Biogeosciences Discuss., 11, C8009–C8012, 2015
www.biogeosciences-discuss.net/11/C8009/2015/

Biogeosciences Discussions

BGD

11, C8009–C8012, 2015

Interactive Comment

Interactive comment on "Export fluxes in a naturally fertilized area of the Southern Ocean, the Kerguelen Plateau: seasonal dynamic reveals long lags and strong attenuation of particulate organic carbon flux (Part 1)" *by* M. Rembauville et al.

Anonymous Referee #1

Received and published: 12 January 2015

The authors present time-series data from a bottom-moored sediment trap at ∼300m on the Kerguelen Plateau, deployed in October 2011 during KEOPS2 just prior to the spring bloom, and recovered a year later in September 2012. They find very low annually-integrated POC flux at 300 m using their sediment traps (0.1 mol C/m2/year) compared to the annually-integrated POC flux at 200 m (5.1 mol C/m2/year), which was estimated by Blain et al. 2007 using a seasonal budget of carbon. This extremely high level of attenuation of annually-integrated POC flux (98% loss of POC flux in only 100

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

m from 200 m to 300 m) was mirrored in comparisons of short-term flux estimates at 200 m (∼2-5.5 mmol C/m2/d by UVP, 234Th, or surface-tethered sediment traps) and 300 m (0.15 mmol C/m2/d in their sediment trap) during the second visit of KEOPS2 (16 November 2011). These attenuation rates are equivalent to a power law exponent of 7-11.3 (as calculated by the authors, depending on which POC flux estimate is used at 200 m). Note that previously reported ranges in the POC flux power law exponent have ranged from 0.4-1.7 (Martin's canonical value is 0.87), so the exponents reported in this manuscript are well beyond the range of what has been previously observed, and therefore raise some alarm bells. The main reason to worry is that the POC flux at 300 m is from bottom-moored sediment traps. Conical bottom-moored sediment traps have been known for some time to have low collection efficiency (40%) in the lower mesopelagic zone (500-700m) (Yu et al., 2001). More recently, (Buesseler et al., 2010) have shown that conical bottom-moored sediment traps at 170 m in the West Antarctic Peninsula undercollected POC flux by 30x compared to estimates from 234Th or surface-drifting traps deployed concurrently! The PPS3 trap design used here has a long cylindrical shape before funneling into a conical part, and is thought to be better than traditional conical traps. However, even though the authors carefully analyze their current meter and tilt angle data from the mooring and show small mooring line angle deviations and low current speeds, and the trap design is thought to be less susceptible to hydrodynamic biases, it has been suggested that there could be consumption of detrital particles by zooplankton feeding along the walls of a conical trap (Buesseler et al., 2010), and this could occur even if the conical part were at the end of a long cylinder, as for the PPS3 trap.

Even if the situation on the Kerguelen Plateau with the bottom-moored PPS2 trap is not as extreme as the West Antarctic Peninsula study, there is no evidence for such high attenuations from other methods used during both KEOPS1 and KEOPS2. During KEOPS1 (summer 2005), POC flux to depth determined from a gel-filled cylindrical surface-drifting trap array between 100-450 m had a power law exponent of about 1.2 (Figure 7 in Ebersbach and Trull, 2008); if only the extreme 200 m (62 mg C/m2/d) and

330 m (8 mg C/m2/d) POC flux values taken (Table 4 in Ebersbach and Trull, 2008), one could calculate a power law exponent of about 3.1 (assuming F=F0(z/z0)ˆ(-b), and z0=200m). During KEOPS2 (Nov 2011), the UVP-based POC flux estimates at 200 m (23.11 mg C/m2/d) and 350 m (3.5 mg C/m2/d) would lead to a power law exponent of about 2.5 (Table 3 in Jouandet et al., 2014). The fact that these other methods do not see the high attenuation further points to a methodological problem.

One final methodological issue: the authors employ a relatively harsh method to get rid of salts in the sinking particles: they resuspended and centrifuged the sinking particles 3x in milli-Q water. They make no mention of buffering the milli-Q, or attempting to make it isotonic to prevent lysing of any intact cells (cf. JGOFS protocol), and I wonder whether they may be losing POC in this processing step.

Given the potential methodological problems associated with the bottom-moored sediment trap and harsh rinsing of the particles with MQ-water, and the fact that the high attenuation is not observed by other POC flux methods, I am not convinced that the 300 m trap POC flux data are accurate. I suspect that they may be internally consistent (i.e., systematically low), which explains why they calculate a similar attenuation rate from annually-integrated vs. short-term POC fluxes. This may mean that the one month lag that they calculate between surface chlorophyll and POC flux to 300 m may be real, and this is a very interesting result. I also suspect that their overall hypothesis that there is high attenuation through the winter mixed layer in the waters above the Kerguelen Plateau may be rightâĂŤindeed, the b values I calculated above from the Ebersbach and Trull 2008 KEOPS1 gel trap (b=3.1 for the extreme case) and Jouandet et al. 2014 KEOPS2 UVP (b=2.5) DO in fact indicate fast attenuation, just not as fast as is suggested by the 300 m trap data presented here.

Because of the suspected major methodological problems I've outlined, I do not think that this paper can be published in its present form. There are interesting pieces of information that may still be salvageable, but it would have to be completely overhauled.

BGD

11, C8009–C8012, 2015

Buesseler, K.O., McDonnell, A.M.P., Schofield, O.M.E., Steinberg, D.K., Ducklow, H.W., 2010. High particle export over the continental shelf of the west Antarctic Peninsula. Geophysical Research Letters 37, L22606.

Ebersbach, F., Trull, T., 2008. Sinking particle properties from polyacrylamide gels during the KErguelen Ocean and Plateau compared Study (KEOPS): Zooplankton control of carbon export in an area of persistent natural iron inputs in the Southern Ocean. Limnology and Oceanography 53, 212-224.

Jouandet, M.P., Jackson, G.A., Carlotti, F., Picheral, M., Stemmann, L., Blain, S., 2014. Rapid formation of large aggregates during the spring bloom of Kerguelen Island: observations and model comparisons. Biogeosciences 11, 4393-4406.

Yu, E.F., Francois, R., Bacon, M.P., Honjo, S., Fleer, A.P., Manganini, S.J., van der Loeff, M.M.R., Ittekot, V., 2001. Trapping efficiency of bottom-tethered sediment traps estimated from the intercepted fluxes of Th-230 and Pa-231. Deep-Sea Research Part I-Oceanographic Research Papers 48, 865-889.

Interactive comment on Biogeosciences Discuss., 11, 17043, 2014.