, 16, 17, and 19 would continue to have low cesium at depth, we have no means of estimating how deep the cesium penetration might be in cores 18 and 20 at this time. While uncommon, studies from the Strait of Canso (Nova Scotia) and the John Brewer Reef (Australia) show extensive bioturbation due to species of burrowing shrimp. In the Strait of Canso, burrows reached 3 m in length and in the reef sediments in near Australia the surface mixed layer has been shown to extend to approximately 50 cm. We hope that future work in the area will result in longer cores, however, without deeper cores, pre-accident coastal bioturbation studies from this area, and/or analysis of the local fauna we cannot offer a suitable estimate of penetration depth in the NCZ.

We did change Lines 24-26, 7254 to the following to address this comment: ‘Although, this inventory could change with the addition of new and deeper cores, because the 3 km subzone only comprises 0.03% of the total area, even assuming a mixed layer depth of 50 cm (cesium penetration to 50 cm; Walbran, 1996) would not change the total regional inventory more than a few TBq.’

Walbran, P.D.,  $^{210}\text{Pb}$  and  $^{14}\text{C}$  as Indicators of Callianassid Bioturbation in Coral Reef Sediment. J. Sediment Res. A, 66(1), 259-264, 1996.

Pemberton, G.S., Risk, M.J., and Buckley, D.E., Supershrimp: deep bioturbation in the strait of canso, nova scotia. Science, 192(4241), 790-1, 1976.

***General comment: ‘Although the mixing does not affect the general distribution and total inventory of sedimentary radiocesium, I think it is necessary to elaborate how the authors applied the values for the validation’***

Lines 8-12, 7254 were changed to address this comment: ‘Using Eq. (4) and the estimates of mixing rates, we determine the average percent of cesium below 3 cm for each zone in June 2011 and used these smaller percentages instead of those in Section 3.5 to adjust the MEXT data. After this adjustment, the total inventory estimate decreased slightly to  $100 \pm 60$  TBq.’

***Specific comment: ‘P7240 L5 “R/V Daisan Kaiyu Maru”: “R/V Daisan Kaiyo Maru”; P7245 L6 “38.50 S”: 38.50 N; P7245 L6 “38.5S”: 38.5 N; P7257 L20: “R/V Daisan Kaiyo Maru”;***

All references to the R/V Daisan Kaiyu Maru were changed to ‘Kaiyo’. The coordinates with degrees South ( $^{\circ}\text{S}$ ) have now been changed to  $^{\circ}\text{N}$ .

### **Comments from Anonymous Referee #1 (C2073-C2073, 2014), submitted as supplement**

***General comment: ‘However the paper is not always easy to read and the writing has to be improved in order to help the reader in following the authors’ reasoning.’***

We have made a considerable effort to improve the clarity throughout the paper in response to the specific comments below and in response to the other referees’ comments.

***General comment: ‘Before going into details in specific remarks, it seems important to me to give a general comment that I consider particularly relevant to this paper but also to various papers dealing with cesium in sediment. Due to the fact that the finer the sediment the higher the exchange surface authors generally look for a relation between grain size and cesium concentrations. However in some cases this quest can be a vain one. Indeed, when dealing with diffuse sources such as global fallout there is no doubt that fine sediment are characterized by higher cesium contents. However this is not always true for point sources such as controlled liquid discharges or accidental releases (except of course if areas around these point sources have high silt contents which is indeed the case for example in the eastern Irish sea close to the discharge point of Sellafield). In case of point sources main factors are obviously the distance or for riverine installations also the time of the discharges (low flow vs high flow rates), the dispersion patterns of the releases, lateral transport etc...’***

For the cesium derived from the Fukushima point source, we have tried to show that both distance, proximity, and grain size can impact core inventories.

