Referee #2:

This manuscript provided the DOC concentrations and distribution in the East China Sea (ECS) and Kuroshio Extension (KE) region in the northwestern North Pacific. Through the comparison of DOC concentrations among different stations that located under the influence of Kuroshio current and Oyashio current and the DOC distribution superimposed on top of the other parameters such as temperature, salinity, DIC, $\Delta^{14}C$-DIC, and AOU, it was concluded that the observed DOC patterns were most likely attributed to the hydrodynamic mixing by Kuroshio current and/or Oyashio current water. Since there is scarce data on the DOC distribution in the ECS and KE regions, this study can help to establish a valuable database on the DOC values in those areas. However, the discussion of linking DOC distribution to physical mixing is not thoroughly developed in the manuscript. For example, (1) the authors discussed the linear regression between DOC value and temperature or DIC (Fig. 4) and used this as an evidence to support the important role of physical mixing in shaping DOC distribution, this data and discussion should be reprocessed and readdressed as this correlation is mainly due to the co-variation of those DOC, DIC values with depth. And DOC decrease with depth is more likely to be controlled by biological processes. The authors need to tease out the effects of physical mixing after filtering out the depth effects first in those discussion. The salinity depth profile patterns could be potential evidence to support physical mixing and intrusion of currents to certain depths in ECS and KE (for instance, the high salinity around 200m in ECS may from intrusion of saline Kuroshio current, and the low salinity around 300-700m in KE may result from intrusion of fresh Oyashio current), but this is not fully discussed in the discussion or result section. Discussion around the Fig.5 and Fig.8 is more convincing to show the physical mixing, which should be emphasized.

R: Yes, the main point we want to make based on this study is to link DOC distribution to physical hydrodynamic mixing in the East China Sea and especially in the Kuroshio Extension. We agree with the Referee #2 that the discussion of linking DOC distribution to physical mixing is not thoroughly developed in our discussion, especially for the correlation between DOC and temperature. This is also a question asked by Referee #1. Based on our data, we agree that in the euphotic zone, the rapid decrease of DOC was largely controlled by biological processes, namely microbial degradation of DOC. Therefore, we should consider this fact. We tried to remove DOC and T data in the upper 200 m for the ECS and 250 m for KE to eliminate biological effect and replot the data. In fact, the correlations were worse than before. We believe that the correlation between DOC and T in the water column is due not only the physical mixing but biological influence as well because temperature also influences biological processes. We discussed more biological influence for DOC in the revised MS. We also added a strong supporting evidence as Figure S2 (Supporting Information), as plotting DOC and T data cited from four nearby stations collected in the CLIVAR 2004 cruise P02 Line. There is a very strong correlation between DOC and T for these four stations ($r^2 = 0.95$, $p<0.001$) mainly because they were in a same water mass hydrodynamic region south of the KE.

(2) While the authors mentioned the mixing of Kuroshio and Oyashio water in the KE, they touched a little on the mixing model but did not provide well-developed discussion on the relative contribution of these two currents in terms of DOC on the surveyed stations. Also there is not enough comparison of the role of biological processes vs. physical mixing in shaping DOC distribution. Since one main conclusion from this study is to show the important role of physical mixing, some direct comparison or estimated percentage of each process that contributed to DOC would be helpful to support the conclusion.

R: Again, we agree with the Referee's suggestions that the relative percentage of the physical and biological processes should be estimated. We have calculated the relative contributions of each process in shaping the DOC distributions in the ECS and KE region, respectively.

For the ECS region, we have added the statements "Based on the calculated ΔDOC and the field measured DOC, we further estimated that the bioavailable fraction of DOC could account for about 7% of the total DOC pool in this region. The value is comparable with the results (6.1% and 10% ± 5%) previously reported for the Kuroshio Current and the shelf-slope region of the South China Sea (Gan et al., 2016; Wu et al., 2017). Clearly, biological processes had significant influence on DOC but were not the dominant controlling on the observed DOC distributions in the ECS." in L 321-327.

