Climate of the Past Discussions

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Comment on cp-2021-134

Anonymous Referee #1

Referee comment on "Summer sea-ice variability on the Antarctic margin during the last glacial period reconstructed from snow petrel (*Pagodroma nivea*) stomach-oil deposits" by Erin L. McClymont et al., Clim. Past Discuss., https://doi.org/10.5194/cp-2021-134-RC1, 2021

This paper describes a detailed investigation of an ancient deposit of snow petrel oil in Antarctica and how it relates to changes in climate and sea ice conditions during the late Pleistocene. It is a unique record and the authors used a number of analytical methods and proxies to infer changes in petrel diet and a paleoclimate record dating from ~22,000 to 28,000 yrs ago. The multiple methods they used served as a cross-check on the results of each analysis, providing strong evidence to back their conclusions, such as the Cu signature for krill in the diet. The paper is also well written and presented, so I do not have many comments for revising this paper for publication.

The method for calibrating their radiocarbon ages needs more explanation. The papers they refer to for their delta-R value of 880 +/- 150 yrs are based on penguin dates, and to my knowledge similar corrections based on dates from modern, pre-bomb snow petrels have not been completed. Using penguin corrections may be okay since the diet of the petrel is somewhat similar, but another analysis of radiocarbon corrections based on two additional modern, pre-bomb penguin dates can be found in Emslie (2001, *Antarctic Science*). This study indicates that a delta-R of 700 +/- 50 yr is more accurate for the Antarctic Peninsula and perhaps the Weddell Sea as well. I'm not sure how much this would change their age ranges for the petrel oil, but it should at least be considered. In addition, the diet of penguins from which corrections are based is not that similar to the diet of snow petrels. Penguin prey are larger size—larger krill, larger silverfish, etc., and we know from other studies that isotope values in krill will change with ontogenetic stage, or size of the krill, and oceanographic conditions (see Polito et al. 2019, doi:10.1002/lom3.10314). This is likely true for squid and silverfish as well and, since snow petrels are feeding on much smaller prey than penguins, it could affect the stable isotope values in the petrels by up to 2.4‰ (or more than the change seen in their samples) as well as their delta-R value.

One weakness of this study, as discussed by the authors, is determining if baseline polynya carbon and nitrogen values changed over time (and very likely did), which in turn would influence the stable isotope values independent of dietary change. One way to test this is by using compound-specific stable isotope analysis so that source and trophic amino acids can be analyzed to determine if a true dietary shift occurred, or if changes in baseline productivity occurred, or both. I am not familiar enough with the stomach oils of petrels to know if the proper amino acids can be extracted and analyzed in this manner, but the authors do not mention this either way. Perhaps their use of multiple proxies helps resolve this issue and if so that should be stated. Their measurements of Cu certainly help show the likely change of krill in the petrel diet over time.

Another set of data that might help would be from ice cores. In Fig. 6 they present some of the WAIS ice core data, but has DMS been analyzed from these cores? DMS can be a proxy for sea ice extent (e.g., Goto-Azuma et al. 2019, *Nature Communications*). This would be another independent data set that could help strengthen their results for presence of polynyas and open water, or extensive sea ice in the past.

Line 545: wouldn’t enhanced upwelling increase (enrich) the carbon isotope values?

Section 4.3 is a bit long, with some repetition from previous sections so I suggest cutting this down a bit.

Figures and tables are all necessary for the paper and are well presented.