Reviewer Recommendation and Comments for Manuscript BG-2018-210

General comments

The manuscript reports on total, small particles and large particles activity of 210Po and 210Pb nuclides along the North Atlantic GEOTRACES GA01 (GEOVIDE) cruise. The paper is well written, well structured and I believe that such measurements in this areas are essential for the scientific understanding of TEI's and biogenic elements in the global ocean. The approach is very good and the compilation of many other joined data (AOU, PP, SPM, chlorophyll, …) is essential to reach this goal. In addition there is a huge effort to include this new dataset with previous ones in order to get a better view of the processes controlling the behaviors of 210Po and 210Pb at a larger scale. Finally I found very interesting news findings that emerge from a new way to confront this 210Po and 210Pb dataset to other variables (comparison with chlorophyll-a from satellite-based data, AOU, …) that merit to be published.

However I found some questioning points that need to be addressed:

- the splitting of the samples between two different labs with two methods that differ in some points is very surprising. Some practical reasons can certainly explain this procedure but they are not mentioned. The reader need to be sure that the results can be compared. Especially since there are distinct features that can be seen between the samples from the two labs and that a part of the discussion relies on such differences.
- the last section of the discussion about the sorption, distribution coefficient and implication for particles and POC export very speculative. This is embarrassing as this appears in the abstract and the conclusion as the most important finding of the study while there are other findings much more robust that are not presented in that way.
- the presentation of the context in the introduction and the state of the art about 210Po and 210Pb isotopes in the ocean is a little bit weak and I think the importance of such measurement in this area should be specifically strengthened.

Consequently, I believe this paper must be published when these points will be addressed.

Specific comments:

Title:

- The part of the title "partitioning between the dissolved and particles phase" is maybe not really appropriate as the most important discussions in the paper is about the processes explaining the variations in the 210Po/210Pb activity ratio within each phase (i.e., total and small/large particles).

Abstract

P2, L22-23: this was not shown in the manuscript

Introduction

P3, L42: "seventh repetition of the OVIDE section": please precise what is the OVIDE section/program?

P3, L44-46: please give a short summary on the hydrological properties on the area.

P3, L47-49: you should illustrate what is this expected "mixture of complex …" and why this section may present a special opportunity.

P4, L72-78: I found this objectives section disappointing and clearly not ambitious enough with respect to the dataset compiled and presented in this paper. I suggest the authors to strengthen this part.

Methods

P5, L104: Please correct the sentence to avoid confusion: what was transferred into a clean bottle? The filters? The filtrate?

P5, L107: is the "Stewart laboratory" the official name of the laboratory?

P5, L107-108: why this splitting procedure of the sample? The reader need to know why this

splitting procedure allow to "ensure higher counting statistic in the samples". Did the laboratory performed intercalibration experiments?
P5, L110: Please correct the sentence to avoid confusion: the filter was not evaporated to dryness.
P5, L110: Remove "eventually"
P5, L112:what weak acid solution?
P5, L120: write "to determine Pb recovery" instead of "to determine sample recovery".
P5, L125-127: why this difference between the two labs?
P6, L137: These two different digestion procedures may give different results? Please explain if tests were carried out. Are the data from the two groups comparables?
P6, L144: what is the Planquette group?
P6, L144: is this sentence correct: "the material on the balance of the screens and filters"?
P6, L148-149: if the method is the same as described by Lam et al. 2015, I suggest to remove the Lemaitre et al. in prep. reference if it is not published at the time of the publication of this paper. Same comment for other reference in prep. in the manuscript.
P6, L158: what is the Dehairs group?
P6, L157-164: a little bit more details is needed here: how the photometric conditions was applied on deck? I guess that 13C was spike before the incubation? ...
P7, L173-174: Before to compare the AOU data from the GEOVIDE program, you should explain how you get it. In facts, the section 2.7 is disturbing. There are two things here: the AOU and the comparison with historical data but there is no link between them. I suggest to split this section in two (even short) sections.
P2, L182-187: SPM, PP, chlorophyll were not considered to try to explain the 201Po-210Pb activities and activity ratios distribution?

Results

- p7, L195-202: there are a clear difference between station 1, 13, 21 and the other ones. These differences also correspond to the two samples groups that were processed by two labs. This is embarrassing if there is nothing that certify that labs results can be compared.
- p7, L200-202: please rewrite this sentence which is very confusing.
- p7, L195-207: this paragraph is confusing. Please describe firstly the surface water then the depth (or in the other way) but not a mixing description.
- p8, L214-216: why the figure is not shown? The particulate profiles should be plotted (at least in the appendix material).
- p9, L242-244: yes, this is not surprising as the small particle are the main particulate reservoir.
- p9, L245-246: which particulate samples are depleted? Where they are located? In surface? Subsurface? Variable depths?