For the KE region, we added the discussion "positive ΔDOC values (~ 6 μM) that accounted for about 11% of the measured DOC at Sta B8" in L 426, and "However, the biological consumptions of DOC would account for 8-20% of the total DOC pool based on the negative ΔDOC values (2-8 μM) and the measured DOC at Stas. B2 and A4." in L 427-428.

(3) In addition, the discussion of DOC and AOU seems to be kind of random. The authors should lay out better what is the purpose of introducing the AOU in the manuscript here, is it to state the refractory quality of DOC or to show that dissolved oxygen is also more affected by mixing rather than biological process? If the authors want to include AOU to evaluate the DOC

oxidization, then more discussion is needed regarding what it really means and relating that to the DOC quality. Also the DOC vs AOU relationship should be evaluated on specific isopycnal layers to filter out the depth effects, rather than on pooled DOC data over different depth.

R: Both Referees have concerns about the discussion of DOC vs. AOU. Since dissolved oxygen concentrations were only measured for some stations in the ECS, not in KE. We feel that there are no sufficient data set to discuss the correlation between DOC and AOU and to better response to the referee's questions. We therefore deleted the whole section on AOU.

Overall, major revision is needed for this manuscript especially in its results and discussion sections.

We thank Referee for the thoughtful review and detailed comments. These comments and suggestions are very constructive and helpful. Below are our responses to the specific comments.

Specific comments:

1) Abstract: The abstract should include some information of the DIC and Δ14C-DIC information, as those are important pieces of evidence in this manuscript to derive the role of hydrodynamic mixing.

R: Excellent comment. Yes, we have added the DIC and Δ^{14}C-DIC information in the abstract as "By comparing DOC results with dissolved inorganic carbon (DIC) and dissolved inorganic radiocarbon (Δ^{14}C-DIC) measured for the same water samples," in L 27-29 and "Based on the previous reported DIC and Δ^{14}C-DIC values for the stations" in L 33-34.

2) Line 24: Any more details on what relative percentage of biological process vs. hydrodynamic mixing each contributes to the distribution of DOC?

R: Based on the DIC-Δ^{14}C isotopic mass balance, we calculated the conservative DOC concentrations of the two mixed water masses. Then by comparing the measured DOC concentration with calculated conservative DOC concentrations, we calculated the possible biological contribution of DOC in L 26-27.

"while the biological processes estimated accounting for 7% and 8-20% in shaping the DOC distribution in the ECS and KE regions, respectively."

3) Line 28: the sentence is not finished yet, so what does the 18% means, this suggesting of other processes (e.g. mixing) controlling AOU?

R: As response to the earlier comments, we deleted the whole section about AOU including this sentence.

4) Line 30: add below how much meters is defined as deep waters, "deep waters (below xxx m)"

R: We have added "(below 1500 m)" to define the deep waters.

5) Line 34: The manuscript doesn't talk about any nutrient, it is a little bit stretching here to say it is the important role of nutrient.

R: We agree with the Referee and we removed the "nutrients as well" from the sentence as suggested.

6) Line 38: Ocean is not the largest carbon reservoir on earth, crust is the biggest, and ocean is the second largest.

R: We have corrected the misstatement by adding "the second".

7) Line 39: not all DOC are active, delete "active"

R: Yes, we deleted "active" from the sentence.

8) Line 41: The FTICR analysis only capture the Solid phase extracted proportion of DOM and doesn't include isomers as well, so the actual individual compounds should be more than 20,000. To be safe, just say "over 20,000 individual compounds".

R: Referee #1 also questioned this statement. In the revised sentence, we stated "~ 20,000 individual molecular formulae".

9) Line 46: Talk more specifically on the biological processes, such as microbial respiration.

R: We have added the details of biological processes, as "biological photosynthesis and microbial respiration processes" in L 50.

