Interactive comment on "An updated estimate of radium 228 fluxes toward the ocean: how well does it constrain the submarine groundwater discharge?" *by* Guillaume Le Gland et al.

Anonymous Referee #2

This manuscript describes the use of an inverse modeling technique to investigate 228Ra fluxes to ocean basins. The inverse modeling technique itself is not novel, nor is its application to studying 228Ra fluxes, however the efforts taken by these authors to examine each of the assumptions of the model is valuable and results in improved estimates of the 228Ra fluxes to each basin. This work also includes flux estimates for the Arctic and Southern Oceans, which have not been included in previous studies. Because of these two valuable contributions I recommend that this paper be published after revisions to address the specific comments below.

Specific comments: 1. I do not think the title accurately represents the main focus of the paper, which is an effort to improve the application of the inverse modeling technique

to 228Ra, as opposed to an interpretation of an updated 228Ra flux estimate or SGD estimates. Either the title should be changed to better reflect the fact that the main contributions of this work are improvements to the model, or more discussion should be added on the interpretation of the results of the model and how they change our understanding of 228Ra and/or SGD. If the latter is chosen, the authors should be sure to highlight how their contributions are unique from those of Kwon et al (2014), aside from simply reporting the newly calculated Arctic and Southern Ocean 228Ra fluxes. 2. Page 2: There is a short discussion about the sources of Ra, and it is mentioned that dust inputs are small compared to the other sources used in the model. The dissolved riverine source should also be introduced here instead of later in the paper, because this is where the sources/sinks are first introduced. You state later on that the dissolved component of the riverine flux is negligible, but it would be better to approximate the relative contribution as you have done for the dust source in line 20. 3. Page 7 lines 17 – 18: Why is the flux of 228Ra (in units of atoms y-1) compared to river discharge (I'm assuming this is units of m3 y-1)? Why not compare the flux of SGD to river discharge, so that it is a volume-to-volume comparison? I'm not sure if this is intended to make the point that the largest flux of 228Ra does not correlate with the greatest river discharge, but the authors argue that rivers do not carry much dissolved 228Ra, so in that case they shouldn't correlate anyway. 4. Page 8 line 11: Should this be a reference to figure 6 instead of figure 7? If you do indeed mean to call figure 7, then the figures should be re-ordered so that they are in the order they are referenced in the paper (i.e. don't reference figure 7 before figure 6 is referenced for the first time). 5. Page 14 line 28: should call figure 9 instead of figure 8 6. Conclusion lines 14 – 15: be specific about the other cost functions that were tested, instead of saying "...the other cost functions...". That way if a reader skips to the conclusion, they will still understand your specific results. The same sentence ends by saying "...more realistic assumptions on error statistics"; again, be specific about what the more realistic assumptions were. A large part of the paper is dedicated to testing assumptions, so the conclusion should point out the results of those tests. 7. Conclusion lines 24 – 25: The sentence that

begins with "Therefore, besides estimating the sources..." should not be included in the conclusion, as it is not one of the main points emphasized in the paper. It is more appropriate to move this line to the end of the "model biases" section or another part of the manuscript. 8. The conclusion should have a stronger ending and remind the reader why it is important to better resolve the 228Ra model. Line 17 is a good reminder of why determining the shelf fluxes is important, but the conclusion should also highlight why it is important to separate the SGD and diffusion sources. This could also be discussed in more detail earlier in the paper, but should at least be mentioned again in the conclusion. 9. Page 16 line 2: include the actual NEMO website 10. Full references for the data sources used in the model are not included in the reference list; is this because they are only listed in the supplementary material? I suggest adding a supplementary reference list for these data sources. Also, in the Arctic references, the year for the Rutgers van der Loeff et al. 2013 reference should be 2012, not 2013. 11. On Figure 9, the cruise across the Fram Strait has been completed, so this should be in yellow instead of red.

Technical corrections: In general, I recommend proofreading the manuscript again for grammatical errors and typos to allow for ease of reading. I have included a few examples here: 1. Sentences should not start with numbers or abbreviations (e.g. page 3 line 31). In many cases "228Ra" is the first word in a sentence; when this is the case it should be spelled out as "Radium-228". 2. Abbreviations should be defined at their first usage (for example, Ra should be defined in the last line of page 1 instead of 2, and NEMO should be defined on page 3 instead of 4). 3. Page 1 line 21: insert the word "are" in between "or" and "pollutants" so the sentence reads "...or are pollutants" 4. Page 2 lines 11-12: use the pronoun "its" instead of "their" 5. Page 3 line 30: delete the word "of" so the sentence reads "...making the Atlantic Ocean..." 6. Page 14 line 10: insert the word "the" before "model" so the sentence reads "However, the model conserves mass..." 7. Page 17 line 2: "si" should be "is"