

Interactive comment on “Robotic observations of high wintertime carbon export in California coastal waters” by J. K. B. Bishop et al.

Anonymous Referee #1

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This paper presents results from robotic observations of carbon export flux from the Santa Cruz Basin located within the coastal upwelling waters off California. The authors report on high resolution POC and PIC fluxes derived from autonomous optical measurements, i.e. Carbon Flux Explorers (CFEs). This method captures particulate organic carbon fluxes below 140 m in the Santa Cruz Basin, CA, in 2 different years and 3 different seasons. One major finding is that the optical data reveal carbon fluxes 20 times higher than fluxes derived from surface tethered sediment traps. Obviously, the traps under sample larger marine snow aggregates of the size class larger than 1mm. Further, optically-derived fluxes were about one order of magnitude higher than previously measured multi-year sediment trap fluxes.

Carbon export from the photic zone is an important issue and only a few methods provide reliable flux data from the upper ocean (e.g. neutrally buoyant traps (NBST),

C1

other free-drifting systems, Martin et al., 1987). These data points determine carbon attenuation curves which may be variable both in space and time depending on the local biochemical conditions and ecology. Additionally, this export sets the conditions for deep ocean carbon flux classically measured with moored sediment traps.

The ms is well and clearly written and fits with no doubt into the concept of BG. I have some major and minor comments/suggestions outlined below.

Following the abstract and introduction, the methods were described in great detail. Sometimes I feel that this is more a methodological manuscript. This can be seen in the high number of figures describing the methods. Even in the result and discussion sections, methodological aspects can be found (e.g. results: chapter 3.3., third paragraph, chapter 3.4.). I wonder whether and how the methods described here are different from the ones presented in earlier papers, e.g. in Bishop et al., 2004 ('Robotic observations.). This should be clarified and then, the method sections could be shortened and the focus concentrated on the gathered data. If the methods differ, the changes/improvements could be briefly outlined. Some figures could also be moved to the appendix.

My major concern, however, is the comparison between optically- and trap-derived (surface tethered and moored traps) fluxes. Both approaches are fundamentally different and comparisons are limited by seasonal, interannual and regional variability. It would be helpful to have more information on the locations of the different types of sediment traps used for comparison (e.g. in Fig. 1) and the exact seasons/years and the water depths. In chapter 4.1. the CFE fluxes from the Santa Cruz Basin were compared to fluxes from the nearby Santa Barbara and San Pedro Basins which were derived from different water depths and different sediment trap types. Flux data from Martin et al. (1987) were captured from more open ocean sites in the far north of the Pacific in different years rather than from a more local basin. To facilitate reading and to follow the presented argumentation and evaluate this comparison more critically, the authors should show a table with optical and sediment trap fluxes but with detailed infor-

C2

mation on locations, seasons, years, water depths, surface or bottom-tethered arrays with traps, type of traps and openings.

Further, the authors cannot explain the large differences (10-20 times) of fluxes in a satisfactory way. It is hard to believe that the CFE's optical sedimentation recorded (OSR) with 1 cm opening was able to better sample large marine snow aggregates of several mm size (which are rather rare in the water column) than a cylindrical tube of about a decimeter or larger in size of a free-drifting (surface tethered) sediment trap. I would expect this to be the other way round. It is hard to believe that the baffles of sedimentation tubes are so small to destroy fragile marine snow aggregates of a few mm in size (page 11, uppermost chapter). By the way, the opening of the tube of the OSR (1 cm) is not larger than the cm-sized trap baffle openings (page 11 lines 6-9).

Sediment traps have their limitations as well, depending for instance on the type of array (surface vs bottom tethered). In particular, bottom-fixed moorings with shallow water sediment traps seem to be critical to record fluxes in the upper few hundred meters of the water column. Shallow traps may not provide an accurate measure of particle fluxes and differ by a factor of 3-10 (Buesseler 1991). Part of the discrepancies discussed here may be attributed to these uncertainties in trap-derived fluxes (e.g. page 9, chapter 4.1. of discussion). Particle fluxes from sediment traps (NBST, surface tethered, moored) on the other hand, measure carbon fluxes more directly and apply less assumptions than the optical methods. There are less than a factor of two differences of fluxes between NBST and surface tethered traps as the authors mention at the end of page 10.

Summarizing this, I suggest to be more careful with this kind of comparison and the conclusions. The problems associated with this comparison of fluxes (optical vs traps) should be clearly mentioned in the discussion.

Minor issues

- page 1 , line 28: ...by grazers or settle down as larger marine snow particles.

C3

- The optical methods to estimate carbon fluxes which are described here need several assumptions, e.g. conversion factors (chapter 2.3.). What are the errors of the individual methods and the potential cumulative errors? Is there any estimation/quantification? Something written in earlier papers?
- page 5, chapter 2.2.4. Do the authors only hypothesize that attenuation is the best proxy for POC? What is the basis for this assumption, please clarify
- page 8, chapter 3.3., sometimes hard to read due to many abbreviations
- Fig. 1, show surroundings of the Santa Cruz Basin to provide more info on the general setting of the study site and the other sites used for comparison

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C4