10) Line 53-72: Here it talks about different processes (biological and physical) in shaping DOC distribution. Since this study will show physical mixing, rather than biological processes, dominated the role in shaping DOC distribution in the ECS and KE region. Would be helpful to provide some background on the relative role between biological processes vs. physical mixing *in other different ocean regions. Any literature on this comparison before?*

R: As suggested, we have added some background and references about the discussion of principal processes in controlling the DOC distribution in different regions in L 64-72 and L 81-82, and added the corresponding references in the reference list.

"However, many previous studies conducted for different coastal and open oceans have shown that the distribution of DOC appeared to depend, in a large extent, on the hydrographical structure and/or the horizontal/ vertical water mixing (Hansell and Waterhouse, 1997; Hansell and Peltzer, 1998; Hung et al., 2007; Ogawa et al., 2003; Guo et al., 1995), and the biological forcing secondary superimposed on the physical forcing (Carlson et al., 2010; Wu et al., 2017). Based on a water mixing model, Wu et al. (2017) also reported that microbial degradation contributed 10% of the DOC removal and physical mixing controlled the majority variation of DOC pool in the northern South China Sea."

"Carlson et al. (2010) later confirmed the DOC export by the Atlantic Ocean's meridional overturning circulation, and further estimated the export and decay rates of DOC during this water circulation."

11) Line 89: What does "reduce the very old DOC 14C-age" mean? The export of DOC makes it younger or older?

R: We have clarified that the export of young DOC would be enriched in Δ^{14}C-DOC values and make the DOC ^{14}C-age younger.

"thus make an enrichment in the Δ^{14}C-DOC values and reduce the very old DOC ^{14}C-age in the Pacific Ocean interior. "

12) Line 156: Samples were analyzed in duplicate sample from different vial or duplicate draws from same vial? Clarify.

R: We have added "from different vials" in this sentence.

13) Section 3.1: Should provide some information of the temperature and salinity on the end members of Kuroshio current and Oyashio current. It would help readers to compare these end member values with observed values in the studied stations.

R: Yes, we added the typical T and S values for the Kuroshio water and Oyashio water in Section 3.1 for comparative information.

14) Line 202-206: Interesting "S" shape, can develop some discussion on why salinity profile is in "S" shape. As mentioned above, it seems to me that the high salinity around 200m in ECS may come from intrusion of saline Kuroshio current, and the low salinity around 300-700m in KE may result from intrusion of fresh Oyashio current. This could be another evidence to show the important role of physical mixing in the studied regions.

R: Yes, this is the point of physical mixing. We have redrawn the T-S diagrams in new Figure 2 in order to distinguish the different water masses more clearly, and put the hydrographic profiles in the attachment as Figure S1 for reference. Accordingly, we have modified the Section 3.1 based on the T-S diagrams in the new Figure 2. It also can see the salinity minimum at the density range of 26.4-26.9 σ_t, indicated the intrusion of fresh Oyashio Current in the KE region.

15) Line 209: somewhere in this section, the authors should introduce the temperature and salinity of the end members from Kuroshio and Oyashio currents.

R: Information was added. See the response for the earlier comment of 13.

16) Line 215: Define your surface water? Top how much meters?

R: We have defined the surface water as the depth ≤10 m and $\sigma_t \leq 22.1$ in this sentence.

17) Line 217: Why sub-maximum? Related to subsurface chlorophyll max?

R: The subsurface DOC maximums at Stn. 1 and Z1 are not related to the chlorophyll maximum in our results. We have added a few discussions about the subsurface maximum in Section 4.1 in L 308-313 and added the corresponding references in the reference list.

"At Stn. 1 and Z1, the subsurface DOC maximums were not related to the chlorophyll maximum (data not shown) and could not accumulate in the developed stratification water column inferred from the σ_t distribution (Fig. 7a). Previous studies have confirmed that fixed sinking particulate organic carbon (POC) would partition into the DOC pool, which could result the subsurface DOC maximum usually observed below the euphotic zone (Druffel et al., 1992; Hansell et al., 2009; Karl et al., 1998)."