***Introduction 7236 line 18-19: TEPCO has reported some of the highest  $^{134}\text{Cs}$  sediment activity (2000 Bq kg<sup>-1</sup>, NRA, 2014a) when where? This number does not seem so high! there are indeed a number of data above 2000 that have been reported by TEPCO, please check and also mention the date/location of the sampling.***

The referee is correct. Although most of the early values reported by TEPCO are in the 2000s, there is a single, much larger value (9600 Bq/kg) from 7/14/2011 at a location just above the FDNPP (TEPCO station 1). We have changed the sentence to the following:

‘TEPCO initially reported some of the highest  $^{134}\text{Cs}$  sediment activities in July of 2011 (TEPCO station 1 at 9600 Bq kg<sup>-1</sup> wet) in grab samples collected within the 30 km zone around FDNPP (NRA, 2014a).’

As we note in the next paragraph, at a later time Thornton et al. (2013) also used a towed gamma spectrometer and saw much larger variations (500 to 40,000 Bq kg<sup>-1</sup> within 3 km of the FDNPP).

***Introduction 7239 line 8, “If conditions are relatively stable, the  $^{210}\text{Pb}_{\text{ex}}$  in a given area will represent the flux to this location averaged over the last century (~5 half-lives)” I think it is  $^{210}\text{Pb}_{\text{ex}}$  inventory. Most of the section dealing with  $^{210}\text{Pb}_{\text{ex}}$  should be move to the methods section, in the introduction you should only mention that in order to help in evaluating the rates of both sedimentation (but nothing on this point is reported in the paper ...) and mixing, two natural-occurring radionuclides have been studied.***

The sentence has been changed to: ‘If conditions are relatively stable, the  $^{210}\text{Pb}_{\text{ex}}$  inventory in a given area will represent the flux to this location averaged over the last century (~5 half-lives).’

The paragraph beginning ‘We estimated the expected...’ has been moved to the methods section for isotope measurements, Section 2.3. This paragraph covers how we estimated expected  $^{210}\text{Pb}_{\text{ex}}$  inventories and therefore fits better in the methods section.

We have assumed that sedimentation is negligible according to the assumptions in Section 2.4. We therefore do not spend significant time addressing it in the manuscript.

***Methods 2.1 Sample collection 7241: It would be useful to have the core section. It is mentioned that a multi-corer has been used. Did you pool several tubes for getting one sample?***

We are unclear about the meaning of ‘It would be useful to have the core section’. We did not pool several tubes to get one sample. To clarify this point Lines 6-7, 7240 were changed to say ‘Individual core tubes were retrieved from a multi-corer and cross-sectioned at sea into 0.5 to 2 cm layers.’

***Methods 2.2 Grain Size Analysis 7240: I understand that for simplification in the presentation of the data, authors have averaged the grain size over the entire cores though measurements have been performed on each layer. Therefore why assume to have a 5% uncertainty when most of the time due to large fluctuations in layer to layer analyses the standard deviation is far greater than this. I strongly recommend to give the standard deviations in table 1. I have to confess that I get lost with all the different kind of uncertainties the reader have to integrate when reading the paper...***

The following sentence ‘While the reported uncertainty of the Coulter counter was minimal, a 5% uncertainty was assumed for all results due to sampler bias and potential variation within each layer,’ was meant to indicate that each individual sample/layer within a core would have some additional uncertainty besides that which was estimated by the instrument. Because this data is not included in the main document, however, we have removed this statement from the text to avoid confusion. As requested, standard deviations have been added to Table 1 for the grain size results (D50, clay, and silt plus clay). We have added the sentence ‘All grain average size results are reported with standard deviations’ to Section 2.2 to further clarify.

***Methods 2.3 Isotope measurements, Please indicate clearly the unit for the results Bq kg-1 dry? (no indication in table or figure legends as well) 7242 line 5: where layer thickness was in meters, activities were in Bq kg-1 (I guess it is dry weight, please clarify)***

Section 2.3 was changed to indicate that all reported activities were in ‘dry weight’. A sentence was added to paragraph 2, 7241 saying ‘All final  $^{210}\text{Pb}_{\text{ex}}$ ,  $^{234}\text{Th}_{\text{ex}}$ , and cesium activities are reported as Bq kg<sup>-1</sup> dry.’ Changes were also made to the supplemental tables to indicate that the activities reported were always relative to dry weight.

