

### **Reviewer #3**

Cheung et al. analyzed modern satellite observations to address the question of whether records preserved in marine sediments can be used to reconstruct Ekman Upwelling in Earth's history. This paper is well written. Deep-water upwelling is important in regulating global climate and biogeochemical cycles, and understanding the modern, instrumental records is paramount for paleo-applications. The take home message is that multi-site and multi-variable reconstructions are the preferred way of evaluation ancient upwelling. I'd like to see more studies like this published on *Climate of the Past*, and recommend publication of this manuscript after addressing a few comments.

We thank the reviewer for pointing out sections that require clarification and providing constructive comments. Point to point reply to comments are below.

I understand that the available satellite-based observations include SSTs, chlorophyll-a and alongshore wind stress. And the authors realized that these factors do not directly translate into proxy-derived information ("Although CHL does not equate precisely to primary productivity, and also differs from productivity inferred from proxy records"), I'd appreciate more elaborations on how to build connections between these two types of variables. Anyhow, this is a ms for *Climate of the Past*, and the audience would want to know. For example, SST would be less of a problem. But common proxies for productivity (e.g., Ba, opal accumulation etc) are actually looking at export productivity. How are they expected to be different from CHL data and are they better in tracking upwelling? Also, I know that one paper cannot address everything, but recent studies have suggested that the carbon cycle might be more sensitive than SSTs to equatorial upwelling (Keller et al., 2015, GRL). Zhang et al., (2017, EPSL) used air-sea disequilibria of CO<sub>2</sub> and export production to infer deep-water upwelling in the eastern equatorial upwelling, which reached very different conclusions from the SST results. Can this modern study weigh in to help people disentangle what is "upwelling" and what is not from the sediment data?

We agree that it is important to try to build a relationship between export productivity (or marine productivity proxy records) and chlorophyll satellite data as this could help putting results from our study into the context of paleoclimate reconstruction. However, we believe it is currently not possible to identify a reasonable quantitative relationship between primary productivity and export productivity and outside the scope of our study. Our argument is as follow.

Previous studies have identified a general relationship between export productivity, marine productivity and sea surface temperature (Dunne et al. 2005; Laws et al. 2011). Sediment trap studies done in the two basins mentioned in this study generally show similar pattern (Thunell et al. 1994; Thunell 1998), with export production correlated positively with primary productivity (organic carbon and opal in Santa Barbara Basin; opal in Guaymas Basin). However, discontinuous sediment trap study done in San Lazaro Basin also suggested productivity driven by remineralization during El Nino, which resulted a low export productivity despite high productivity (Silverberg et al. 2004). This highlights the potential complexity in continental margin, where they can experience both eutrophic and oligotrophic conditions. In fact, Dunne et al. (2005) examined the proposed parameterization by synthesizing different sediment trap sites and showed that the positive relationship between primary productivity and export productivity works in a global sense but not small scales. Furthermore, many studies have highlighted other factors to consider when considering export production, for instance particle size, ballasting

effects, remineralization, eddy subduction, mixed layer pumping (see Lam and Marchal 2015, Boyd et al. 2019 and references therein). While it might be possible to infer particle size in a paleoclimate context based on measurements of different proxies (nannofossil assemblages, comparison between diatom productivity proxy and coccolithophore productivity proxy), other parameters cannot be constrained in proxy records. Therefore, we believe it is currently not possible to argue for a quantitative relationship between primary productivity and export productivity. Nevertheless, we now include a brief discussion on the relationship between primary productivity and export productivity at our sites.

There are a few other issues. For examples, I'm also confused like the other Referee about how Fig. 8-10, the pseudo-proxy time-series were generated

We agree that this was not very clear. We have remade the figures and added a detailed description including the algorithm and equations on how Figures 8-10 were generated.

#### References:

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