

Interactive comment on “Use of Ra isotopes to deduce rapid transfer of sediment-derived inputs off Kerguelen” by V. Sanial et al.

Anonymous Referee #1

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This paper reports on the activities of three isotopes of radium (^{224}Ra - $t_{1/2}=3.66\text{d}$, ^{223}Ra - $t_{1/2}=11.4\text{d}$, and ^{228}Ra - $t_{1/2}=5.75\text{y}$) measured in the vicinity of Kerguelen Island during the KEOPS2 project. The authors find significant activities of the very short-lived Ra isotopes downstream of the Island both north and south of the Polar Front. They use the depth profiles of the trio of isotopes to convincingly argue that the activities of the shortest lived isotopes must be from lateral transport rather than vertical mixing. From the ratios of ^{224}Ra and ^{223}Ra , they calculate the apparent ages of the water since contact with sediments, separating into ages >2 months (both isotopes below detection), 1-2 months (^{224}Ra below detection), and <1 month (both isotopes above detection). By comparing their Ra-based ages to surface drifters and Lagrangian back trajectories, they conclude that some of the young apparent ages of water south of the Polar Front derived from Kerguelen Island, across the Polar Front.

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This is a very clearly written paper with a nice pairing of isotopic data and physical modeling to determine water ages and origins of water. It was a pleasure to read. I have only a few relatively minor comments:

Section 4.1: origin of radium enrichments Prior to this paper, the view was that water to station A3 south of the Polar Front was likely advected from the vicinity of Heard Island and the southern Kerguelen Plateau. The authors used the transit times of two drifters released at station A3 to argue that the circulation in this region is too sluggish to account for the presence of the activities of the short-lived ^{223}Ra and ^{224}Ra isotopes observed at the stations south of the polar front that are east of Kerguelen. It is interesting to note that a close study of the satellite chlorophyll in figure 2 shows that this recirculation area remains relatively low in chlorophyll through the growing season, suggesting that even if short-lived Radium isotopes are occasionally quickly transferred across the Polar Front, this cross-frontal transport seems to be a less important source of iron compared to the regions experiencing advective transport from Island sources (eg. north of the Polar Front, east of 74°E from Kerguelen Island; south of the polar front, in the tongue coming up from Heard Island and the Plateau).

- p. 14026 line 8: Should be “One of the largest phytoplankton blooms. . .”
- p. 14030 line 7: “. . .analyzed *for* ca. 120h”
- p. 14033 line 8: delete “towards”: “gradually decrease offshore.”
- p. 14033 line 22: “. . .200 kilometers offshore *from* the Kerguelen Islands”
- p. 14034 line 9: “offshore *from* the islands”
- P. 14037 line 16: add “. . .is the initial ratio *in source waters*”
- p. 14037 line 21: should be “see Sect 4.1”

Figure 10 caption: Please be specific about what the colorbar is (eg. “Colorbar indicates time elapsed since water body left the 2000 isobath”)

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