***Methods 2.4 Modeling 7242 In this part arise a confusion which appears even more clearly in the section 3.7 where, if I am correct, the authors consider that Db represents mixing due to bioturbation processes only when Db represent also other processes such as physical resuspension etc.. This latter process is certainly quite important in NCZ and SCZ and cannot be rule out especially since the areas (1) have been subject to a strong tsunami and we do not know if sediments have been consolidated leading then likely to easier re-suspension phenomena and (2) are regularly under influence of typhoons.***

This section has been significantly changed to clarify the meaning of ‘sediment mixing’ and to address the concerns above. Please see Section 2.4 directly.

***Results 3.1 7244 line 5 “We could not obtain ... which suggest that the factors controlling local inventories may vary for the two isotopes” Suggests and may seem inappropriate: replace suggests by confirms and delete may. There is no reason to have a good correlation between***

***the two isotopes, their sources and entry route in the environment are completely different here.***

Because we see a broad inverse trend at the regional scale we felt it important to note that at any given location, we do not see any relationship between the Pb and Cs isotopes. At the regional scale  $^{210}\text{Pb}_{\text{ex}}$  inventories generally increase with water depth and  $^{137}\text{Cs}$  inventories decrease with water depth. We changed this sentence to say the following: ‘We could not obtain a coefficient of determination ( $R^2$ ) greater than 0.1 for an exponential, logarithmic, or linear regression of  $^{134}\text{Cs}$  and  $^{210}\text{Pb}_{\text{ex}}$  inventories, which confirms that the factors controlling inventories at the local scale vary for the two isotopes.’

***Results 3.1 7244 line Please clarify sentence and redraft :Overall... considered: greater than what do the authors mean? High variability in both activity and inventory? greater than what?  $^{210}\text{Pb}$ , if it is the case there is no interest in doing so (various sources for the two isotopes etc..)***

This sentence was removed.

***Results 3.1 Line 11 Please clarify sentence :The replicate cores... across all samples relative to the order of magnitude differences seen in cesium activities??***

This sentence was changed to the following: ‘Although we observed large tube to tube differences in the cesium activities, the grain size results for each of the 8 subcores were relatively similar in magnitude (Supplement S4).’

***Results 3.1 7244 Lines 23-25 Last sentence of this part: Although particle size characteristics may not control local differences in radionuclide activities where variations in size are comparatively minimal (not clear ?), they are important over large regional scales: just because when looking at a larger scale there is a smoothing in the influence of factors with high variability that occur in coastal areas***

This sentence has been changed for clarification: ‘Although particle size characteristics do not appear to control local differences in radionuclide activities, where variations in average particle size and abundances of particle types (clays, etc) are relatively small, they may be important over larger regional scales where mineralogical differences are greater (See Sect. 3.5).’

***Results 3.2 7245 lines 5 to 8 In the coordinates change S to N***

This comment has been addressed in the section for Referee #3 and the changes made.

***Results 3.2 7245 line 25, The remaining cores were visually assess? Please precise what you mean exactly .. this is far better explained in table 1 legend***

Details from the Table 1 legend were inserted to this section for clarification: ‘The remaining 4 cores were visually assessed with a hand lens and assigned a general size class relative to the Udden-Wentworth Classification scheme.’

***Results 3.2 7245 line 27 These cores had the lowest average standard deviation (see comment on 2.2 it will be useful to have theses standard deviation values for D50 and % clay, silts mentioned in table 1) Redundancy between lines 10-11 (... And relatively consistent ..) and lines15-16 (D50 values remained fairly consistent..)***

As addressed in an earlier comment standard deviations were added to Table 1. The second sentence with ‘consistent’ was removed from the text.

