

Interactive
Comment

Interactive comment on “Late Holocene variations in Pacific surface circulation and biogeochemistry inferred from proteinaceous deep-sea corals” by T. P. Guilderson et al.

T. P. Guilderson et al.

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1. I could not find the information of the water depths where these samples were collected. Although the general habitat depth of *Gerardia* in Hawai’ian waters is mentioned in the introduction, the information of the samples in this study is also needed. There is also little discussion of the dependence of stable isotope data on water depth. Is diagenesis of sinking POM negligible in the water column of these sites?

Authors’ response:

The depth distribution of living specimens is strongly tied to the upper portion of the low oxygen zone – ie where oxygen begins decrease significantly. Near Hawai’l this

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is nominally 400m and ranges a few tens of meters. Visual observations of *Gerardia* by us and others indicate that the distribution zone is no deeper than 500m. This is consistent with the HOT-ALOHA timeseries of oxygen concentration.

We only had a small number of dives in the Line Islands and thus the observational basis for the distribution is not as extensive as in the Hawai'ian islands. Living *Gerardia* were a little shallower <400m, which is consistent with the distribution of oxygen.

Given the velocity of sinking POC and the shallow depth of our "living sediment traps" we do not anticipate significant diagenesis of sinking material. Compound specific amino acid isotopic analysis would explicitly document the influence of heterotrophic modification of the sinking POC. This is something that we are actively pursuing.

2. Seasonality would be important for the discussion of the long-term trends. Is there significant seasonality bias in these coral stable isotope records? For example, a recent paper (Karl et al. 2012, PNAS) showed that episodic POM exports events of NPSG in summertime (July 15–August 15). I wondered that the insolation change during Mid to Late Holocene could modify the seasonality.

Authors' response: As noted by the reviewer and shown in figure 1b, there is seasonality in the stable isotopic composition of sinking POC and thus such a possibility cannot be excluded. We assume that the skeletal material is a reflection of the "isoflux" weighted average (solid filled symbols on figure 1b). It should also be noted that the stable isotope measurements are based off of homogenization (finely milled powder) that integrate multiple decades. The diameter of the spherical bur diameter used was 1.8mm and the sampling was primarily for ^{14}C analyses which requires much more material than stable isotopes, so in general the divot was not quite 2 diameters wide. Thus on average our sample resolution is 50-100 years for the majority of the Hawai'ian Island samples and 60-120 years for the Line Island specimens. Convolution of the integration with a flux-weighted average would tend to minimize singular extreme events or even a few years of extreme events.

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3. The authors discuss reduction of the tradewinds since the Mid Holocene as a cause of the long-term trends in $\delta^{15}\text{N}$ records of Hawaii corals. In addition, I felt that the position of Intertropical Convergence Zone (ITCZ) could be also important. During the Mid to Late Holocene, the ITCZ shifted south due to the weakened orbital forcing in Northern Hemisphere summer (e.g., Wanner et al. 2008, QSR). If this ITCZ shift was also significant in the NPSG area, it could impact the production of mesoscale eddies.

Authors' reply:

The reviewer is correct: the strength and the intensity of the tradewinds and the general position of the ITCZ are related. To the level that the upper ocean currents and winds are coupled (most definitely quite strongly) the production of eddies would.

Specific comments

Pg 3930 Ln 6: When were these samples collected?

Authors' reply The corals were collected during three different expeditions in 2004, 2007 (Hawaiian Islands), and in 2005 (Line Islands).

Pg 3930 Ln 15-17: The term "Range finder sampling" was unclear for me. Does it come from some references?

Authors' reply The term is a colloquialism on our part. The stable isotope results presented in this manuscript are from remaining material utilized to determine the age range of the (mostly) sub-fossil specimens.

Pg 3931 Ln 3: Is pretreatment of "Radiocarbon samples" same as the stable isotope samples? (decarbonation, rinse, drying, : : :)

Authors' reply Yes. The majority of bulk organic stable isotope analyses on marine sediments and deep-sea corals includes an acid soak/rinse to remove any occluded carbonate.

Pg 3933 Ln 16: The term "nutrient trapping" in this sentence is unclear. More explana-

tion is needed.

Authors' reply Nutrient trapping refers to conditions where remineralization of recently fixed photosynthesis products occurs before the fixed nutrients can be exported out of the mixed layer or before being exported below the permanent thermocline. If the reviewer would like, we are happy to rewrite this section and discuss the ^{13}C gradient in terms of (simply) remineralization and export.

Pg 3937 Ln 18-21: A recent paper (Cobb et al. 2013, Science) suggested highly variable ENSO activity during the last 7000 years, with no evidence for a systematic trend in ENSO variance, which is contrary to model studies such as Clement et al. (2000). Therefore, this Cobb et al. (2013) should be included in the discussion.

Authors' reply We will indeed include a statement regarding the inferences presented by Cobb et al. which was published subsequent to our submission to BGD. A similar request was made by reviewer #1.

Pg 3941 Ln 16: measureeonts -> measurements

Authors' reply We will fix the typographical error.

Pg 3941 Ln 28-30: Does this reference have same contents as the paper with the same title in JGR? (Jenkins, 1998, Journal of Geophysical Research 103, 15817-15831) If so, the JGR paper would be more suitable to cite.

Authors' reply Although the titles are the same, the JGR article is nearly exclusive to tracer results for the Atlantic. If the reviewer and editor would like we can substitute a more easily accessible reference but also specific to the Pacific (e.g., Fine et al., J. Phys. Ocean. 17, 5, 553-564, 1987).

Pg 3943 Ln 2: Deep-Sea Res. Pt. II -> Deep-Sea Res. Pt. I

Authors' reply We will correct the typographical error.

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