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Composition of settling particles in the Southern Ocean and processes controlling seasonal variations of deep export production

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In order to understand the processes controlling the biological carbon pump and the efficiency of export production, we need time series in contrasted oceanic regions that fully describe seasonality. Due to strong logistic constraints, especially in the Southern Ocean, such data can only be obtained from above (satellite) or from below (sediment traps). In this study, settling particles of Subantarctic Zone (SAZ), Polar Front Zone (PFZ) and Antarctic Zone (AZ) along the CLIVAR-SR3 transect (140°E, south to Tasmania) have been collected in sediment traps deployed at 1000, 2000 and 3800m (SAZ), 800 and 1500 m (PFZ) and 200 and 3700 m (AZ). In addition to the measurements of Particulate Organic Carbon, Particulate Inorganic Carbon, Biogenic silica we have measured particulate composition of some trace and major elements (Al, Ca, Fe, Ti, Ba, Sr, Mn, U, light Rare Earth Elements) by ICP-MS.

When looking at correlations between elemental fluxes we show that there are generally different modes of variations. Surprisingly, those are not necessarily site-specific, i.e. different periods of SAZ and AZ traps can behave in a similar way, while they can be strongly decoupled at other periods. This is the case not only for biogenic elements (e.g. Ba, Ca, Sr) but also for elements usually representative of lithogenic particles (e.g., Al, Fe, Ti). More particularly Al vs. Fe fluxes appear to be strongly bimodal: Al fluxes are generally higher in northern traps while Fe fluxes are higher in AZ and PFZ traps; moreover single data points of both traps are distributed over two clear correlation lines, each one displaying little scattering. This suggests that the types of Fe- and/or Al-bearing particles vary more seasonally than spatially. In contrast, Ba fluxes, which are used in paleo-oceanography as a proxy of export production, are very similar to Ca fluxes, whatever the location. This suggests that carbonate productivity is more prone to deep carbon export compared to opal-dominated productivity probably as a result of higher mesopelagic C remineralisation efficiency reducing deep C export for the later.

We will further discuss the implications of these results for our understanding of the element biogeochemical cycles in the Southern Ocean and their likely impact on surface productivity, ballast effect and carbon cycle.