**Results 3.4** *This part is quite difficult to read mainly because authors mentioned data not shown and I did not succeed in calculating them i.e. 7246 line 26 Average surface activities (top 3 cm) in the 20 cores ranged from  $2.1 \pm 0.1$  to  $640 \pm 40$  Bq kg<sup>-1</sup> for 137Cs and from 0 to  $550 \pm 30$  Bq kg<sup>-1</sup> for 134Cs (Supplement S6). We have no mean to check these numbers which I guess were calculated taking into account activities and weight of each layer over the first 3cm). In addition it would help the reader to mention in which core the min and max are found. In the table S6 (which is very useful) give the layer thickness in cm rather than in m! and precise for the Bq kg-1 and m-2 if it is wet or dry weight In addition when calculating average  $\pm$  should be standard deviation?*

- To clarify how the values were calculated from the supplemental table 6, the following sentence was changed in the methods section near Line 26, 7241, ‘All final <sup>210</sup>Pb<sub>ex</sub>, <sup>234</sup>Th<sub>ex</sub>, and cesium activities for an individual layer are reported as Bq kg<sup>-1</sup> dry and surface activities were calculated as the weighted (relative to layer thickness) average of layer activities for the top 3 cm of each core.’
- Throughout this section when we use a range we have added the names of the cores that correspond to maximum and minimum values. All +/- values for surface activity averages represent error propagation.
- The thickness of section column in Supplemental 6 is in meters because of Eq (1), which is based in meters and shows how inventories were calculated. The thickness column can be multiplied by the bulk density and activity columns to find any layer inventory. The units have therefore not been changed.
- A designation for ‘dry weight’ has been added to the notes in Supplemental 6.

**Results 3.4** *7246 line 28 sentence not clear: The OZ sediment activities ranged from 0 to  $13 \pm 1$  Bq kg<sup>-1</sup> for 134Cs, while the MCZ activities ranged from  $2.7 \pm 0.5$  to  $57 \pm 3$  Bq kg<sup>-1</sup> for 134Cs. > It was impossible to find what exactly these number refer to...Are they still averaged activities over the top 3cm ?*

The sentence was changed to: ‘The average surface activities in the OZ ranged from 0 (C3) to  $12 \pm 1$  (C6) Bq kg<sup>-1</sup> dry for <sup>134</sup>Cs, while the MCZ activities ranged from  $3 \pm 0.5$  (C7) to  $57 \pm 2$  (C11) Bq kg<sup>-1</sup> dry for <sup>134</sup>Cs.’ All surface activities refer to 0 to 3 cm averages as stated in the first sentence of the paragraph.

**Results 3.4** *7247 line 5 : within 3 km of the FDNPP, contained an average of  $550 \pm 30$  Bq kg<sup>-1</sup> 5 in the top 3 cm perhaps useful to precise with the highest content in the first centimeter.*

The first 1 cm and 0.5 cm activities can be seen in Supplemental 6. Other studies and datasets like Kusakabe/MEXT use the activities for the top 3 cm so we have included these average activities as well so readers can easily compare.

**Results 3.4** *7247 Lines 6-8 With the exception of this single core in the NCZ, the cores in the SCZ had the highest AVERAGE (?) activities of all zones, with 134Cs values ranging from  $167 \pm 7$  to  $230 \pm 10$  Bq kg<sup>-1</sup>. If I understand correctly the first § of 3.4 refer all to the average activities in the top 3cm, please be clear in the writing.*

The sentence was changed to say: ‘highest average surface activity’. Again, the first sentence of the paragraph refers to the ‘top 3 cm’ surface activity averages.

**Results 3.4 7247 Lines 12-13** *The MCZ cores generally showed similar exponentially decreasing CESIUM activities with depth with the exception of core 11, which showed a pronounced cesium peak between 1 and 4 cm.*

The word 'cesium' was added and moved accordingly.

**Results 3.4 7247** *The penetration depth of 134Cs was deeper here, on average, than in the AZ and OZ core. In order not to mix the various terms average I suggest rewriting as follows Generally, the penetration depth of 134Cs was deeper here, on average, than in the AZ and OZ cores.*

The sentence was changed accordingly.

