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Biogeosciences
Discussions

Interactive comment on "Equatorial Pacific peak in biological production regulated by nutrient and upwelling during the late Pliocene/early Pleistocene cooling" *by* J. Etourneau et al.

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General Comments

Etourneau et al present new, high-resolution records of export productivity and nutrient utilisation/supply from two sites in the Eastern Equatorial Pacific during the Plio-Pleistocene. These records constitute an important contribution to our understanding of the factors driving the EEP export productivity peak between ~2.9 and 1.6 Ma, already identified in a number of records from the region. Etourneau et al infer that the peak in EEP export productivity between 2.2 and 1.6 Ma, and the subsequent decline in export productivity after 1.6 Ma, was primarily driven by changes in nutrient inputs to

EEP surface waters via upwelling. These nutrient changes are suggested to occur primarily via changes in upwelling intensity (driven by changes in Walker circulation), and secondarily by changes in the pre-formed nutrient content of mode waters that feed the EEP thermocline (i.e., nutrient utilisation in the Southern Ocean and N. Pacific). The authors also suggest that denitrification may have contributed to the demise of the EEP productivity maximum after 1.6 Ma. Overall, the data are of high-quality, the paper is well written and ideas clearly expressed. The correspondence between the new C37 concentration record from Site 1239 and the published record from Site 846 is striking.

Specific comments

1. Mass Accumulation Rates

Given that there is good age control at both sites, the authors should consider plotting C37 concentration, % N and % TOC records as mass accumulation rates because variations in accumulation rates are a more accurate reflection of biogenic material fluxes to the sea floor. Does this alter long-term export productivity trends?

2. Focus on 2.2-1.6 Ma

The current manuscript is primarily focused on understanding the EEP export productivity peak between 2.2 and 1.6 Ma. In this interval, low SSTs, high C37, TOC and TN contents, and low d15N are interpreted together as showing an increase in upwelling and low relative nutrient utilisation (here interpreted as an increase in nutrient supply rather than a decrease in consumption). This interpretation of the proxies for the interval 2.2-1.6 Ma is internally consistent and makes sense. However the authors make no attempt at understanding in the above terms what is happening between 2.9 and 2.4 Ma.

In this interval, their records from Site 1239 show:

(1) High C37 concentrations (some peaks in this interval are higher than in the interval 2.2-1.6 Ma). High alkenone content in this older interval is also seen in the Site 846

record. (2) Low d15N (similar to d15N in the interval 2.2-1.6 Ma, therefore also suggestive of low relative nutrient utilization) (3) Medium to low TOC and TN % (significantly lower than in the interval 2.2-1.6 Ma, but slightly higher than during the interval 1.6-0 Ma). (4) Relatively warm SSTs (suggestive of low upwelling intensity compared to the interval 2.2-1.6 Ma, or warm upwelled waters).

I think some discussion of what the proxy records suggest for this interval would be appropriate and also interesting. In this context, some discussion of the origin of the different proxies presented could be included and might help with the interpretation (for example, alkenones are exclusively from coccolithophores, TOC originates from all exported production, d15N reflects N usage by all primary producers(??)). Do shipboard records of CaCO3 versus opal accumulation provide any clues as to which groups were dominating primary production during the interval 2.9-2.4 Ma versus 2.2-1.6 Ma? In this context, the statement line 14 page 5543 “Prior to the event, between 3.2 and 2.2 Myr, export production was overall low while d15N values were relatively high and variable” is not really true for Site 1239.

Technical corrections

Line 9 page 5537: “surpassing by a factor of almost ten that of the last deglaciation”. Please add reference.

Line 11 page 5537: “to” a lesser extent

Line 15 page 5537: “Changes in circulation in the North Atlantic related to ice sheet expansion were also invoked to explain the spatial distribution of nutrients in the low-latitudes regions, and its impact on EEP variability (Bolton et al., 2011).” In the cited paper, Bolton et al in fact suggest that oceanographic conditions at tropical sites are strongly linked to changes occurring in the Southern Ocean via upwelling and the circulation of sub Antarctic mode water, but that productivity at high-latitude northern hemisphere sites may be responding more directly to northern hemisphere ice-sheet growth.

Line 10-15 page 5538: it is not clear if you are talking exclusively about the EEP or equatorial regions in general. Please clarify.

Line 24 page 5538 and line 1 page 5539: tuned “to” the LR04 stack

Line 11-13 page 5539: do the quoted precisions apply to both machines?

Line 20 page 5539: same time “as” the Uk37

Line 21 page: “0.05 units” - what units?

Line 2 page 5541: record not records

Section 5.2: In the introductory part of this section, it might be useful (for readers not versed in nitrogen isotope systematics and interpretation) to explicitly state “an increase in bulk sedimentary d15N is interpreted as indicating an increase in relative nutrient utilisation, either via an increase in N utilisation by phytoplankton and bacteria or a decrease in N supply to surface waters” or something similar.

Line 4 page 5543: the increased demand for nutrients “suggested” by the “high” export production

Line 10 page 5543: where the nutrients “are” sourced

Line 1 page 5544: the intensification of what?

Line 26 page 5545: over the last X(?) million years

Figure 1 caption: provide references for the SST, chlorophyll and nitrate data on the maps.

Please also note the supplement to this comment:
http://www.biogeosciences-discuss.net/10/C2633/2013/bgd-10-C2633-2013-supplement.pdf

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