18) Line 226: Where is your DIC, 14C-DIC, AOU data? They are important component to support your physical mixing conclusion, should be included in the main text rather than the supplemental table. If this data have already been published in previous papers, just redraw the figures or tables to fit into this manuscript and state that it is adapted from previous papers.

R: As suggested, we have added the vertical profiles of DIC and Δ^{14}C-DIC in the new Figure 5 and briefly stated the results in Section 3.3 Concentrations and radiocarbon distribution of DIC in L 238-255.
As response to the earlier comments, we deleted the whole section on AOU.

19) *Line 234: Again, the correlation between DOC and temperature is mainly just due to covariation with depth. Should filter out the depth effect first, for example, compare DOC vs temperature at the same depth across stations.*
R: We clearly realized that the correlation between DOC and temperature is a major concern for the Referee. It could be a covariation with depth but there must reasons to cause the change. As suggested by the Referee, we tried to filter out the depth effect by comparing DOC vs temperature at the same depth across all stations. We found there was no good correlations at all for each depth.

20) Line 241-243: Why this correlation indicates physical mixing? Not convincing.
R: Again, this is the major concern of Referee. We agree with the referee that the correlation of DOC with temperature should not be caused by physical mixing alone. Biological processes could also influence the distribution changes of DOC. However, DIC and its Δ^{14}C values have been used as conservative tracers to study the sources, movement and mixing of different water masses in the ocean. For example, in the WOCE and CLIVAR Programs. We believe that in addition to salinity, water temperature is also a good parameter for mixing processes as we observed in the KE region. We added more discussion on this.

21) Line 263: In line 261, it just said there are little effects of upwelling intrusion to <100m in the shelf stations. Z4 not included as a shelf station? But Line 213 said Z4 is defined as shelf-edge station. Need clarification here.
R: We agree that there are some confusion in our statements. We have modified these sentences to clarify the confusion. With water depth of 400 m, Z4 is a shelf station in the ECS, but also close to the shelf break.

22) *Line 275-277: As mentioned above, provide some quantitative percentage to compare the relative role of biological processes vs. physical mixing in shaping DOC distribution. More well-developed discussion related to the dominant role of physical mixing and its comparison*

with biological processes are needed overall. Also should include some literature comparisons here.

R: Yes, we tried to discuss these question more in the revised MS as combined with the earlier related comments by the Referee. As we responded above, we estimated the conservative DOC based on the two water masses mixing with their DIC-Δ^{14}C values. We compared the estimated conservative DOC with field measured DOC to estimate the biological contribution to DOC (production or removal). In L 322-328, we added the discussion as "Based on the calculated ΔDOC and the field measured DOC, we further estimated that the bioavailable fraction of DOC could account for about 7% of the total DOC pool in this region. The value is comparable with the results (6.1% and 10% ± 5%) previously reported for the Kuroshio Current and the shelf-slope region of the South China Sea (Gan et al., 2016; Wu et al., 2017). Clearly, biological processes had significant influence on DOC but were not the dominant controlling on the observed DOC distributions in the ECS."

23) Line 281: DOC vs. AOU regression should filter out the depth effects as well. For example, should be reprocessed on specific isopycnal layers.

R: As response to the earlier comments, we deleted the whole section on AOU.

24) Line 292: What is the dissolved oxygen value of the end member from the Kuroshio current? Any way to build a conservative mixing model to estimate what percentage of AOU pattern is attributed to the physical mixing? Is it just the rest of 18% (i.e., 82%)?

R: As response to the earlier comments, we deleted the whole section on AOU.

25) Line 310: Any chlorophyll data from CTD to get some idea on primary production in the region?

R: Unfortunately, there were no chlorophyll data measured by CTD during the same cruise. We have used the data of integrated Chl *a* (35-44 mg m^{-2}) and primary production (483-630 mg C m^{-2} day^{-1}) from a spring April cruise in 2008 for reference in L 347-348. These data were reported by Nishibe et al., 2015 in Journal of Oceanography.

