Methods in Oceanography 8 (2014) 13–22

Contents lists available at ScienceDirect

Methods in Oceanography

journal homepage: www.elsevier.com/locate/mio

Full length article

A revised sediment trap splitting procedure for samples collected in the Antarctic sea

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ARTICLE INFO

Article history:
Received 22 April 2014
Accepted 31 May 2014

Keywords:
Sediment trap
Splitter
Swimmer
Antarctic region

ABSTRACT

In order to correctly understand the rates and mechanisms of biogeochemical cycling along the water column, special attention must be paid to data analysis techniques.

We propose a revised procedure combining precision and practicality to minimize sample handling errors that would affect the determination of both mass fluxes and the composition of material collected by sediment traps in the Antarctic region. The key points to take in account are: (i) the mesh size used for removing "large" particles or aggregates (from 150 micron to 1 mm); (ii) the absence of filters; and (iii) the use of a microscope to pick out "swimmers".

We also recommend: removal of all swimmers using a 650-micron mesh; analysis using a stereomicroscope; and quantitative subdividing using a peristaltic pump.

Abbreviations: MA, mooring A; MB, mooring B.

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http://dx.doi.org/10.1016/j.mio.2014.05.003
2211-1220/

1. Introduction

Particle fluxes are an important means of evaluating the transfer of organic carbon and biogenic particles (carbonate and opal) through the water column. The conversion of dissolved CO_2 to biological materials followed by particle export lies at the heart of the biological pump. Understanding the role of particle fluxes is therefore crucial for evaluating C exchange between the atmosphere and the ocean. Biogenic material accumulating on the sea floor is controlled by the balance between the export of particulate matter from surface waters, and losses – through dissolution or remineralization processes – occurring as material sinks through the water column (Dunbar et al., 1998; Langone et al., 2003). As a result, the particulate export is subjected to seasonal and inter-annual variability as well as to short-term climatic events (Buesseler et al., 2007).

Sediment traps are one of the most important tools used to determine this temporal variability in particle fluxes and to investigate the mechanisms regulating biogeochemical fluxes in the oceans.

Many studies have been carried out on the efficiency of sediment traps (Heussner et al., 1990; Buesseler et al., 2007). Cylindrical traps have been found best for long-term sampling in areas with low sediment fluxes like the Southern Ocean, while conical traps are considered more efficient on account of their large collection surface (0.5–1.0 m^2) (GOFS, 1989). In all cases, the sediment trap aperture is covered by a honeycomb-shape baffle consisting of many cells shaped like small cylindrical sediment traps.

The particle composition of the materials collected by sediment traps allows estimation of a variety of vertical fluxes (e.g. organic C, radiolarians, biogenic silica, calcium carbonate) through the water column as well as their seasonal variability. The export of POC produced by phytoplankton in the euphotic layer gives an estimation of the efficiency of the biological pump (Ducklow et al., 2001).

In order to study samples from sediment traps, a series of sample handling procedures are generally followed. Sediment trap samples have to be processed in order to measure the mass flux and split into quantities suitable for laboratory analyses. These procedures are subjected to different biases such as equipment accuracy and operator skill. While an instrumental error may be quantified, the operator error is difficult to measure. The main problem connected with sample treatment is obtaining incorrect mass flux values in excess or default. It is imperative therefore to establish a defined procedure in order to obtain comparable results. Great attention should be given to swimmer removal, sample preservation, the splitting instruments used, mesh size of any sieves, and the loss of material during handling.

There is no single, standardized handling procedure in use today. Different protocols are adopted depending on the composition and origin of material. Methods differ mainly in the way swimmers are removed (picking vs sieving). For example, a larger sieve mesh may be used for samples with large swimmers while the removal of smaller organisms will require a smaller mesh. Since different swimmer removal methods may affect biogenic flux values, it is important to adopt a suitable procedure for the area under investigation.

Another important step is the way the sample is handled once the swimmers are removed (wet splitting and bulk drying, Table 1). Different splitters modify measurement precision of the sample mass. Some authors (Conte et al., 2001; Honjo and Manganini, 1993; Miquel et al., 1994; Karl et al., 1996) use one or more sieves with different meshes (125, 500, 600, 1000, 1500 micron and 1 mm) before splitting to remove the larger swimmers or flocculated material. This procedure is followed on occasion by swimmer picking under a microscope (Miquel et al., 1994; Conte et al., 2001). In some cases, swimmer removal is by sieving alone (Honjo and Manganini, 1993; Karl et al., 1996). Others (Steinberg et al., 2001; Antia et al., 1999) remove swimmers only by picking under a microscope. Splitting and drying methods vary widely depending on the different analyses to be performed.

In addition, there are differences also in the splitting schemes (number of fractions) (Honjo and Manganini, 1993; Miquel et al., 1994; Karl et al., 1996; Antia et al., 1999; Steinberg et al., 2001; Conte et al., 2001).

In Table 1 we report these methods and, where available, the devices used.