**Results 3.4 7247 line 17** *Penetration depths for 134Cs were at least 16cm in the SCZ. This sentence is not very informative, it would be more useful to say that the entire thickness of the sampled layer was labelled with 134Cs in both SCZ and NCZ. Perhaps useful also to comment on the vertical profile in core 14 compared to cores 12 and 13 due to its higher contents in sand (higher mean D50 and lower % silt and clay though these latter data are averaged so authors have to check if it is really the case)*

The sentence was changed to the following: '<sup>134</sup>Cs was found to a depth of 18 cm in core 12 and over the full length of cores 13 (19 cm) and 14 (16 cm) in the SCZ.' Core 14 is slightly more 'sandy' than 12 and 13 but the D50 in the 70-80 um range is still closer in magnitude to those of cores 12 and 13 (D50s 30-40 um). The NCZ has D50 values from 160 to 690, an order of magnitude larger. We are not sure that the connection between the sand content of core 14 relative to that of 12 or 13 indicates anything related to the vertical nature of the profile or a connection to the vertical profile shapes in the NCZ. Therefore, no additions to the text were made relative to this comment.

**Results 3.5 7247 Line 25 :** *Total 134Cs and 137Cs inventories ranged from 0 to 74000±2000 Bqm-2 (COR XX) and 21±1 to 73000±2000 Bqm-2 (CORE YY), respectively (Table 1). In order to help the reader please indicate the core number where min and max are found.*

This comment has already been addressed.

**Results 3.5 7248 Line 13-16:** *We observed inventories consistent with weapons testing fallout in the AZ and OZ cores (134Cs/137Cs of 0 to 0.86). Larger inventories and 134Cs/137Cs ratios of 15 \_ 1 in most of the MCZ, NCZ, and SCZ cores suggested negligible contributions from weapons testing 137Cs. I suggest to modify as follows : We observed inventories consistent with weapons testing fallout in the AZ and OZ (134Cs/137Cs = 0). Larger inventories and 134Cs/137Cs ratios of ~1 in most of the MCZ, NCZ, and SCZ cores suggested negligible contributions from weapons testing 137Cs. Indeed there is no more 134Cs in global fallout, cores 5 and 6 are closer to the MCZ and represent a kind of transition inventories between the two cases i.e. only weapons testing and mainly Fukushima influence.*

The sentence was changed to the following: 'We observed inventories consistent with the presence of substantial weapons testing fallout in the AZ and OZ cores with inventory ratios for <sup>134</sup>Cs/<sup>137</sup>Cs of 0 to 0.86. Larger inventories and <sup>134</sup>Cs/<sup>137</sup>Cs ratios of ~1 in most of the MCZ, NCZ, and SCZ cores suggested negligible contributions from weapons testing <sup>137</sup>Cs, relative to the larger and more recent FDNPP source.'

**Results 3.5 7248 Line 22 /The percentages for those (?) cores in the MCZ ranged from 0 to 33% for  $^{134}\text{Cs}$  and from 10 to 36% for  $^{137}\text{Cs}$ , 7248 Line 23: The average inventory below 3 cm in the MCZ cores attributed to Fukushima ( $^{134}\text{Cs}$ ) was  $15\pm 16\%$ , which agreed closely with the Ootosaka and Kato (2014)  $^{134}\text{Cs}$  average from this zone of 19%. When we combined the two datasets for this zone ( $n = 15$ ) the average inventory below 3 cm was  $18\pm 16\%$ . I suggest authors underlined the very high variability in inventories in MCZ**

Both comments are addressed with changes in the sentences as follows: ‘In the MCZ, the percentage of total inventory below 3 cm was highly variable, ranging from 0 (C7 and C10) to 33% (C8) for  $^{134}\text{Cs}$  and from 10 (C10) to 36% (C8) for  $^{137}\text{Cs}$ . The average inventory below 3 cm in the MCZ cores attributed to Fukushima ( $^{134}\text{Cs}$ ) was  $15 \pm 16\%$ , which agreed closely with the Ootosaka and Kato (2014)  $^{134}\text{Cs}$  average of 19% from core locations within the MCZ.’

**Results 3.5 7249 lines 3-6: Figure 3a.... despite that the remaining core inventories .... I am getting lost, what do the authors mean?**

This sentence was changed for clarification: ‘Figure 3A, shows a general decrease in cesium inventories with increasing distance from the FDNPP and water depth, despite that cesium inventories for cores 1 to 19 show little to no statistical relationship to proximity or water depth (exponential regression  $R^2$  values  $< 0.25$ ).’