"(483-630 mg C m^{-2} day^{-1}) accompanied by high Chl *a* concentration and high column integrated Chl *a* values (35-44 mg m^{-2}) in April (Nishibe et al., 2015)."

26) Line 312: "around the axis", what axis?

R: Clarified to “around the KE axis”.

27) Line 315: Modify this part to say more clearly. You mean primary productivity should be high in the north stations like Sta B2 And A4 and result in higher DOC concentration there, but in reality, DOC is low at Sta B2 and A4, indicating it is due to physical mixing, right?

R: Yes. We have added the sentence “The relatively high primary production should result in a high level of DOC in the stations located north and around the KE, but the measured DOC concentrations was rather low at Stas. B2 and A4.” in the former part in L 348-350 to support the statements more clearly.

28) Line 320-325: Again, need to filter out the co-variation (with depth) factor, reprocess the correlation data here.

R: We tried this but results look worse.

29) Line 329-335 and Fig.7: Need to related back those water masses to your studied stations, thus can further evaluate the effects of physical mixing. For example, are the dots of water mass C with higher densities in Fig.7 the stations in the north that is more affected by Oyashio current? Otherwise it would still be the effects of water masses from different depths.

R: Yes. We have re-divided the water masses into four different parts (A, B, C and D) instead of the three parts, and have changed the text in L 373-379.

“The denser water mass C with density levels of 26.4-27.1 σ_t around 500-800 m was likely originated from the subarctic gyre which had low temperature and salinity; and was transported by the south-flowing Oyashio Current along the western boundary to the KE region. This water is then mixed with the warm saline water mass transported by the northeast-flowing Kuroshio Current (Fig. 2b and Fig. S1). In contrast, the lower density water mass A with high temperature and salinity corresponding to the six stations (K2, A1-b, A6, A8, B8 and B9) in the south of KE axis are most related to the Kuroshio Current.”

30) Line 370: Where is the ratio data? I cannot tell which dot is which station on Fig. 9. Need better way to show the exact ratio data for each station. The mixing of two currents is touched upon a little here, but not well developed. This should be discussed more thoroughly.

R: Yes, we added more discussion on this. If we took Δ^{14}C-DIC value of 50‰ for the Kuroshio water and -220‰ for the NPIW of Oyashio (Ding et al., 2018), we were able to calculate the relative mixing contributions of the Oyashio and Kuroshio Currents for the five stations (Stas. B2, B8, A4, A8 and B9).

"For example, 55-58% Oyashio water could contribute to produce the observed Δ^{14}C-DIC values at the depth of 500 m in Stas. B2 and B8; 100% Oyashio water at Sta. A4 and 96-100% Kuroshio water at Stas. A8 and B9, respectively." in L 415-418.

31) Line 376: Can you use this to derive the percentage of biological process vs. physical mixing?

R: Yes. We have calculated the relative contributions of each process in shaping the DOC distributions in KE region, and added in the main text.

"positive ΔDOC values (~ 6 μM) that accounted for about 11% of the measured DOC at Sta B8" in L 424, and "However, the biological consumptions of DOC would account for 8-20% of the total DOC pool based on the negative ΔDOC values (2-8 μM) and the measured DOC at Stas. B2 and A4." in L 429-430.

32) Line 394: After the separate discussion for ECS and KE, somehow the authors should connect the ECS and KE data together to derive some general pattern or their contribution to form the overall current that enters into North Pacific. Otherwise it is just like put two separate survey studies together side by side without any connection.

R: Agree. In the last paragraph in Section 4.2, we have added a few discussions combined the two different oceanic regions together in L 444-448.

"On the other hands, comparing with the deep DOC results in the slope region of the ECS, it can be seen that the deep DOC level in the KE was on average 10-15 μM lower than that in the ECS, implying that the possibility of lateral transport of DOC from marginal seas to the ocean interior and cycled in the deep ocean for very long time."

33) Fig.3: Hard to look at the data since all lines are pretty close to each other. Need a better way to present this data. Maybe using color in ODV plots? Can leave this figure as a supplemental figure if needed.