Discussion

- p10, L264-265: large excess is not seen at depth.
- p10, L260-267: I don't understand how an upwelling along the Iberian coast can bring excess 210Po all over the water column in the 3 station from the WEB.
- p11, L295-298: what do you mean by significant? Are they significantly different than this other station? Statistically tested? Is this confirmed from the data on the geochemical composition of SPM?
- p11, L304-308: this is an interesting point. Is there a figure (or a way) to illustrate this? For example a plot showing the AR in surface or subsurface as a function of the time since the last bloom?
- p12, L321: Is this particulate 210Po depletion in the coastal sea related to the 210Po/210Pb AR in these the terrestrial/riverine particles or is this due to the nature of those particles that present a lower scavenging efficiency of dissolved 210Po with respect to 201Pb?
- p12, L331: AOU must be defined in the method section. What a negative AOU value means?
- p12, L332: remineralization + respiration + oxidation reactions.
- p12, L333-334: I do not see why water mass aging may change the OAU if there is no mineralization. To my opinion, only biogeochemical processes may change OAU values while the

time can only change the intensity of O2 consumption by those biogeochemical processes. I think this should be better specified in this part to avoid confusion.
- p12, L336: what is an old particle? Weeks? Months? Years?
- p12, L336-338: time will induce an AR approaching 1: decreasing AR if the initial AR is >1 and increasing if the initial AR is < 1. Here you hypothesis that the initial AR in particle is <1 but both cases are possible. Please correct.
- p12, L343-357: very interesting results and interpretation! However, I have two mains questions:
  - Why the increase of AR from negative value to value close to 1 for OAU > 25 µmol/kg? Higher the OAU, higher the mineralization. So intuitively, the AR should be maintained more and more negative with increasing OAU?
  - I do not understand why it is said that this observation stands only for high latitude in the northern hemisphere. Other campaigns from high latitude in the Northern hemisphere are also reported on figure 5 but are not considered. In addition, GA-03 campaign are not from high latitude. What gives this relationship for other campaigns? Why this 4 campaigns was selected?
- p13, L370: What do you mean by investigation of pigments? There is nothing about it in the material and methods section.
- p14, L377-378: what do you mean by "as the above cited papers have seen elsewhere"? Please precise
- p14, L378-380: this is expected for the eastern part of the transect only?
- p14, L391-392: how did you calculate the dissolved activity? This is not indicated. When you consider the Kd for the small particles you normalize with the SPM for the small particles also? Same question for the total particulate. Please precise.
- p14, L399-401: How this is possible as the small particulate activity is necessary lower than the total particulate activity? Is it associated to the SPM normalization?
- p14, L401-403: here you affirm that the scavenging and export is mostly driven by small particles. But there is nothing to confirm this. Although this can be plausible, this is just an hypothesis.
- p12-14, L362-404: this section is very surprising. From the title of the section I excepted to find POC export calculation. In facts, there is no data really discussed or even showed (pigment, primary production, …) and most of the discussion is based on hypothesis without real solid basis to support them. I suggest to rewrite this section around concrete data only and to change the title of this section.

Conclusion:
- p15, L415-420: again this was not clearly demonstrated. This conclusion should be very robust because it can have large implications in the future sampling strategy. Differently: does the sampling and analysis of two particulate size fractions is necessary in the future? So this has to be very robustly demonstrated. I agree with the fact that the high proportion of particulate nuclides is found in the small particle indicates that small particles are important in the sorption process. But I'm clearly not convinced from the data showed in the manuscript there is evidence to say that the small particles play an important role in the export of particles. If so, this should be strengthened.
- I may suggest to synthesis the most important findings based on the data only. There is nothing on the time elapsed since the last bloom for example.

Fig 3:
- I doubt the sentence "A closer look at only the zoom" is correct in the caption
- Stn 60: 2 dot are missing for 210Pb at approximatively 50 m and 120 m depth.

Figure 6:
- negative AOU value need to be explained?
- with the uncertainty on Po/Pb AR there is (most of the time) not significant deviation from the 1 AR for the "other points". I suggest to integrate the "other points" within the regression keeping the only separation lower or above 25 µmol/kg for OAU.

Figure 7:

- the axis labels on the figure and in the caption are not the same. Please homegeneize.