**Results 3.5 7249 from line 10 to 20 I have the feeling that one important factor is missing i.e. lateral transport, this is an important factor in coastal zones especially with a point source; and indeed the authors mention this in the section 3.6 when dealing with  $^{210}\text{Pb}$  activities (lines 8-10 p7250), 7255 line 10-20 I am not really convinced by the main influence of grain size. Don't you think that this reflects a mixing of various factors such as grain size, dispersion of the releases in coastal areas, lateral transport...**

We have changed the lines slightly to : ‘In summary, proximity dominated within the 3 km zone of FDNPP, despite the high sand content of core 20 (D50 of 160  $\mu\text{m}$ , percent sand  $\sim 94\%$ ), grain size was the most important difference between the NCZ and SCZ, and water depth (higher particle fluxes are generally observed over more productive coastal waters) may have contributed to cesium variability in locations such as the MCZ and OZ, where water column activities were relatively low.’

**Results 3.6 7249 line 21 :  $^{210}\text{Pb}_{\text{ex}}$  surface activities ranged from  $12\pm 3$  (core XX) to  $2000\pm 100$  Bq kg $^{-1}$  (core YY), indicate the cores concerned to help the reader, in addition clarify the word surface, is it 0-1, 0-3cm? are they averages?**

This comment has already been addressed.

**Results 3.6 Does the authors have an explanation for  $^{210}\text{Pb}_{\text{ex}}$  profile in 4-OZ which is a deep location (3259m)?**

We did not speculate as to what might have caused the vertical nature of the  $^{210}\text{Pb}_{\text{ex}}$  profile for core 4. We only see Fukushima-derived  $^{134}\text{Cs}$  in the uppermost layer. We also do not see substantial fallout-derived  $^{137}\text{Cs}$  or  $^{234}\text{Th}_{\text{ex}}$  at depth so mixing cannot have been rapid enough to create this vertical  $^{210}\text{Pb}_{\text{ex}}$  profile. Therefore, whatever may have caused the shape of the deeper profile (slumping? depositional event?) it does not impact our conclusions about  $^{134}\text{Cs}$ , would pre-date the arrival of  $^{134}\text{Cs}$ , and would only be a guess without more data.



**Results 3.6 7250 line 3 :  $^{210}\text{Pb}_{\text{ex}}$  inventories, ranging from  $2700 \pm 200$  (core XX) to  $28000 \pm 1000$   $\text{Bq m}^{-2}$  (core YY) Add underlined information**

This comment has already been addressed.

**Results 3.6 7250 Line 3-5:  $^{210}\text{Pb}_{\text{ex}}$  inventories, ranging from  $2700 \pm 200$  to  $28000 \pm 1000$   $\text{Bq m}^{-2}$ , reflect changes in grain size, water depth and local processes, and give support to the similar trends observed for cesium inventories (Table 1, Figs. 1 and 3b) There is no reason that the two isotopes (Cs and Pb) have the same trends since their sources are completely different.**

The language in this sentence was corrected to more clearly state the authors' point: ' $^{210}\text{Pb}_{\text{ex}}$  inventories, ranging from  $2,700 \pm 200$  (C18) to  $28,000 \pm 1,000$  (C1)  $\text{Bq m}^{-2}$ , reflect changes in grain size, water depth and local processes, the factors that also impacted cesium inventories (Table 1, Fig. 1 and 3B).'

**Results 3.6 Lines 13-14: An exponential regression of  $^{210}\text{Pb}_{\text{ex}}$  inventories vs. percent clay indicated a strong relationship ( $R^2 > 0.9$ ) between grain size and inventories. Right and this confirms the previous remark.**

We hope the reader's understanding of the author's point is clearer after the changes made for the previous comment.

**Results 3.6 7250 line 24-25:  $^{234}\text{Th}_{\text{ex}}$  activities, ranging from  $20 \pm 10$  (core XX) to  $1300 \pm 100$   $\text{Bq kg}^{-1}$  (core YY) in the top 0 to 0.5 cm (Fig. 2) Surface (0 to 3 cm)  $^{234}\text{Th}_{\text{ex}}$  inventories peaked at  $2400 \pm 300$   $\text{Bq m}^{-2}$  in the SCZ (core ZZ). Add underlined information**

This comment has already been addressed.