R：As suggested, we have redrawn the T-S-DOC diagrams in new Figure 4. Correspondingly, we have modified few statements for the DOC results in Section 3.2 based on the new T-S-DOC diagrams in the new Figure 4.

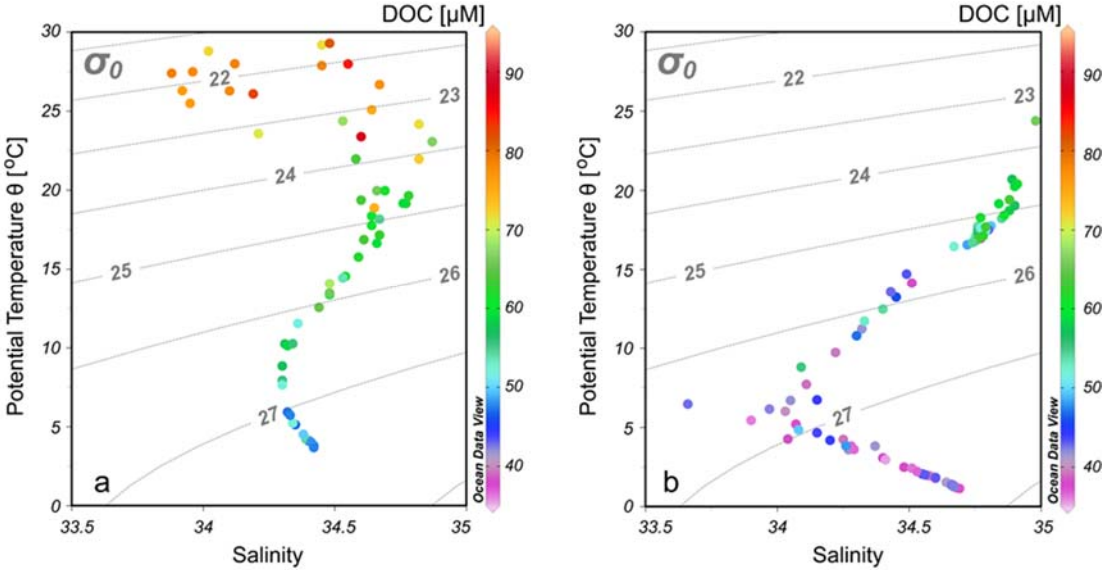

Figure 4. Measured DOC concentrations superimposed on the plots of potential temperature versus salinity for the sampling stations in (a) the East China Sea and (b) the Kuroshio Extension in the northwestern NP.

34) Fig.7: What about the leftover dots not in water mass A, B, C? How did you decide the grouping of those different water mass? Is it statistically different?

R：See the earlier comment. In the old Figure 7 now Figure 8, we have re-divided the water masses into four different parts (A, B, C and D) mainly referred to the different density and the DIC/Δ^{14}C-DIC values without statistically estimate.

Technical comments:

35) Line 21: Add "the" before ECS

R: Done.

36) Line 29: should be "lower in surface waters than that in the ECS"

R: Yes, we added "than that in the ECS" in the sentence.

37) Line 40: Clarify as "DOC in the ocean is. . .."

R: Yes, we clarified the sentence by adding these words as suggested.

38) Line 42: Delete "therefore", not a result caused by previous sentence.

R: We have removed "therefore" in this sentence.

39) Line 80: "exiting", not "existing"

R: We corrected the typo in this sentence.

40) Line 85: restructure this sentence

R: We have rephrased the sentence as: "The newly-formed North Pacific Intermediate Water (NPIW) in the mixed water region has been given attention, not only due to its important role in the ocean circulation systems, but also for its impacts on the regional carbon cycle and climate variability".

41) Line 92: change to "have been collected. . ."

R: Yes, we changed this sentence to "DOC observations on WOCE (World Ocean Circulation Experiment) and CLIVAR cruises have been collected at Line P02 stations along a 30° N latitudinal transect, yet the distribution of DOC near the KE was not investigated during these cruises.".

