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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.

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Dear Isaac Santos

Thank you for the thorough reading of our manuscript and your constructive comments. Here are the answers to your comments:

1) The radium flux of our study is around 20% lower than the inventory of radium 228 in the Atlantic by Moore et al. [2008] and the global estimate of Kwon et al. [2014], which is significant. This will be stated in the abstract and the conclusion. The possible reasons are discussed in 4.1.

2) Page 2 line 33: This sentence is ambiguous and will be rephrased. No assumption

is required to perform box averages or interpolations. The "raw assumptions" are the very fact that box averages or linear interpolations can produce a precise and unbiased estimate of the total flux, which is not true when data are sparse.

3) This is a very interesting question. I think there are two points here: a) At page 7 line 17, a comparison is made between radium fluxes, a proxy of SGD, and rivers. My point is that these two sources of water and nutrients are distributed in a very different way. But, given the size of the basins, rivers may be more biased than radium/SGD. The Indo-Pacific basin accounts for 52% of continental shelves and 63% of radium fluxes, compared to 29% and 27% for the Atlantic. In order to address a comment by referee #2, this comparison will be moved to 3.4, transformed into a comparison between rivers and SGD, and the previous remark will be added among other improvements. b) The distribution of fluxes is more complex than "high in the Indian and Pacific, low in the Atlantic and Arctic". Differences within each basin are larger. Except for a few cases where the explanation is obvious, for instance the very low fluxes in the eastern Pacific, where the shelves are very thin, it is difficult to identify the reasons why some regions emit more radium than others. This is probably related to the local geology: high fluxes may be due to more permeable sediments, to more wave, tide or geothermal energy inducing larger SGD, but also to a higher content in radium-228 and its parent radionuclide, thorium-232. We are not specialists of this field and the literature we know so far does not provide the global scale pattern of these parameters. For instance, it does not explain what the main differences between regions like the Bay of Bengal or the Gulf of Guinea are. Previous radium and SGD studies do not explain the reason for the source distribution either. A few explanations on the potential causes will be added in the discussion, but relating differences in radium-228 fluxes to a specific geological parameter is not possible.

4) There may be a misunderstanding. No integration (averaging) on the water column is performed. So no extrapolation has to be made on concentrations between observations. This is the strength of inverse modeling. We just minimize the differ-

ences between observed concentrations and model concentrations at all observation points shallower than 200m, without assuming anything about radium concentration elsewhere or regional averages. This will be made clearer in the introduction, where some sentences of the current manuscript are ambiguous, especially on page 3 from lines 2 to 6.

5) Page 10 line 21: “A fraction” will be replaced by “nearly all”, and more detail will be given about the small amount of riverine dissolved radium.

6) Page 10 line 30: More information will be added on the methods used to compute diffusion from sediments. Their results will be summed up in a table. It will show that some methods produce high values, close to the average shelf fluxes.

7) Page 11 line 20: Indeed, SGD is mainly recirculated saline water, as already explained in the introduction. According to Taniguchi [2007], there is only 2600 km3/yr of fresh SGD, between 2% and 20% of the total SGD. The comparison with rivers is made because they both contain nutrients and trace elements. The end of 3.4 will be changed to explain all this more clearly, using the literature.

8) Indeed, seepage meters are not representative of total SGD, as they are concentrated close to the coast, where both fresh and saline SGD are expected to be higher than the continental shelf average. This is why the fluxes of most local studies are one order of magnitude higher than ours. We will explain this more clearly. In the current version of the manuscript, the only mentioned weakness of seepage meters is spatial variability, which is incomplete. However, seepage meters are interesting because they are independent from radium and are not affected by uncertainties on radium diffusion or radium concentration in groundwater. Not mentioning them would be strange. Radium studies, at a larger scale, are already the object of the previous paragraphs.

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