**Results 3.6 Lines 1-2: "intra-zonal variability was high and more often than not inventories did not vary negatively with increasing depth". I suggest to replace vary negatively by decrease?**

The change was made.

**Results 3.7 See remark on § 2.4, this is especially true for coastal zones such as NCZ and SCZ where profiles show strong mixing processes that can be related to both bioturbation and physical reworking by currents in areas often affected by typhoons and storms. And indeed the authors mentioned this factor lines 1-5 p7252 but p7251 lines 11 they wrote that "Mixing rates in the SCZ and NCZ reflected intense bioturbation, with full core  $^{210}\text{Pb}_{\text{ex}}$ -derived estimates starting at  $11 \text{ cm}^2 \text{ yr}^{-1}$  and the majority of rates being unquantifiable due to the vertical  $^{210}\text{Pb}_{\text{ex}}$  Profiles." Lines 16-17 reworking by physical factors also decrease with water depth....Clarify this section and others in this respect.**

This comment was addressed in the modeling methods section (2.4) as well as this section (3.7). We have kept our wording broad to include both bioturbation and physical mixing processes, even though we do not currently see strong evidence for tsunami deposits and/or resuspension.

**Results 3.7 In addition I am not sure that mixing rates derived for SCZ are correct due to the shape in  $^{210}\text{Pb}_{\text{ex}}$  vertical profiles...and therefore calculations in 3.8 may not be correct**

Each of these profiles shows a decrease in  $^{210}\text{Pb}_{\text{ex}}$  over the length of the core and start at a relatively high  $^{210}\text{Pb}_{\text{ex}}$  value, unlike in the NCZ cores which have very low  $^{210}\text{Pb}_{\text{ex}}$  and show no trend with depth.

**Results 3.8 7252 Line 20 add input or release after Fukushima maximum**

The word 'release' was added.

**Results 3.9 7253 comment: it is always very difficult to assess inventories especially with data with such high variability but this allows to give orders of magnitude.**

We agree.

**Results 3.9 7253 Line 9 add about after contained**

The word 'approximately' was added.

**Results 3.9 7253 line 6-7 "Because of the inventory variability and grain size influence in the NCZ and SCZ" I do not see the idea behind...**

This sentence was shortened to: 'The final totals for each zone were calculated by finding the mean inventory of all cores within that zone and multiplying by the area of the zone.' We have already made the strong point that there is enormous variability observed at a variety of scales so it does not need to be reiterated.

**Results 3.9 I get lost in this section line 17 it is said "we used cores recovered in February 2012 by MEXT (Kusakabe et al., 2013)" when I thought that cores reported by Kusakabe were in group (4) and cores recovered in February only were in group(3), please clarify in order to help the reader. It would be helpful to give the column number, I guess that here we are in the second set of columns of table 3b with data from (1),(2) and(3). May be also useful to give in the table the total number of data used (if I am correct n=18 for the first set, n=50 for the second and n=199 for the third, Clarify also with fig 5 in this respect MEXT (3)=? What about (4)? May be there is no need to mention (1) (2) and (3) in fig 5 if they do not mean the same than in table 3 and only mention "This study, OTKA and MEXT"...Check also the end of section 3.9**

References to datasets (1) through (4) have been added to the text in this section for clarification. The numbers in Tables 3A and 3B agree with Figure 5. We realize that the setup of Table 3B can be confusing with a lack of vertical lines to delineate different sections. We will work with the editors to format the table so that 3 individual sections are readily apparent in this table and the titles and totals (top and bottom of sections) are centered properly.

**Results 3.9 7253 Lines 26-27 "The addition of 50 locations slightly increased the sediment inventory estimate to 100±40 TBq", There is no increase since we had already 100 TBq line 5! May be the reason is that the authors mentioned rounded numbers for the total inventory since if we sum the numbers mentioned in the table the first estimate is 96 and the second one is 104...but the uncertainties are very high and therefore they are not statistically different....**

We agree and have changed the sentence to remove the words 'slightly increased'.