42) Line 97: delete "a"

R: Done.

43) Line 112: add "that" after "branch"

R: Yes, added.

44) Line 113: "higher primary productivity" higher compared to where?

R: We replaced the "higher primary productivity" with "high primary productivity" .

45) Table 1: Sampling data for ECS not clear, Stn.1,7 both on 12 July? Z1,Z2,Z4 all on 14 July?

R: Yes. We added the sampling date for each station.

46) Line 143: change to "rinsed with seawater three times"

R: Changed

47) Line 151: change to "standards"

R: Changed.

48) Line 154: delete "before", just "every five samples". What does the content in parenthesis mean? The blank is also run before each deep station sample?

R: We changed to "between the samples" and "before every sample for the deep seawater", respectively.

49) Line 164: Change "was" to "were".

R: Yes, changed.

50) Line 173: Add "the" before "DOC and DIC analyses".

R: As responded for the earlier comment, we deleted the AOU section including this sentence.

51) Line 210: Change to "Concentrations"

R: Yes, we corrected to "Concentrations".

52) Line 214: "fewer variation" than what? Compared to KE?

R: We replaced "fewer variation" with "less variation".

53) Line 222: Is 36-53uM the DOC value for Sta A4 and B2?

R: Yes, the concentration range is for Sta A4 and B2. We moved the DOC values (36-53 μM) after the Sta A4 and Sta B2 to include both stations.

54) Line 228: Change to "Processes controlling the DOC distribution. . ."

R: Yes, we changed the title of Section 4.1 to: "Processes controlling the DOC distribution in the ECS".

55) Line 237: delete "depth"

R: Yes, deleted.

56) Line 258: Change to "high concentrations of DIC and. . ."

R: Yes, changed as suggested.

57) Line 259: restructure this sentence

R: As suggested, we restructured this sentence to "This intrusion of Kuroshio intermediate water diluted the DOC at Stn. 11 and Z4 (Figs. 7b-d)." in L 298.

58) Line 262: Change to "the well mixed shelf water not only contributed to . . .."

R: We have deleted the sentence "As shown in Fig. 5d, the well mixed shelf water could not only contribute to the ^{14}C-depleted DIC signature in the upper 100 m layer at station Z4, but also elevate DOC concentrations, as compared with the DOC levels in the upper water column at the other three slope stations (Stas. Z1, Z2 and Z3) as influenced by the Kuroshio Current (Figs. 3b and 5b). The river influence and inner shelf export of DOC appeared to be limited in the deep slope stations.". We also added "On the contrary, as shown in Fig. 2a and Fig. 7, the intrusion of the saline Kuroshio water in density range of 23.2-24.9 σ_t instead of the intermediate Kuroshio water not only contributed to the salinity maximum around 150 m water depth at Stn. 1 and Stn. 7, but also affected concentrations of DOC/DIC and the DIC-$\Delta^{14}C$ values, as compared to the upper waters at the other three slope stations (Stas. Z1, Z2 and Z3) influenced largely by the Kuroshio Current (Figs. 3a and 7b-d). The river influence and inner shelf export of DOC appeared to be limited in the deep slope stations." in L 302-308.

59) Line 292: Change to "statistically significant"

R: Deleted this sentence which is included in the AOU section.

60) Line 295: Change to "Processes"

R: Yes. We changed the title of Processes influencing DOC profiles in the Kuroshio Extension.

61) Line 305: "among these stations" means "spatially", right?

R: Correct. We have rephrased the sentence as "large spatial variations for DOC concentration among these stations".

62) Line 307: 'significantly lower than other stations"

R: Yes, we added "than other stations" for the sentence.

63) Line 310: "with values that are 28% higher"

R: Changed.

64) Line 318: delete "most"

R: Yes, we deleted "most" from the sentence.

65) Line 375: change "modulated" to "modulating"

R: Done. We replaced "modulated" with "modulating".