General comments

The authors have used a coupled physical biogeochemical model to general three dimensional, seasonal maps of POC flux and investigate the factors controlling export ratios and transfer efficiency of carbon to the deep sea. Model results are compared to simpler parameterizations and sediment trap POC fluxes.

Export ratio is modeled as a function of "ecosystem structure" (i.e. diatom relative abundance) and temperature while transfer efficiency is determined by mineral ballast, temperature and O2. Sinking POC is divided into three fractions: "free" POC, which decays exponentially with a length scale that depends on temperature and O2; "soft-mineral" associated POC, whose decay is controlled by mineral dissolution (opal, carbonate, clays), and "hard-mineral" associated POC, which does not decompose during transit through the water column.

The POC fluxes generated by the coupled model were fitted to a 3-parameter exponential model which uses net primary production (derived from satellite data and the coupled model), zo (export depth, generated by the coupled model) and 3 adjustable parameters (export ratio, labile fraction of POC, and remineralization length scale). They were also compared to the POC flux generated by the model of Lutz et al which estimate POC fluxes from satellite derived NPP and seasonality. The purpose of this exercise is to establish whether the coupled model-generated POC fluxes could be reasonably reproduced by simpler exponential models and whether the geographic distribution of the fitted parameters could provide insight into the controlling processes.

The elaborate parameterization of export ratios and POC decomposition length scales as functions of ecosystem structure and ballast minerals used in the coupled model generates POC fluxes that approximate reasonably well the fluxes measured by sediment traps. This suggest that both ecosystem structure and ballasting minerals, which were taken into account in the model, must play an important role in controlling POC flux in the ocean. However, the information derived from the simpler exponential parameterizations or from applying Lutz et al.'s model is less clear to me. We are told in the introduction that the reason for undertaking such exercise is to reduce the complexity of the coupled model parameterization to a smaller set of parameters (export ratio, labile fraction, and remineralization length scale) "that could be more easily studied and understood". Presumably, the geographic distribution of the parameter values would inform us on what could control them, and this could possibly suggest simpler approaches to predict POC fluxes. I think the paper needs a section more explicitly discussing the insight gained from this exercise.

The main conclusion is that because diatom relative abundances and ballasting fluxes are not entirely independent, it is difficult to distinguish between community structure and ballasting mineral as the primary control on transfer efficiency of POC. While I would agree with this general statement, I also believe that there are instances where the two can be distinguished (e.g. we could document the impact of the ballasting effect of dust by contrasting transfer efficiency in the North Atlantic subtropical gyre and the other main subtropical gyres). I think the discussion could also be more explicit about what "ecosystem effects" are and how they could affect POC flux.

Another important aspect of the study which I feel needs clarification is how the partitioning between the “soft” or “hard” part of the 3 minerals (opal, carbonate, dust), and the partitioning of POC between “free”, “soft mineral associated”, and “hard mineral associated” have been established

Specific comments

P21 line 15: what is the difference between NPP and POC production?

P24 line2: I find it difficult to distinguish the 8 different parameterizations of POC flux from the text alone. A table contrasting the different methods would be helpful

P26 line 7 + P28 line 29: I find it surprising the lambda your change with latitude because of temperature. Is there a significant latitudinal change in the temperature of the mesopelagic zone?

P28 line 4: are there sediment trap data from the Arabian Sea that would support >70% lithogenics in settling material?

P28 line 20: how is dust flux affecting labile POC fraction? (This goes back to my question regarding the partitioning of POC in the model between free, soft and hard mineral associated)

P35 line 5: Shouldn’t it be 11 PgCy-1? (Table 5)

P37 line 15: It is not clear to me how (and why) the lithogenic flux affects the POC remineralization length scale.