**Results 3.9 7254 line 2: replace Fig 4 by Fig 5**

We made the change.

**Results 3.9 7254 line 16-17 "The MCZ contained between 15 and 18% of the total 137Cs in each case and made up 30% of the total area". I suggest rewriting as follows The MCZ represents 30% of the total surface area and contained 15 to 18% of the total 137Cs inventory.**

The changes were made.

**Results 3.9 7254 line 28** “...and consistently showed the greatest variability in inventories”. I do not understand... in table 3b standard deviations (I guess it is 1 sigma standard deviation? Please precise in the legend) to the mean are not higher for SCZ and NCZ compared to the other zones in % of the inventories, for example in the first column for OZ 160 (the standard deviation) represents 94% of the mean when for SCZ 13 000 represents 81% of the mean....

The point we were trying to make here was that each time we add more data from other studies (Table 3b) we see that there is very little change in the mean inventories of the OZ and MCZ. The mean inventories of the SCZ and NCZ change the most. To avoid confusion we have removed the end of the sentence. It now reads: ‘The NCZ and the SCZ, on the other hand, contributed the most cesium by far (over 70%), yet composed only 9% and 6% of the total area, respectively (Tables 3A and 3B).’

**Results 3.9 Fig. 5 and 6, why the 199 data mentioned for calculating the third set of inventories (table 3b) were not taken into account here ? can you explain.**

We could include all the data in Fig. 5, but the additional MEXT points are so close in location that they show up as one point (square shape). Therefore, we chose to show only the sampling event (date) for MEXT closest to our sampling dates. In addition, in Figure 6 this provides a better approximation of spatial distributions at a given time (closest to our sampling dates) rather than using additional, very early sampling dates.

**Results 3.9 7255 line 9-10** “... which we suggest reflects the importance of grain size distribution in these zones (Fig. 3a). see previous comment

This comment was addressed above and in previous sections of the text. We acknowledge there are many factors at play here and we are simply suggesting that one of the important ones in the NCZ and SCZ is grain size. This is by no means the definitive and only factor.

**Results 3.9 The compiled inventories from 150 to 1500m showed a stronger relationship to water depth ( $R^2 = 0.30$ ) Is this number statistically significant?**

We agree that the value is not significant. The word ‘stronger’ was in reference to the previous sentence ‘had a low  $R^2$  value ( $<0.01$ ) relative to water depth’. We have removed this sentence because readers can see from the figure that there is still significant scatter in the bottom of Fig. 6 and the  $R^2$  values is reported there.

**4 Conclusions 7256 line 2: robust is perhaps too strong due to the very high variability encountered in each zone.**

We agree and have changed the sentence to read: ‘Our zonal analysis of cesium inventories, in conjunction with  $^{210}\text{Pb}_{\text{ex}}$  and grain size analyses, has provided an assessment of the total cesium inventory that will inform future studies.’

**4 Conclusions 7257 line 3: mixing rates**

The change was made.

**4 Conclusions 7257 lines 5-10 If riverine inputs appear to be important at least locally what do you think about the decay correction of the data to 6th April?**

We brought up the potential impact of rivers here for two reasons. First, to illustrate that overall, river inputs are only a small fraction of the total release. Second, these areas need more study at

the local level (as suggested by the comment). There are currently no reported cores from the coastal ocean in the immediate vicinity of the mouth of this river.

We decay corrected to the maximum release date because this was when most of the cesium was delivered and  $^{134}\text{Cs}$  decays fairly rapidly in comparison to  $^{137}\text{Cs}$ . For comparison purposes (to see a 1:1 ratio) both should be decay-corrected. Some of the cesium released to the environment originated during explosions (atmospheric releases) before the major discharge releases to the ocean, as mentioned in the introduction. However, because of the half-life of  $^{137}\text{Cs}$ , the difference between these releases over 1 month is relatively small. In addition, the cesium coming down from the rivers originated from the same FDNPP source in 2011 so to remove the effect of decay on all of the data, any cesium needs to be corrected to this common release date.