

## ***Interactive comment on* “Contribution of changes in opal productivity and nutrient distribution in the coastal upwelling systems to late Pliocene/early Pleistocene climate cooling” by J. Etourneau et al.**

### **Anonymous Referee #2**

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Several recent studies attribute the late Pliocene to early Pleistocene global cooling to a major decline of atmospheric CO<sub>2</sub> in the order of 100 ppm. However, the processes driving this CO<sub>2</sub> drawn-down are still a matter of debate. Etourneau and co-authors present a new line of evidence suggesting that the biological carbon pump was enhanced during a time of major diatom deposition off Namibia, as observed in other upwelling areas during that time (e.g., off California). The causes for this scenario are discussed in terms of subantarctic to subtropical ocean circulation evolution.

In general it is a well organized and presented paper. The figures are fine except for minor changes as suggested below. The new data presented in this manuscript are of

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excellent quality, worth of being published in *Climate of the Past*. However, the given interpretations are not always supported by the data, and the following considerations may help to improve the paper:

P672 L1 Please describe in a few words which hydrological conditions do you mean. Furthermore, is there any evidence for a changing diatom flora in the other upwelling areas as well?

P672 L5 This is actually been done between 3.5 and 1.0 Ma.

P675 L9++ Are you sure about this statement? You are comparing a low resolution d30Si signal with a high-resolution BSi-MAR record. I would prefer to see a regression of d30Si over BSi-MAR, separated in sub-data sets before, within, and after the Matuyama diatom maximum, to corroborate the ascribed relationship.

P676 L8(+16) To my knowledge, Lange et al. recognized within the MDM just intervals rich in *T. antarctica* alternating with intervals dominated by upwelling species such as *C. radicans* and *C. cinctus*, not a complete floral shift. Could you add a graph on that in Fig. 3? It would call for much more variable conditions during the interval of interest, and maybe better explain the large shifts in your d30Si signal.

P676 L13++ You should be careful in your observations, as stated above (P675 L9). Furthermore, the largest step in d30Si occurred at 3.2 Ma, well before the increase in BSi-MAR, with no major shift in d15N. How to explain that?

P677 L25++ This statement is not correct. Cortese et al. 2004 showed indeed that the opal concentrations in the Southern Ocean sites were low during the MDM, but they were already low a long time before. The only sites, where you had higher opal concentrations before the MDM, were the N Pacific sites. Thus, why the silica advection should be related to unutilized opal from the Southern Ocean? Furthermore, you cited carbonate production during the MDM interval in the Southern Ocean (Gersonde et al. 1999 - give the exact sites, which you are referring to) - that doesn't call for an extended

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ice cover?

P678 L4+ I do not think that the reorganization of the nutrient cycles between the North Pacific and Southern Ocean was similar to that between the subtropical upwelling systems and the Southern Ocean. Instead, the opal maxima in the subtropics during the late Pliocene/early Pleistocene mark a transitional step during this time of global ocean geochemical reorganization.

P680 L8++ I am fully in line with the argumentation, but would reword the sentences to: “Compared to the high silicate utilization, the supply of nitrate in the BUS between 3.0 and 2.4 Ma was probably surpassing the nitrate demand of primary producers in the BUS (Etourneau et al. 2009), as suggested by the reconstructed light d15N values (Fig. 3).“

P681 L5+ No, see above and Lange et al. 1999.

P681 L7+ There is evidence from several other studies (e.g., Sachs et al. 2001, MARGO 2009, Kim et al. 2012) that the Uk37 proxy tends to exhibit warmer-than-average temperatures in high productivity areas. Do you think that this is of any importance off Namibia? In particular, Rommerskirchen et al. 2011 showed for the oceanic BUS site ODP 1085 that TEX86 exhibited the expected cooler temperatures during several Neogene upwelling intervals, while Uk37 temperatures remained warm.

P683 L21++ Maybe I didn't get you right, but if the opal production is just shifted from the N Pacific to the low latitudes, there should be no difference in the global pCO<sub>2</sub> balance, because you do not enhance the opal accumulation in total. Therefore, Fig. 4 is also misleading, because it does only present the low latitude BSi-MAR, not a globally compiled one. It is a bit out of the scope of your study, but I really would like to see a box model study on balancing the carbon, silica, and nutrient cycles during this time of Plio/Pleistocene global ocean geochemical reorganization.

P684 L23 Breczinski et al. 2002 is not the right citation here, because during

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glacials you definitely have a higher iron fertilization of the surface Southern Ocean, as recorded by the dust accumulation in Antarctic ice cores.

FIGURES FIG 1 10 m water depth is definitely not the water depth of silica transport towards the Benguela upwelling system. May by a meridional section of silica concentrations of the upper 1500 m would help to better illustrate the modern pathway of silica advection between the subantarctic and South Atlantic realms.

FIG 3 Since these exciting records contain so many details, the size of the figure should be enhanced to a full page. As mentioned above (P676 L8) there should be an additional graph on the abundance of *T. antarctica* relative to species indicating the normal upwelling.

FIG 4 Beside the low latitude BSi-MAR you should add the ones of the N Pacific and the Southern Ocean.

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